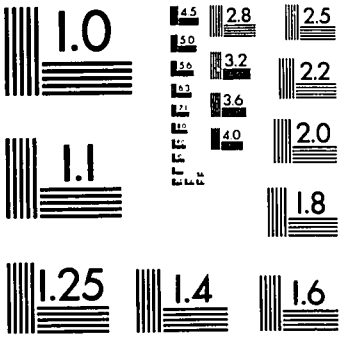

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Maynard, Charles C.

BLACKS IN THE CORONARY ARTERY SURGERY STUDY

University of Washington PH.D. 1986

Blacks in the Coronary Artery Surgery Study

by

CHARLES MAYNARD

A dissertation submitted in partial fulfillment
of the requirements for the degree of

Doctor of Philosophy

University of Washington

1986

Approved by Thomas W. Pullum
(Chairperson of Supervisory Committee)

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Lloyd Fisher

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to Offer Degree SOCIOLOGY

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Abstract

Blacks in the Coronary Artery Surgery Study

by Charles Maynard

Chairperson of the Supervisory Committee:

Professor Thomas Pullum
Department of Sociology

This thesis examines the experience of blacks in the Coronary Artery Surgery Study (CASS) with respect to (1) risk factors, symptoms, and coronary artery disease, (2) clinical decision making for coronary artery bypass graft surgery, and (3) therapeutic outcome as indicated by mortality, morbidity, and quality of life. Data from the CASS registry are used to examine these topics which are reviewed in the introductory chapter. In this thesis, race is defined as a social category which is related to the epidemiology and treatment of coronary disease as well as to outcome. The findings of this study are as follows. First, blacks in CASS had high levels of modifiable risk factors, yet low levels of angiographic coronary artery disease despite the presence of chest pain. Second, blacks and in particular black laborers were underserved with respect to coronary bypass surgery; the black-white difference in surgery rates persisted even when statistical controls for the predictors of

surgery were institituted. Third, blacks had higher mortality, morbidity, and poorer quality of life than did their white counterparts. However, differences in survival for black and white surgical patients were not statistically significant.

Alternative explanations for these findings are evaluated, although the absence of relevant data makes this a speculative venture. The findings of this study raise several important questions. First who were these blacks in CASS, and how were they selected for angiography? Second, to what groups of blacks beyond those in CASS are these findings applicable? Third, what is the nature of coronary artery disease in blacks, and fourth, what is the place of hypertension? Fifth, could blacks, who were surgical candidates yet did not have bypass surgery, have lived longer and better lives if they had had the operation? Finally, the many questions left unanswered by this study point to the need for the collection of socioeconomic data in future clinical trials and data registries. Also, multidimensional concepts of socioeconomic status and the input of social scientists are required.

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Acknowledgments

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Chapter 1
Sociological and Epidemiological Perspectives

Heart disease is the leading cause of death in the United States today; despite a recent secular decline in mortality due to heart disease, it still accounts for approximately one-third of all deaths in the United States (1). In addition, heart disease is extremely costly to individuals and the greater society. One group of experts estimates that heart disease cost the nation $60 billion in the year 1977, and will cost $366 billion by the year 2000 (2). The social and economic burden of heart disease is reflected in measures of medical care utilization and functional impairment. Heart disease, included under the title of diseases of the circulatory system and compared with 15 other diseases, ranked either first or second with respect to person years of life lost, total economic costs, hospital days, physician office visits, and disability or limitations in major activity during the year (3).

Coronary Artery Disease: Diagnosis and Treatment- This dissertation is concerned with one type of heart disease, namely coronary artery disease which results from the buildup of atherosclerotic plaque in the

arteries which supply blood to the heart. These atherosclerotic lesions restrict or in some cases totally obstruct the flow of blood to the heart muscle. The manifestations of this disease process include myocardial infarction, angina pectoris, unstable angina pectoris, and in some cases sudden death. Myocardial infarction or heart attack refers to the the death of heart muscle which results from the lack of oxygen rich blood, whereas angina pectoris or chest pain is a consequence of reduced levels of oxygen which reach the myocardium or heart muscle. Typically, angina pectoris is related to levels of exertion and is relieved by rest. On the other hand, unstable angina pectoris has no such distinct pattern, and with respect to severity is thought to be somewhere between stable angina and myocardial infarction. Finally, some individuals exhibit no manifestations of coronary artery disease despite the presence of lesions in the coronary arteries. In some instances, the first symptom of coronary disease for these asymptomatic individuals is sudden death.

In most cases, the clues to diagnosis of coronary disease are provided by the primary manifestations of the disease, angina pectoris or myocardial infarction. The diagnosis of suspected coronary disease is confirmed by a series of procedures including physical examination,

exercise stress testing, echocardiography, myocardial imaging, and coronary angiography which involves coronary arteriography and left ventriculography. Although noninvasive procedures such as exercise stress testing and myocardial imaging play an important role in the evaluation of patients with coronary disease, there is little doubt that cardiac catheterization is the "gold standard (4)." Cardiac catheterization is an invasive procedure which consists of the infusion of a radiopaque dye through a coronary catheter into the coronary arteries and the left ventricle. Coronary arteriography is employed to study the presence of lesions in the coronary arteries, and left ventriculography is utilized to evaluate the motion of the left ventricle, the major pumping chamber of the heart. The procedure requires the presence of a physician trained in the techniques of cardiac catheterization, as well as that of several technicians. The procedure is performed in a special laboratory, and because of special technology and personnel requirements, its total cost is considerable. Cardiac catheterization yields essential data which are the bases for critical diagnostic and treatment decisions.

There are essentially two major strategies for the treatment of coronary artery disease. Medical therapy, which has existed for some time, includes the use of drugs to control chest pain Three general classes of drugs, nitrates, beta blockers, and calcium channel blockers, are commonly employed. The drugs have different actions, but the goal of therapy is to keep the patient angina free or to reduce the frequency of angina attacks (5) In addition, these therapies may reduce the incidence of myocardial infarction and death (5). Another aspect of medical therapy has to do with the modification of risk factors which are thought to be associated with coronary disease. The cessation of cigarette smoking, control of hypertension, reduction of serum cholesterol levels, appropriate levels of physical exercise, and elimination of undue stress are important goals of medical therapy. In addition a more recent therapy, balloon angioplasty or percutaneous transluminal coronary angioplasty, has been used to reduce blockages in the coronary arteries. Also, thrombolytic or clot dissolving agents such as streptokinase have been used in treating patients with acute myocardial infarction. Balloon angioplasty and thrombolysis are important therapies of the 1980s.

The second strategy for the treatment of coronary disease is coronary artery bypass graft surgery. Unlike medical therapy, bypass surgery has been a standard treatment for coronary disease only since the early 1970s (6). Many years were needed to develop the life support systems and surgical techniques for bypass surgery to become reality. The purpose of bypass surgery is to bypass occluded arteries by means of a saphenous vein graft, internal mammary artery, or other suitable conduit. The surgery does not change the disease process occurring within the coronary arteries. Rather it provides new, unobstructed channels through which blood can flow by grafting a suitable saphenous vein from the aorta to unobstructed portions of the coronary arteries distal to the lesions. In short, bypass surgery is a palliative procedure since it attempts to relieve chest pain by detouring obstructions in the coronary arteries.

Medical and surgical therapies are not mutually exclusive in that prospective surgical candidates are maintained on medical therapy until the time of surgery. In fact, some patients continue to receive medical therapy after surgery, although a major goal of the procedure is to eliminate chest pain and the need for drugs required to control such pain. An important goal of surgical therapy as with medical therapy is the

reduction of modifiable risk factors. Therefore, surgery is not so much an alternative as it is an adjunct to medical therapy.

Nevertheless, it is important to realize that both physicians and patients are confronted with a choice of surgical therapy. Claims which make surgery appear to be an attractive therapy have been made. These claims are that surgery alleviates chest pain, makes one feel better, reduces the chance of heart attack, and even prolongs life. During the 1970s, these claims were made, despite the fact that scientific evidence, for the most part, did not exist to support them (7). Evidence from major clinical trials of the late 1970s and early 80s indicates that these claims may be true but only so for certain patient subgroups. However, the fact that at least 388,000 coronary bypass operations were done during the four and one-half years between September 1974 and May 1979 (8) indicates that many felt there was strong evidence in favor of surgical therapy. In 1981, before results from the Coronary Artery Surgery Study (9,10) and European Study Group (11) were released, approximately 159,000 coronary bypass surgeries were performed in the United States. Assuming that in 1981 the total cost of each surgery was $15,000, bypass surgery in the United States had become a two billion dollar a year business.

Clearly, coronary artery bypass surgery has become an important therapy from a number of perspectives (12).

Blacks and Coronary Artery Disease-In the United States today, coronary artery disease, primarily a condition of middle and old age, affects both sexes and all racial groups. It is the impact of coronary disease on black Americans that is of major interest in this thesis. Specifically, how is being black associated with the epidemiology and treatment of coronary disease as well as with mortality and quality of life? A related issue is whether blacks have a different experience with respect to these matters than do members of the dominant white society. The diagnosis and treatment of chronic diseases such as coronary disease involve numerous types of patients and professional groups as well as organizations that deliver complex health care technology (13). The effectiveness of treatment is often measured by mortality and quality of life, yet the outcome of treatment is determined by factors in addition to treatment per se. These attributes, which include education, income, access to a regular source of health care, certain health behaviors, and the existence of other diseases, are often associated with racial group membership. A key contention of this thesis is that race is an important determinant of treatment outcome as well

as a critical factor in the diagnosis and the choice of therapies used in treating coronary artery disease.

In this study, certain key assumptions are made about the concept of race. First, race as a biological concept is deemphasized; instead race is viewed as a social category. Second, it is important that the health status of blacks be understood within the context of these assumptions. Cooper (14) has outlined various reasons for rejecting race as a biological entity. He states that the assumption that race designates important genetic factors in a population is in most cases false. Of course genetic conditions such as sickle cell anemia are exceptions, but as Cooper indicates, variation in a single gene does not mean that groups that vary in that gene will vary in important ways for other health conditions. In short, a single trait such as skin color is simply not sufficient to explain human diversity.

Instead, the concept of race is better portrayed as social group membership, the result of social, economic, and cultural forces operating in history. Blacks in the United States are diverse in a social and economic sense, but they are also unified by institutional racism. Blackwell (15) defines the black community as a "diversified set of interrelated structures and

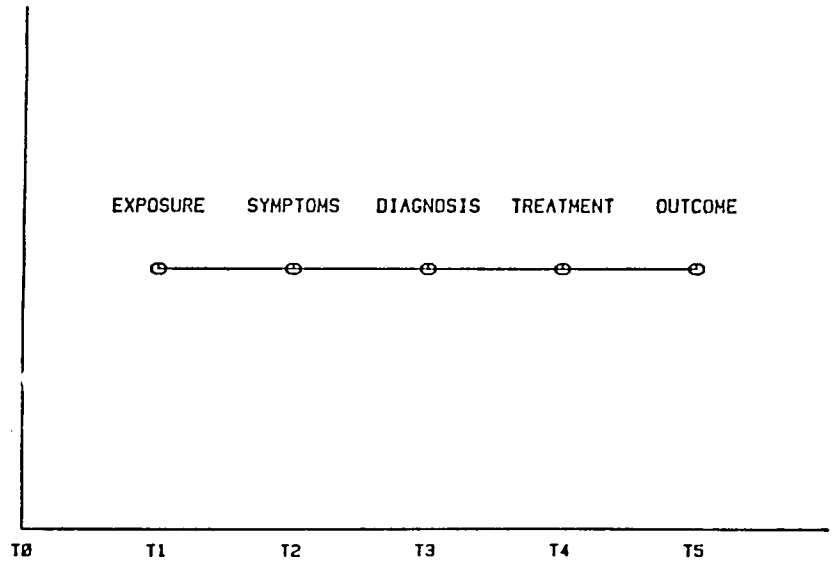
aggregates of people who are held together by forces of white oppression and racism." It is important to recognize as does Jackson (16) that blacks in the United States form a culturally distinct group separate from the dominant white society. Although there has been progress in the categorical treatment of blacks, there still exists in the 1980s considerable inequality between blacks and whites. This inequality exists on many levels including health and health care.

It is important that the health problems of blacks be examined within the perspective of the social concept of race. A major implication of this assumption is that racial differences in common diseases are social in origin. A possible exception to this proposition is hypertension to which some believe blacks are genetically predisposed (14). However, Cooper states that an environmental hypothesis to explain racial variation in hypertension is tenable. In the Hypertension Detection and Follow-up Program, blood pressure differences between black and white females disappeared with control for education and obesity (17). The same finding did not hold for males, although the white-black gap was reduced by controlling for education (18). In examining racial variation in coronary artery disease, it is important to take into account attributes such as occupation, income,

education, health behaviors such as cigarette smoking and diet, and the existence of other health problems such as hypertension. In examining treatment selection and outcome, as well as epidemiology, social factors, including race, are of paramount importance.

Decision Model of Coronary Artery Disease—A decision model of coronary artery disease is presented in figure 1. The model represents a time frame in which key decisions, both conscious and unconscious, are made by patients and physicians. The process takes place over a period of many years since there is a long period of time between exposure to factors thought to be related to coronary artery disease and the development of disease as indicated by symptoms. Key decision points in the model are (1) exposure to risk factors thought to be related to coronary artery disease, which in part consists of conscious or unconscious decisions to engage in health behaviors related to the disease, (2) the decision to seek medical care for diagnosis of symptoms suggestive of coronary artery disease, (3) the decision to undergo coronary artery bypass surgery for the treatment of coronary artery disease, (4) the decision to change health behaviors such as cigarette smoking and hypertension which are related to treatment outcome as indicated by mortality, myocardial infarction, and

Figure 1. Decision Model of Coronary Artery Disease.


EXPOSURE
SYMPTOMS
DIAGNOSIS
TREATMENT
OUTCOME
T0
T1
T2
T3
T4
T5

quality of life.

The time intervals between decision points are variable and are certainly not equal as implied by the figure. For example, the interval between T1 and T2, most likely a period of years, is much longer than the interval between diagnosis and treatment, a matter of days to months. This should be evident given that exposure to risk factors such as cigarette smoking and foods high in cholesterol occurs at a young age, and that coronary disease is a condition of middle and old age. Of course, genetic disposition to disease such as hypercholersterolemia can alter the age pattern of the disease such that it occurs in the late teens and early twenties. Moreover, the length of time between the same decision points varies with the patient. For example, the time between bypass surgery and outcome as measured by mortality is likely to be shorter for a patient with poor left ventricular function than for a patient with moderate or good function. Finally, it is apparent that measurement of the time between intervals can be precise for some intervals, but very imprecise for others. For example, the period of time between T1 and T2 can be estimated at best given the difficulty of determining when exposure began and when symptoms started. By contrast, the time between T4 and T5 can be determined

precisely, given appropriate medical records.

Risk Factors and Coronary Artery Disease-Time T1 represents the beginning of exposure to risk factors related to coronary artery disease. Most of these factors consist of health behaviors which are the result of conscious or unconscious decisions. The major risk factors for coronary artery disease as established by the Framingham Study are age, sex, cigarette smoking, hypertension, and elevated serum cholesterol (19). Other factors which have been implicated for coronary disease include physical inactivity, personality characterized by hard driving compulsive behavior and hostility, overweight, and alcohol consumption levels other than moderate (20). Presence of the three modifiable, major risk factors is related to certain health practices; diet is of particular importance in hypertension and elevated serum cholesterol in that proper diet can be used to control both conditions. In its early stages hypertension is a symptomless disease which can be detected by periodic blood pressure screening. Once identified the condition can be controlled by appropriate diet and/or medication. However, since the disease produces no symptoms, individuals must have their blood pressure checked, and if the disease is detected, they must be motivated to follow instructions concerning diet

and medication for control of the condition. Similarly, elevated cholesterol levels can be reduced by eliminating certain foods and by drugs. Cigarette smoking is an addictive behavior which must be eliminated or reduced if risk reduction is to occur.

On the the other hand, there exist immutable factors associated with coronary disease. Most notably, the incidence of coronary disease increases with age, is more likely to occur among males, and is more likely to occur in individuals whose blood relatives had the disease before the age of 55. Evidence on the role of race in coronary artery disease is sketchy and conflicting. Unfortunately, there exist few studies which have examined the role of race in the incidence of coronary disease. Gillum reports that there have been seven population based studies that have reported incidence or hospitalization rates for blacks (20). Most notable of these is the Evans County Study, the a community-based, cohort study of blacks in the United States. Data from Evans County indicated that black males had lower incidence rates of coronary disease than did white males, although rates were similar in women (21,22). The Health Insurance Plan of New York, which studied an insured population in the early 1960s, found that black males had a lower incidence of myocardial infarction than did white

males (23). A study of disease prevalence in Evans County reported that age adjusted rates of coronary disease defined as any one of angina pectoris, history of myocardial infarction, or electrocardiographic findings suggestive of infarction were three times higher in whites than in blacks (24). In summary, the number of studies which have examined the association of race and coronary disease are few, and those which have been done had small numbers of blacks. Consequently, conclusions regarding race and coronary disease incidence are difficult to make.

Aside from the question of race and coronary disease incidence, it is useful to consider the relationship between race and the major risk factors. It is important to recognize that the major risk factors were established in white populations and may not be relevant for black populations. Gillum and Grant (25) have carefully reviewed the literature which is concerned with coronary disease risk factors for blacks. The Evans County study (26) and the Charleston study (27) are prospective incidence studies of coronary disease risk factors in blacks. In the Evans County study, elevated blood pressure and elevated serum cholesterol were found to be risk factors for black men, but not for black women. Cigarette smoking was also discovered to be a risk factor

for black males as was being overweight, but results for black women were not reported. Information for other risk factors such as diabetes mellitus, type A or coronary prone behavior, and socioeconomic status were not reported in the Evans County study. Since all black men in Evans County, Georgia, were classified as farmers, sharecroppers, or laborers in 1960-1962, it was not possible to assess physical activity as a risk factor. In the Charleston study, an inverse relationhip between socioeconomic status and coronary disease was noted for black men, although the numbers were small.

The Second National Health and Nutrition Examination Survey examined the prevalence of major risk factors in black and white populations (28). Both black males and females had higher prevalence of elevated blood pressure than did their white counterparts, whereas a higher percentage of black males were current smokers. However, both white females and males were heavier smokers than black females and males. Differences in total serum cholesterol were not apparent. Gillum and Grant (25) conclude that several of the established coronary disease risk factors are more prevalent in black populations; they include hypertension, diabetes mellitus, electrocardiographic abnormalities, overweight in women, and low socioeconomic status. Other factors which show

no racial difference in prevalence are elevated total serum cholesterol, cigarette smoking, and overweight in men.

The Decision to Seek Medical Care-Many years after exposure to risk factors and disease development, symptoms of coronary disease become evident to the individual. The major symptom of coronary artery disease is chest pain on exertion. As mentioned earlier, other symptoms such as myocardial infarction and atypical chest pain occur, and in some cases, individuals are asymptomatic. However, chest pain that is related to exertion and is relieved by rest is the classic symptom of coronary disease. This is the symptom which most often alerts individuals to seek medical diagnosis and treatment.

Much has been written on the subject of how individuals decide to seek medical attention for a perceived illness. Becker and Maiman (29) have reviewed the extensive literature on models of health related behavior, including preventive, illness, and sick role behaviors, and McKinlay (30) has identified economic, sociodemographic, geographic, social psychological, sociocultural, and organizational approaches to the question of utilization of health services. Of major

interest is how it is that individuals with a perceived illness such as coronary disease decide to seek medical attention. Different perspectives on this health related behavior will be examined.

An important sociological perspective on individuals' decisions concerning the utilization of health services has been presented by Edward Suchman (31, 32, 33). Suchman was concerned with social patterns of illness behavior that accompany the search, discovery, and expedition of medical care. In addition he discussed the relationship of social structure and medical orientation to individual variations in response to illness and medical care. Suchman proposed a sequence of medical events which included five stages: (1) symptom experience, (2) assumption of the sick role, (3) medical care contact, (4) dependent patient role, and (5) recovery or rehabilitation. Furthermore, Suchman asserted that health behavior during these five stages reflected an individual's social group affiliation and health or medical orientation.

Social group membership was characterized on the levels of community, family, and friendship, and was further described by the degree of social organization on each level, which is defined as the level of ingroup

attraction and exgroup exclusion. The combination of these two concepts resulted in three dimensions of social group membership; ethnic exclusivity on the community level, friendship solidarity on the social level, and orientation to family tradition and authority on the family level. These three dimensions were then combined to form an index of cosmopolitan parochial social structure such that parochialism represented high ethnic exclusivity, high friendship solidarity, and high family orientation.

Suchman then identified a continuum of health orientation ranging from scientific to popular such that the scientific end represented an objective, professional, impersonal approach, whereas the popular end was defined as subjective, lay, and personal. The orientation was based on "knowldege about disease," "skepticism of medical care," and "dependency in illness," with the popular orientation defined as minimal knowledge about disease, high skepticism of medical care, and high dependency in illness. Suchman hypothesized that health orientation and social group membership affected behavior through the five stages of the illness process. For example, an individual with parochial group membership and popular health orientation would most likely exhibit delay and underestimate the seriousness of

symptoms in the first stage. Most likely, the same individual would delay in seeking medical care and would be skeptical of diagnosis during the medical care contact phase.

Becker and Maiman (29) report that Suchman's hypotheses have been tested with varying degrees of success, and that the relationship between health orientation and social structure is not always consistent. The authors conclude that attention needs to be given to subcultural beliefs and practices of the group independent of group structure. An important example is the Mormon group which exhibits a high family orientation, but a high scientific orientation to health.

In contrast to Suchman's perspective, which places heavy emphasis on contextual variables, the Health Belief Model emphasizes individual or personality variables in explaining health behavior. As conceived by Rosenstock (34), the Health Belief Model posits that generally individuals will not seek preventive care or health screening unless three conditions are satisfied. First, the individual has to be ready to take action regarding the perceived condition. In order to do so, one has to possess minimal levels of relevant health knowledge and motivation. These levels are determined by the

individual's perceived susceptibilility to the condition and his or her evaluation of the seriousness of the condition. Second, for the given individual, the benefits of taking action in terms of reducing susceptibility and/or threat have to exceed the perceived financial, physical, and other costs associated with taking action. Finally, a "cue to action" coming from internal (eg. symptoms) or external (media campaign or social interaction) sources is required to trigger the appropriate behavior.

Kasl and Cobb (35) have presented a modification of the Health Belief Model to take into account the presence of symptoms. As with the basic model, it was hypothesized that the readiness to take action is dependent upon perceptions of susceptibility and threat as well as evaluations of the costs and benefits of taking the proposed action. However, the pain and discomfort associated with symptoms are seen as influencing one's perception of threat as well as the actual behavior itself. Other variables such as social characteristics, pain tolerance, and coping mechanisms are seen as having indirect effects on health behavior. Becker and Maiman (29) report there is considerable support for the Health Belief Model's ability to explain health behaviors such as undertaking preventive care,

seeking diagnoses, and following treatment. As such the model emphasizes the role of the individual in determining health behaviors, whereas in Suchman's sociocultural model the group is paramount.

A framework which combines elements of the Suchman and Health Belief models is Andersen's behavioral model of health services utilization (36). Andersen hypothesized that a family's use of health services is dependent upon (1) the predisposition of the family to use services, (2) its ability to procure those services, and (3) the need for such services.

Predisposing variables include demographic variables such as age, sex, and marital status; social structure variables such as education, occupation, and race or ethnicity; and health belief variables such as knowledge of health and attitudes about physicians. These constructs are seen as determinants of variation in inclination toward use and not as direct determinants of health care utilization. The second component refers to resources which enable the family to obtain health services. Enabling conditions include family resources (eg. income, wealth, health insurance, or other third party coverage including Medicaid and Medicare, and a regular source of care) as well as community resources

(eg. availability of health services and personnel). Finally when appropriate predisposing and enabling conditions are present, Andersen asserts that variation in the perception of illness and the manner of response to illness will determine the use of health services. Perceived need is both subjective as indicated by sick days, symptoms, and self reports of general health and clinical as measured by the likelihood that symptoms are indicative of a given illness. The manner of response to illness is defined by whether the individual consulted a physician for evaluation of symptoms.

Thus for Andersen, the amount of health services used by a family is dependent upon its predisposing and enabling characteristics as well as its perceived need for those services. Review of the relative contributions of these components showed family size to be the only predisposing variable which was significant in explaining variation in health services utilization. While family size explained 15% of the variation, enabling conditions such as health insurance and a regular source of care explained only 6% of the variation. The most important set of variables was perceived need which accounted for 20% of the variation in health services utilization. This systems approach to health services utilization is important from a number of perspectives. First, it

provides an overall picture of the health care delivery process, and how it works for different groups of individuals. Second, from a policy perspective it identifies variables that can be manipulated to provide access to health care for those who need it. In a recent publication the question of access has been discussed by Andersen and colleagues (37) who analyze data from the 1982 National Survey of Access to Medical Care.

This review of models of health behavior suggests the question of whether blacks and whites differ with respect to health behaviors. For example, do blacks and whites differ in the way they define symptoms, and do they differ in the ways in which they seek care. Jackson (16) has extensively reviewed the health characteristics of urban black Americans and concludes that not much is known about how blacks define symptoms. Jackson hypothesizes that racial differences in symptoms definition may be best explained by social class. For example, more educated blacks and whites are more likely to take a scientific orientation to symptoms, whereas less educated individuals are more likely to assume a popular orientation. Jackson has presented evidence that blacks are more likely to delay in seeking diagnosis and treatment for cancer and heart disease. She states that it is simplistic to conclude that racial discrimination

alone is responsible for this delay; instead, the effect of subcultural factors unrelated to racial discrimination must be considered. These factors possibly include elements of social group membership and health orientation as defined by Suchman. Consequently, blacks and whites may differ with respect to health behaviors, but it is important to consider the effects of other predisposing and enabling conditions in considering these differences.

Clinical Decision Making-Once the individual has sought medical attention for symptoms, key diagnosis and treatment decisions must be made by physicians, nurses, and other medical personnel as well as patients. Although there is a considerable body of literature concerned with identifying optimal therapy for coronary disease (38,39,40), there exists scant information on the question of how real life medical decisions are made. Clinical decision making is difficult to analyze for a variety of reasons. First, it is usually quick; second, it incorporates a considerable amount of data; third, its style differs according to physicians and clinical problems; and finally, it is mostly unconscious (41). Moreover, there are many factors which are likely to influence the decision making process. These factors include patient characteristics (medical, social,

economic, and psychological), physician attributes, (eg. experience, specialization), characteristics of the organizations in which health care takes place (eg. type of hospital, bed size, number of surgeons), and community characteristics (eg. geographic location, urban or rural).

Elstein and colleagues (42) in an important article have described approaches to identifying the determinants of clinical judgements in situations where competent physicians differ in their diagnostic and treatment recommendations. The authors identify three theoretical frameworks and three methods of data collection for studying clinical decision making, and discuss their advantages and disadvantages. The information processing approach is combined with ethnography and involves direct observation of physicians and patients as well as review of medical records. Bosk (43) has used this approach in analyzing how surgeons manage their mistakes, and Katz (44) has employed a similar strategy in identifying non medical factors in decision making by surgeons. Second, social judgement, theory, which is rooted in cognitive psychology, examines the reasoning process employed by physicians in decision making. This approach often employs the method of simulated or structured cases as a means of data collection. Finally, decision analysis is

a third approach to studying clinical decision making. This approach utilizes Bayesian probability theory and utility analysis to identify optimal therapies for a variety of medical problems. Decision analysis is concerned with how decisions should be made and not how they are made.

Eisenberg (41), a physician, has examined sociological influences on decision making by clinicians. He indicates there is considerable evidence that sociological factors play an important role in clinical decision making, but he also asserts that few studies are of sufficient methodolgical quality to stand on their own. He criticizes these studies for failing to control for case mix or severity of disease, for failing to identify confounding variables, and for using simulated rather than actual clinical cases. Furthermore, there is a need to understand how physicians actually behave, rather than describing how they should behave. Eisenberg (41) reviews a variety of studies which examine patient characteristics including social class, income, and ethnic background as well as physician and professional characteristics, and the doctor patient relationship. He concludes that more methodologically sound studies are required if clinical decision making is to be better understood.

There have been few studies which examine clinical decision making for coronary artery bypass surgery. Aside from decision analytic approaches (38,39), very little has be done in this area. Alderman and colleagues (45) from the Coronary Artery Surgery Study (CASS) exmained the clinical and angiographic determinants of the decision for bypass surgery. An important finding of this study was that the institution where diagnosis and treatment took place was an important determinant of surgical rates. Maynard and colleagues (46) further examined the role of institution and concluded that governmental and hospital policies influence surgery rates. The authors also indicated that more institutions and more institutional data were required to better understand the influence of institutional characteristics on clinical decision making.

As with risk factors and health behaviors, it is reasonable to ask if there are racial differentials with respect to clinical decision making for various medical conditions. Eisenberg (41) reviewed several studies which examined racial factors in the clinical decision making process. The findings from these studies revealed that whites were more likely to be referred to specialists, and that despite similar insurance coverage, whites were more likely to be assigned private rooms than

were blacks. The clerks responsible for room assignments in this study were predominantly black. The Institute of Medicine study of racial factors in health care reported blacks' disproportionate use of clinics and emergency rooms and the expenditure of greater amounts of travel time to obtain care (47). The study also reported that after controlling for income and insurance coverage, two important determinants of the ability to obtain health care, race was still an important factor in explaining differences in the utilization of health services.

The Institute of Medicine study attempted to find answers to three questions concerning blacks and health care. First, do racial and ethnic factors affect people's ability to obtain needed care? Second, what is the extent of racial separation in health care? Third, do race and ethnicity affect the quality of medical received? The study concluded that there is considerable evidence that racial and ethnic factors continue to influence the patterns of health care in ways that are not in the interests of the groups affected. Second, racial and ethnic factors in health care utilization deserve much more serious and systematic attention than they have received to date from government statistical and funding agencies. The report also stated that the question of racial separation in health care and

associated questions regarding quality of care also require much more serious attention. Finally, the President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research has also stated that efforts must be made to insure equal access to health care for all Americans (48).

With respect to coronary bypass surgery rates, little is known about racial differentials. Data from the University of Alabama in Birmingham indicated that blacks were less likely to receive bypass surgery even after controlling for relevant clinical and angiographic variables (49). Reasons for the differential were difficult to pinpoint due to unavailability of information on income, education, occupation, and insurance coverage. Information from the National Center for Health Statistics also indicated low proportions of blacks undergoing coronary bypass surgery (8). Finally, Young (50), using a 1977 national patient sample, found the chance of surgery for nonwhites was one percent point less than for whites. However, he did report that self-pay and privately insured patients had a five percent greater chance of surgery than did publicly aided (Medicare or Medicaid) patients. As expected, the clinical condition of the patient as well as age and sex were important predictors of the chance of surgery as was

geographical region. These few studies demonstrate that race may be an important factor in affecting the chances of coronary bypass surgery for those who need it.

Mortality, Morbidity, and Quality of Life--At this point, it is relevant to discuss the results of decisions regarding risk factor exposure and diagnosis and treatment. The results of these decisions can be described in terms of mortality, morbidity, and quality of life. Not only do diagnostic and treatment decisions affect outcome, but decisions to change cigarette smoking and dietary habits are also presumed to influence outcome. Unfortunately, in some instances the achievement of a favorable outcome is beyond the control of patients and physicians; examples of such instances include sudden death and severe myocardial infarction as the first manifestations of coronary disease. In these situations initial myocardial damage can be so devastating that nothing can be done to insure an outcome other than death within a short time of the event. In this part of the discussion, the literature examining the relationships between outcome and risk factor exposure and outcome and therapy will be considered.

The contributions of changes in life style, improved standard of living, public health measures, and therapy to mortality decline have been considered in different historical settings. The question surfaced in accounting for the decline in mortality which led to the modern rise of population. McKeown (51) concluded that public health measures and an improved standard of living and not medical care were the most likely reasons for the decline in mortality which occurred in 18th and 19th century Europe.

Most recently the question has arisen with respect to the dramatic decline in mortality due to ischemic heart disease (52). A number of individuals have assessed the contributions of risk factor reduction and therapy to the decline of heart disease mortality in the United States population. Stern (53) concluded that only one half the decline in men and one third the decline in women could be accounted for by reduction in mean serum cholesterol levels, decline in the per capita consumption of cigarettes, and an increase in the detection and treatment of hypertension. Stallones (54) concluded that secular trends in risk factor prevalence were not always consistent with trends in coronary heart disease mortality. Innovations in medical therapy such as the coronary care unit, emergency medical services, and

coronary artery bypass surgery probably have had a minor impact on the decline in mortality due to heart disease, although more studies are needed to determine the impact of improved medical care on the nationwide decline in mortality from coronary heart disease (55). Reduced cigarette smoking, increased control of high blood pressure, and reduced serum cholesterol levels brought about by dietary changes are the most likely reasons for the decline in heart disease mortality, although it is difficult to assess their relative contributions (55).

Moving from the general population to subsets of indviduals who are at risk or who have coronary disease, investigators have used the clinical trial to assess the importance of certain interventions on mortality. The Multiple Risk Factor Intervention Trial (MRFIT) was conducted in part to determine if a special program aimed at changing risk factors would reduce mortality. The group concluded that mortality rates in the special care and usual care groups were the same, although both groups had sustained reductions in mortality (56). A number of studies from the randomized trial part of the Coronary Artery Surgery Study have considered the role of coronary bypass surgery in enhancing survival. Although in the total group of 780 patients survival was not improved, elective bypass surgery did prolong survival in those

with three vessel disease and impaired left ventricular function (9,57). Bypass surgery has been shown to prolong life in selected patient subsets, although these subsets comprise a small percentage of those with coronary disease.

While most research efforts have focused on mortality, some investigators have examined coronary disease morbidity, in particular myocardial infarction. Pell and Fayerweather (55) reported a decline in the incidence of myocardial infarction in male employees of the Du Pont Company as well as a decline in their mortality due to infarction. The authors state that their results are consistent with other studies of morbidity trends in coronary heart disease. They suggest that improved control of hypertension may have been a factor in the declining incidence of myocardial infarction in these individuals. However, the authors also indicate that the results of studies of survival after myocardial infarction are mixed, and that more studies which examine the effect of medical care on survival are needed. In particular, assessment of coronary care units and emergency medical services in preventing deaths from myocardial infarction is required. Data from the CASS randomized trial indicated that bypass surgery did not prevent infarction in patients who had

mild angina or were asymptomatic after infarction (58).

Finally, quality of life has also been an endpoint in evaluating therapeutic outcome. Since one of the results of risk factor reduction is better health, the relationship between risk reduction and quality of life has been assumed and not explicitly investigated. However, the relationship between dramatic interventions such as bypass surgery and quality of life has been given some attention, particularly since bypass surgery has improved survival in only certain groups of patients with coronary disease. Quality of life has been defined as "an individual's ability to perform a variety of social roles and to derive satisfaction from them (59)." Dimensions of life quality include (1) performance of social roles, (2) the physiologic state of the individual, (3) the emotional state of the individual, and (4) general satisfaction (60).

Data from the CASS randomized trial indicated that bypass surgery improved the quality of life as manifested by relief of chest pain, improvement in both subjective and objective measurements of functional status, and less reliance on drug therapy. However, the effect of bypass surgery on employment or recreational status was not significant (10). Numerous studies have reported the

disappointing result that bypass surgery was not an important predictor of work status in the years following diagnosis of coronary disease (61). Other factors, including social and economic ones and work status prior to diagnosis of coronary disease, have been identifed as important predictors of employment status in the years following diagnosis.

At this point in the discussion, it is reasonable to ask how these findings relate to blacks. First, the decline in mortality from coronary disease has benefited all Americans including blacks, although it is still the leading cause of death for blacks (52,20). Second, data from the National Health and Nutrition Examination Surveys indicate major changes in risk factors for black Americans (28). Reductions in cigarette smoking and elevated blood pressure appear to explain part of the decline in mortality for blacks (28). Moreover, data from MRFIT indicate that blacks of varying educational and socioeconomic backgrounds are just as likely as their white counterparts to make changes with respect to smoking and dietary habits and to adhere to hypertension control programs (62). Finally, how surgical therapy has influenced mortality and quality of life in black patients is not well known. Oberman and Cutter (49) reported that blacks and whites at the University of

Alabama in Birmingham had similar survival except that older black surgical patients had poorer survival than did their white counterparts. One would expect pain relief to improve life quality for blacks as it has for whites. Comparison of the impact of surgery on quality of life for blacks and whites is confounded by the fact that whites are generally better off socially and economically than blacks.

Study Questions and Organization—The decision model and attending literature raise many questions concerning blacks and coronary artery disease. As the review of research has indicated, the answers to many of these question remain unknown. The major goals of this thesis are first, to identify questions concerning specific aspects of the decision model of coronary disease, second, to provide answers to these questions, and third, where this is not possible, to suggest ways this information can be obtained. In specifying questions for study, three major topics will be considered; they include (1) risk factors and coronary artery disease, (2) clinical decision making for coronary artery disease, and (3) treatment outcome as indicated by mortality, morbidity, and quality of life.

Data from the Coronary Artery Surgery (63) registry will be the primary source of information for this thesis, although other readily available data sources will be used. CASS is a multi-center research program consisting of a randomized trial of medical and surgical treatment of coronary artery disease and a data registry of patients undergoing diagnostic evaluation including coronary angiography for suspected coronary disease. Enrollment of patients began in July 1974 and ended in May 1979; follow-up of patients ended in May 1983 except for randomized patients who are currently being followed. Information on the design of the randomized trial and data registry, including organizational status, study protocol, admission criteria, and informed consent is contained in the CASS baseline paper (63). The CASS data registry contains extensive demographic, clinical, angiographic, and follow-up information on all consecutive individuals, who giving informed consent for both angiography and data collection, underwent coronary angiography for suspected or proven coronary artery disease. Since the registry does not contain information on the decision to seek medical care, this topic will not be considered further.

As the review of relevant research indicated, there have been few studies which have examined the relationship between risk factors and coronary disease incidence in blacks. Although CASS was not designed as a prospective study of disease incidence, it does contain information on the prevalence of risk factors and the presence of coronary disease as documented by coronary angiography. With this in mind, the following questions are of interest. First, what is the distribution of coronary disease risk factors in blacks and whites enrolled in CASS? Second, how does the distribution of the three major risk factors (cigarette smoking, elevated blood pressure, and elevated serum cholesterol) in CASS blacks compare with the distribution of these same risk factors in other United States blacks? Is hypertension a particular problem for blacks enrolled in CASS? Third, do blacks and whites differ with respect to the symptoms which led them to seek medical care? Fourth, how do blacks and whites in CASS compare concerning various arteriographic indicators of coronary disease as well as indicators of left ventricular function? Fifth, is race in and of itself a predictor of coronary artery disease; that is, after controlling for relevant risk factors including age and sex, is race associated with the presence of significant lesions in the coronary arteries?

Finally, recognizing that blacks in CASS are a select group, what can be said about them in comparison to blacks in the U.S. population?

As indicated by its considerable numbers, coronary bypass surgery has become an important therapy for coronary disease. It is important to ask how important it has become for blacks. First, of blacks who have significant, documented atherosclerotic lesions and chest pain, what percentage actually have bypass surgery? Second, after controlling for the significant clinical and angiographic predictors of surgery, what is the black experience with respect to surgery? Are blacks with significant coronary disease and chest pain symptoms underserved in comparison to their white counterparts? In examining this issue, statistical adjustment for clinical and angiographic differences in blacks and whites must be made. However, if there is a racial differential in surgery rates despite adjustment, one must ask why is this so. Unfortunately, the CASS registry does not provide the information to answer this question. Consequently, possible reasons for a potential differential will be discussed, and relevant factors which influence the clinical decision making process will be identified for further study.

Finally, mortality, morbidity, and quality of life differences in blacks and whites in CASS will be explored. The CASS registry provides a minimum of four and one half years of follow-up information on mortality, occurrence of myocardial infarction, hospitalization, and quality of life indicators. First, age adjusted death rates by sex and race for the CASS population will be analyzed and compared to the general U.S. population. Particular attention will be given to analysis of the causes of death, and the identification of important covariates of mortality, including age, sex, modifiable risk factors, clinical and angiographic variables, and race itself. In particular the role of hypertension in black mortality will be assessed. It is important to ask if race is a significant predictor of mortality after statistical adjustment for relevant covariates. Also, if there is a racial differential in surgical rates, the implications for mortality will be considered. Morbidity and quality of life data are not as complete as are mortality data. However, these data will be analyzed, and racial differentials will be identified.

In summary, many questions regarding aspects of blacks and coronary disease have been raised by important sociological and epidemiological research. In addition important theoretical perspectives on health behaviors,

health services utilization, and clinical decision making have provided important foundations for this research. These perspectives and relevant research have given a focus for the topics considered in this dissertation. Moreover, an historical and cultural perspective which views blacks as diverse groups of individuals, yet united by their struggle with the dominant white society, also informs this thesis. Finally, a key assumption of this thesis is that social forces influence to a great extent the etiology, diagnosis, treatment, and outcome associated with disease.

The major topics of risk factors, clinical decision making, and outcome will be discussed in the three chapters to follow. Each chapter is an independent entity with sections on data and methods, results, and discussion of significant findings. Descriptions of data sources, important variables, and statistical methods are contained in each chapter. A concluding chapter which outlines significant findings and their relationship to previous research and theoretical perspectives presented in this chapter, is also provided. Finally, a review of suggestions for much needed research on aspects of the three major topics will be presented.

Chapter 2
Risk Factors and Coronary Artery Disease

As indicated in Chapter 1, the relationship between risk factors and coronary artery disease has been the subject of numerous investigations (64-69). The established, independent risk factors for coronary disease include cigarette smoking, hypertension, hypercholesterolemia, low high-density lipoprotein cholesterol (HDL), diabetes mellitus, electrocardiographic (ECG) abnormality, age, sex, and type A behavior pattern (68). Other less well established risk factors are obesity, physical inactivity, hypertriglyceridemia, hyperuricemia, psychosocial stress, and low socioeconomic status (68). It is important to realize that these risk factors have been established for white populations and may not be as relevant for black populations. It has been difficult to establish risk factors for blacks, because there have been so few prospective or even retrospective studies of disease incidence in blacks (26,27). Nevertheless, there is available considerable information on the prevalence of potential risk factors in black populations (20, 25, 26, 27, 28, 70, 71, 72, 73).

The purpose of this chapter is first to examine the distribution of risk factors in blacks and whites in the Coronary Artery Surgery Study patient population. A second task is to compare the distribution of the three major risk factors (elevated blood pressure, current smoking status and elevated serum cholesterol) in CASS with the distribution of the same risk factors in the second National Health and Nutrition Examination Survey (NHANES II). A final purpose is to examine in the CASS population the relationship between race and the presence and extent of coronary disease.

Data and Methods

Patient Populations-Data analyzed for this study come from two sources; the first is the CASS registry (63) which contains extensive demographic, clinical, and angiographic information on all consecutive individuals, who giving informed consent for both angiography and data collection, underwent coronary angiography for suspected or proven coronary disease . The second is the NHANES II, a program that collects morbidity and related health information through direct standardized examinations, histories, tests, and procedures used in clinical practice (28). CASS patients were enrolled between July 1974 and May 1979, whereas NHANES II participants were enrolled between February 1976 and February 1980. NHANES

II used a multistage probability sample, details of which have been published (74). The CASS enrolled patients from 14 clinics in the United States and one in Canada. This analysis includes 23,581 of the 24,959 patients who were enrolled in CASS. Patients with previous bypass surgery and/or those of races other than black or white were not included in the analysis.

Study Variables in CASS-Numerous demographic, clinical, and angiographic variables were recorded at baseline. Demographic variables collected included age, sex, race, employment status, and occupation. The observed race was recorded as "white," black," or "other," with the choice of category being left to the interviewer. Employment status referred to the amount of the time the patient was working at baseline; the categories included (1) full time, defined as 40 hours or more per week, (2) part time or less than 40 hours per week, (3) retired or stopped working when retirement age was reached, (4) quit or forced to quit prior to retirement age because of cardiac symptoms, with or without the recommendation of a physician, and (5) other or currently unemployed (by economic circumstances or choice), on temporary sick leave, or disabled secondary to non-cardiac illness.

Occupation was categorized as (1) manual, defined as work that includes routine performance of heavy manual labor and/or physical exertion, (2) clerical, defined as any form of employment not regularly associated with heavy manual labor that does not involve stressful decision making responsibility, (3) professional, defined as work that requires advanced training and involves mental rather than physical tasks, as well as a definite amount of stress and responsibility associated with decision making, (4) homemaker, defined as tasks associated with the management of a household, and (5) other, defined as any occupation that does not meet the above criteria.

Information concerning the three major risk factors was collected. Current smoking was defined as continued smoking within 3 months of entry into the study. Systolic and diastolic blood pressures were recorded on the initial physical examination at the time of study entry. Elevated blood pressure was defined as a systolic reading of 160 mmHg or greater and/or a diastolic reading of 95 or greater mmHg. For those receiving medications, blood pressure readings were taken while patients were on medications. These individuals on medication were defined as hypertensive as were those who had at anytime been treated for hypertension. Serum cholesterol was

obtained at the initial physical examination. Since the analysis of serum cholesterol was not a primary goal of the study, and was recorded only if done clinically, no attempt was made to control the laboratory analysis at cooperating clinics aside from the standards imposed by the Joint Commission on the Accreditation of Hospitals. Consequently, not all patients in CASS had serum cholesterol analyzed. For those who did have the analysis, elevated serum cholesterol was defined as a reading of 260 or more mg/dl in order to facilitate comparison with NHANES II cholesterol data.

Information on other risk factors was collected. This included early family history of coronary disease, defined as angina or myocardial infarction (MI) in parents, siblings, or aunts and uncles related by blood before the age of 55 years. History of diabetes, history of congestive heart failure, and history of hypertension were noted as was the presence of an enlarged left ventricle or abnormal contour on chest x-ray. Also the existence of a prior MI as reported by the patient and documented by medical record was noted. The Quetelet index of relative body weight (75) or the ratio of weight divided by the square of height was calculated. Finally, the level of daily recreation and/or physical activity during the three months prior to enrollment was assessed.

In addition to risk factor assessment, information related to clinical and angiographic indicators of coroanry artery disease was obtained. The presence of chest pain was noted; the likelihood that the chest pain was angina was evaluated as definitely not, probably not, definite, or probable (63). The limitation of activity due to chest pain was measured by the Canadian Cardiovascular Society classification (76), and the presence of unstable angina was recorded. The predominant symptom of the disease was reported as angina, congestive heart failure, asymptomatic, arrhythmia, or other, and the functional impairment due to congestive heart failure was evaluated.

Also several measures of the extent of disease and left ventricular function were obtained. The number of diseased vessels, a measure of the extent of coronary disease based on interpretation of the coronary arteriogram, was calculated (63). The left ventricular wall motion score, a measure of segmental left ventricular function based on interpretation of the left ventriculogram filmed in the right anterior oblique projection, was also determined (63). The score is comprised of individual assessments from 5 defined regions, and ranges from 5 (totally normal) to 30 (never observed-the whole heart aneurysmal). Finally, the

presence of a 50% or greater stenosis in the left main coronary artery was indicated as was the dominance of the coronary circulation.

Study variables in NHANES II—The details of variable definition have been reported (28). Race was defined as "white," "black," or "other," and category selection was made by the interviewer. A current cigarette smoker was defined as an individual who had smoked at least 100 cigarettes and was currently smoking. Both systolic and diastolic pressures were measured three different times, and the average of the three readings was recorded. The measurements were done by physicians with the first and third readings taken with the subject sitting and the second with the subject supine. The definition of elevated blood pressure was the same as that employed in CASS. In NHANES II as in CASS, patients who were taking antihypertensive medications had blood pressure readings taken while on those drugs. Finally, serum cholesterol values were recorded by a single laboratory. Elevated serum cholesterol was reported as 260 or more mg/dl.

Statistical Methods—Risk factors are reported in percentages and means by sex and race. The chi-square test was used to test for statistical differences for categorical variables, and the t test was used to test

for statistical differences for continuous variables. In comparing the prevalence of risk factors in CASS and NHANES II, rates were adjusted by age using the direct method of standardization.

Multivariate statistical methods were used to identify those risk factors which best predicted whether an individual had a 70% or greater stenosis in one or more of the three major coronary arteries. Stepwise linear discriminant analysis (77) was used to distinguish the diseased from the non-diseased group. In order to determine whether race was a significant, independent predictor of coronary disease, at the first level all risk factors but race were allowed to compete for entry. Then, once variables with the most predictive power were selected, at the second level, race was permitted to enter the model.

The principle of linear discriminant analysis is to select the combination of variables which most completely separates the two groups. The process is carried out in a stepwise manner so that the relative importance of each variable selected for the model is identified. The process stops when the remaining, unselected variables do not add statistically significant predictive power to model ($p>0.05$).

Results

Distribution of risk factors in CASS—The prevalence of risk factors in the CASS patient population is reported in table 1 by race and sex. With respect to demographic factors, the 573 blacks in CASS were younger and had a higher percentage of females than did their 22,781 white counterparts. The percentages of blacks and whites working full or part time were roughly the same, although a slightly lower percentage of blacks was retired, and a slightly higher percentage of blacks was forced to quit work because of coronary disease. The racial differences for occupation were much more apparent; two-thirds of black males in CASS were laborers, whereas only 40% of white males were employed in manual labor. Almost 30% of white males were employed in professional positions, whereas only 8.8% of black males were employed in such positions. The findings for females were also striking in that 26.7% of black females were employed as laborers, yet only 10.6% of white females were doing this kind of work. On a percentage basis, slightly more black females than white females were employed in professional positions, yet a much higher percentage of white females was listed as housewives than were black females.

Table 1
Risk Factors by Race and Sex in CASS

Risk Factor	Male		Female	
	Black (363)	White (17,377)	Black (210)	White (5631)
Fam Hx Angina, MI	30.0%	41.1% +	42.9%	51.2% +
Hx Hypertension	56.8%	30.6% +	65.7%	41.1% +
Elevated BP*	24.5%	16.1% +	20.0%	16.7%
Elevated Chol**	18.6%	23.2%	24.2%	27.7%
Current Smoker	49.7%	33.1% +	41.4%	31.5% ++
Smoking > 2 Packs/Day	14.8%	22.8% ++	3.8%	7.2%
Hx Diabetes	14.3%	9.6% +	20.5%	11.9% ++
Prior MI	50.4%	52.9%	33.3%	32.4%
Documented MI	38.2%	44.0% +++	22.4%	23.4%
Lv Abnormality on Chest X-ray	23.2%	18.1% +++	23.7%	16.8% +++
Hx CHF	12.1%	9.8%	14.3%	11.6% +++
Quetelet Index	2.73	2.62 +	2.81	2.52 +
Sedentary Rec Act	33.9%	32.5%	41.0%	43.6%
Age	49	53 +++	48	54+
Age > 59	14.9%	23.7% +++	10.0%	28.9% +
Employment Status				
Full or Part	64.3%	63.7%	67.6%	72.4% +++
Retired	11.6%	14.2%	5.7%	7.9%
Quit	16.8%	14.3% +	17.6%	11.5% +
Occupation				
Laborer	67.7%	40.4%	26.7%	10.6%
Professional	8.8%	29.2%	9.5%	7.2%
Clerical	17.7%	23.2%	24.8%	26.6%
Homemaker	.3%	.3%	32.9%	51.6%
Other	5.5%	7.0%	6.2%	4.0%

* Systolic blood pressure 160 mmHg or greater and/or diastolic blood pressure 95 mmHg or greater.

** Cholesterol 260 mg/dl or greater.

+ P<.0001
++ P<.001
+++P<.05

In looking at the three major risk factors of current cigarette smoking, elevated blood pressure, and elevated serum cholesterol, it is apparent from table 1 that higher percentages of both black males and females were current smokers and had elevated blood pressure. Almost 50% of black males were current smokers, whereas 30.6% of white males were current smokers ($p<.0001$). It was the case, however, that white males were heavier smokers in that 22.8% of them smoked more than two packs per day, whereas 14.8% of black males smoked more than two packs per day ($p=.0002$). The same general relationship was true for black females in that a greater percentage of them smoked at baseline ($p=.001$), yet a greater percentage of white females smoked more than two packs per day ($p=.06$). Racial differences with respect to elevated blood pressure were also apparent in that 24.5% of black males and 20.0% of black females were hypertensive, while 16.1% of white males and 16.0% of white females were found to be hypertensive. Only the difference between black and white males was statistically significant, however. On the other hand, racial differences with respect to serum cholesterol were not statistically significant. A somewhat higher percentage of white males had elevated cholesterol than did black males, and only a slightly higher percentage of

white females had elevated readings than did black females.

In addition to the three major risk factors, other risk factors were also investigated. From table 1, it is the case that a lower percentage of blacks reported an early family history of angina or MI. Very high percentages of both black males and females reported a history of hypertension (56.8% and 65.7%, respectively). The percentages of white males and females who reported a history of hypertension were much lower (30.6% and 41.1%, respectively). A higher prevalence of diabetes mellitus, a higher level of relative body weight, and a higher prevalence of congestive heart failure at baseline were also characteristics of blacks in CASS, although the latter difference applied only to black females. On the other hand, white males had a higher rate of prior documented MI (44.0% vs. 38.2%, p=.03) than did black males, yet there was no difference between rates for black and white females. A higher percentage of both black males and females had abnormal left ventricles on chest x-ray (p=.02, for both males and females). Finally, there appeared to be no signficant differences in the level of recreational activity for blacks and whites.

Comparison of CASS and NHANES II-In order to better understand the distribution of risk factors in blacks in CASS, the prevalence of the three major risk factors in blacks in NHANES II was also examined. Age adjusted rates of elevated blood pressure, current smoking, and elevated serum cholesterol were computed for blacks and whites, ages 25-74, in CASS. Age specific and age adjusted rates in NHANES II have been reported (28). The distributions of the CASS, NHANES II, and 1978 United States populations according to age, race, and sex are shown in table 2.

Age specific and age adjusted rates of elevated blood pressure, current smoking, and elevated serum cholesterol for blacks are reported in table 3. In comparing age adjusted rates for black males, it was apparent that the CASS and NHANES II populations were similar, although CASS blacks had a slightly higher rate of elevated blood pressure and a slightly lower rate of current smoking than did NHANES II black males. None of these differences was statistically significant, however. Elevated serum cholesterol rates were similar for both groups. For black females, the two populations were similar with respect to elevated blood pressure and elevated cholesterol, although CASS black females had a higher rate of current cigarette smoking than did NHANES

Table 2
CASS and NHANES II Populations by Age and Sex

	CASS (1974-1979)		NHANES II (1976-1980)		US(000) 1978	
	N	Pct.	N	Pct.	N	Pct.
All Patients	23,581					
Ages 25-74	23,398	99.2	10,450		114,280	
White Men						
<25	37					
25-34	534	3.1	901	20.9	13,864	29.0
35-44	2660	15.4	653	15.2	9,808	20.5
45-54	6438	37.4	617	14.3	9,865	20.6
55-64	6052	35.1	1086	25.2	8,642	18.1
65-74	1576	9.1	1045	24.3	5,576	11.7
>74	80					
	17,377		4302		47,757	
White Women						
<25	15					
25-34	119	2.1	1000	20.9	14,494	27.7
35-44	761	13.7	726	15.1	10,584	20.2
45-54	1977	35.6	647	13.5	10,369	19.8
55-64	1988	35.6	1176	24.5	9,601	18.3
65-74	725	13.0	1245	26.0	7,329	14.0
>74	46					
	5631		4794		52,378	
Black Men						
<25	4					
25-34	27	7.5	139	26.3	1,546	30.6
35-44	95	26.5	70	13.3	1,112	22.0
45-54	131	36.6	62	11.7	1,044	20.6
55-64	87	24.3	129	24.4	801	15.8
65-74	18	5.0	128	24.2	555	11.0
>74	1					
	363		528		5,059	
Black Women						
25-34	11	5.2	145	22.8	1,953	31.1
35-44	61	29.0	103	16.2	1,415	22.5
45-54	85	40.5	100	15.7	1,215	19.4
55-64	48	22.8	135	21.3	959	15.3
65-74	5	2.4	152	23.9	733	11.7
	210		635		6,275	

* All comparisons for CASS vs. NHANES II, P<.0001.
** All comparisons for CASS vs. 1978 U.S. population P<.0001.

Table 3
Age Specific Rates of Elevated Blood Pressure, Current Smoking and Elevated Cholesterol for Blacks in CASS and NHANES II

	Elevated Blood Pressure		Current Smoker		Elevated Cholesterol	
	CASS	NHANES II	CASS	NHANES II	CASS	NHANES II
Black Men						
25–34	25.9	11.7*	37.0	61.0*	13.6	9.3
35–44	17.9	22.3	59.0	50.0	15.3	23.6
45–54	25.9	23.0	53.4	52.1	17.4	25.3
55–64	26.4	39.2*	40.2	50.1	26.4	24.2
65–74	44.4	27.5	38.9	26.9	27.3	18.7
Age Adjst.	26.7	23.1	45.6	50.7	18.8	19.3
Black Women						
25–34	18.2	4.3*	54.6	35.6	16.7	6.0
35–44	13.1	17.6	49.2	40.7	13.5	13.3
45–54	24.7	37.3	45.9	34.8	22.4	25.0
55–64	18.8	36.4*	25.0	24.1	44.4	32.2
65–74	40.0	43.4	0.0	12.8	25.0	29.9
Age Adjst.	21.3	24.4	39.5	31.6*	23.2	19.0
White Men						
Age Adjst.	14.8	15.9	38.3	39.6	23.4	16.3
White Women						
Age Adjst.	13.9	11.1	38.8	33.3	23.9	19.5

* P<.05

II black females ($p=.04$).

It is possible to examine the racial differences in risk factor prevalence for the two populations by examining information presented in table 3. In both CASS and NHANES II, it was apparent that black males had considerably higher rates of hypertension ($p<.0001$ for both CASS and NHANES II), and current smoking than did white males ($p=.005$ for CASS and $p<.0001$ for NHANES II). With respect to elevated cholesterol, there were no statistically significant racial differences in the two populations. On the other hand, a different pattern emerged for blacks females. Like black males, black females in both CASS and NHANES II exhibited considerably higher rates of elevated blood pressure than did white females ($p<.0001$ for both populations). Yet, black and white females in both populations demonstrated similar levels of current smoking and elevated serum cholesterol. Racial differences with respect to the three risk factors for both sexes were consistent in both populations.

Finally, multiple risk factors were examined and are presented in table 4. In CASS, the percentages of white males and females with one or more of the three major risk factors were 60.0% and 60.9%, respectively. The percentage of black females with one or more risk factors

Table 4
Distribution of Risk Factors by Race and Sex
(Age Adjusted)

	None		One		Two or More	
	CASS	NHANES II	CASS	NHANES II	CASS	NHANES II
White Men	40.0%	42.5%	43.4%	44.5%	16.4%	13.0%
White Women	39.1%	47.1%	44.6%	42.9%	16.3%	10.0%
Black Men	31.6%	29.3%	48.5%	51.4%	19.8%	19.3%
Black Women	41.2%	41.3%	43.2%	43.7%	15.6%	14.9%

was 58.8%, yet the percentage of black males with one or more risk factors was 68.4%. In NHANES II, 52.9% of white females had one or more risk factors, whereas 57.5% of white males had one or more risk factors. For NHANES II blacks, 70.7% of the males had one or more risk factors and 58.7% of the females had one or more risk factors. Clearly, the distributions of multiple risk factors for blacks of both sexes in CASS and NHANES II were similar. Black white differences were evident for CASS males ($p=.009$) and for NHANES II males ($p<.0001$) and females ($p=.006$). Racial differences were not apparent for CASS females. White females in CASS were at considerably higher risk than were NHANES II white females in that 60.9% of those women in CASS had one or more risk factors, while only 52.9% of those in NHANES II had one or more risk factors.

Clinical and angiographic findings in CASS-Clinical and angiographic information concerning symptoms, limitation of activity, functional impairment, presence of coronary artery disease, and left ventricular dysfunction are presented in table 5. It was evident and expected that the presence of chest pain was the major reason why blacks and whites were studied angiographically. More specifically, angina was the predominant symptom in over 80% of both blacks and

Table 5
Clinical and Angiographic Findings in CASS
by Race and Sex

	Male			Female		
	Black	White	P	Black	White	P
Chest Pain	88.2%	86.1%	NS	93.8%	93.3%	NS
Angina as Primary Symptom	81.5%	82.2%	NS	88.1%	85.4%	NS
Prob or Def Angina	62.8%	76.1%	<.0001	46.7%	64.3%	<.0001
No Angina	37.2%	23.9%	<.0001	53.3%	35.7%	<.0001
Class I or II (mild or moderate)	22.6%	29.5%	.004	10.5%	19.6%	<.0001
Class III or IV (severe)	32.0%	38.8%	.008	29.1%	36.4%	.03
Unrelated to Exertion	8.3%	7.9%	NS	7.1%	8.3%	NS
No CHF	87.9%	90.2%	NS	85.7%	88.4%	NS
NYHA I or II	6.3%	4.8%	NS	4.8%	5.3%	NS
NYHA III or IV	5.8%	4.9%	NS	9.5%	5.3%	.06
Unstable Angina	27.8%	27.1%	NS	23.8%	25.6%	NS
Number Diseased Vessels			<.0001			<.003
Zero	47.0%	19.7%		67.3%	54.5%	
One	19.6%	22.0%		10.1%	17.0%	
Two	14.1%	25.5%		11.1%	13.9%	
Three	19.3%	32.8%		11.5%	14.6%	
LV Score			.007			.04
5	49.0%	40.6%		74.9%	67.9%	
6-11	31.2%	39.4%		17.7%	22.7%	
12-16	15.9%	15.6%		7.4%	7.1%	
>16	4.0%	4.4%		0.0%	2.4%	
LMCA > 50%	1.9%	8.6%	<.0001	1.9%	4.3%	NS
Dominance			.03			NS
Left	13.1%	9.7%		10.6%	8.3%	
Right and Balncd	86.9%	89.3%		89.4%	91.7%	

whites. However, only 62.8% of black males and 46.7% of black females had probable or definite angina, whereas 76.1% of white males and 64.3% of white females had probable or definite angina ($p<.0001$ for both males and females). Blacks and whites also differed with respect to the level of chest pain. A smaller percentage of black males had mild or moderate angina than did white males ($p=.004$), and the same trend was true for black females ($p<.0001$). A smaller percentage of blacks had severe Class III or IV angina than did whites ($p=.008$ for males, $p=.03$ for females), although a slightly higher percentage of black females had functional Class III or IV than did white females ($p=.06$). Finally, the presence of unstable angina was similar in all four groups.

Of considerable interest were the results of coronary arteriography also presented in table 5. Examination of the number of diseased vessels indicated that blacks of both sexes had considerably less disease than did their white counterparts ($p<.0001$ for males, $p=.003$ for females). In fact 47.0% of black males and 67.3% of black females had normal or minimally diseased coronary arteries, while only 19.7% of white males and 54.5% of white females had normal coronary arteries or minimal disease (zero vessel category). Three vessel disease was most prevalent in white males (32.8%), but

was equally distributed in black and white females (11.5% vs. 14.6%). It was also apparent that black males had a lower prevalence of left main disease than did white males; white males had over four times more left main disease than did black black males ($p<.0001$), and white females had over two times that of black females, although the difference was not statistically significant. A higher percentage of blacks had normal left ventricles than did whites ($p=.007$ for males, $p=.04$ for females), although racial differences for more severely impaired left ventricles were not apparent. Finally, blacks males were more likely to be left dominant than were white males ($p=.03$).

In summary, blacks in CASS had high levels of risk because of hypertension and cigarette smoking. Nevertheless, these levels of risk were similar to those exhibited by blacks in the population based NHANES II. Clinically, high percentages of black males and females presented with chest pain, but in a significant portion of cases the chest pain was determined not to be angina pectoris. Angiographically, a significant proportion of blacks had normal coronary arteries and normal left ventricular function. The typical black patient was a laborer who smoked, was hypertensive, and had chest pain, yet had no significant angiographic findings to support

the diagnosis of coronary artery disease.

Multivariate Analysis-In order to more fully examine the relationship between race and coronary disease, multivariate analysis was employed. The results of this analysis are reported in table 6; two types of F statistics are reported, the univariate F ratio and the F for when the variable entered the linear model. Using the risk factors listed in table 1 (history of prior MI and congestive heart failure were ommitted), linear discriminant analysis was used to identify the predictors of coronary disease which was defined as one or more diseased vessels. All variables with the exception of race were allowed to compete for entry with the result that male sex, increasing age, elevated cholesterol, current smoking, history of diabetes, family history of coronary disease, non-laborer occupation, sedentary recreational activity, lack of full or part time employment, and history of hypertension were associated with one or more diseased vessels. When all of these variables had entered the model, race was then allowed to enter. For the 17,726 individuals included in the multivariate analysis, being black was associated with absence of coronary disease. Race was still a significant predictor of coronary disease even after controlling for other important risk factors such as age,

Table 6
Results of Stepwise Linear Discriminant Analysis

Step	Variable	Univariate F Ratio	F Ratio at Point of Entry
0	----	----	----
1	Sex	2291.34	2291.34
2	Age	866.76	1158.66
3	Elevated Cholesterol	193.64	304.96
4.	Smoking Status	236.49	275.47
5.	Hx Diabetes	42.92	51.36
6.	Fam History	5.35	47.67
7.	Laborer	47.81	47.02
8.	Recreational Actity	4.41	27.81
9.	Full or Part Time Employment	94.10	18.59
10.	Hx Hypertension	3.05	10.49
11.	Race*	122.27	59.54

* Race entered at second level after all other variables were allowed to enter.

sex, elevated cholesterol, and current smoking. Due to the large sample size, all variables, including race, were highly statistically significant ($p<.0001$).

Multivariate analysis was also used to determine if the risk factors for whites were different from those for blacks. For the 17,361 whites in the analysis, the first six variables to enter the analysis in order of entry were sex, age, elevated cholesterol, current smoking, family history of coronary disease, and history of diabetes. For the 365 blacks, the five variables that entered in order of entry were age, sex, elevated cholesterol, current smoking, and history of diabetes. For both blacks and whites, a similar set of risk factors was associated with the presence of one or more diseased coronary arteries.

Discussion

These results from CASS indicate that both black males and black females studied by angiography have high levels of risk factors. In comparison to their white counterparts, black males had a higher prevalence of elevated blood pressure, were more likely to have been treated for hypertension and diabetes, and were more likely to be current cigarette smokers, although they did not smoke as heavily. Black females, when compared with

white females, were also found to have a higher prevalence of age adjusted elevated blood pressure, and were also much more likely to have reported a history of hypertension or diabetes. However, when current cigarette smoking was adjusted for age, black and white females in CASS exhibited comparable rates of current smoking, although white females were heavier smokers. On the other hand, both white males and females had more family history of coronary disease. These data clearly indicate that in CASS, black males and females exhibited a higher degree of modifiable risk factors than did white males and females. However, it is important to recognize that in CASS blacks were younger than whites, and that this reduced their level of risk.

Whereas both blacks and whites presented with chest pain as their chief complaint, in almost half of black males and two-thirds of black females, no significant coronary disease could be found to account for this chest pain. This paradox of relative youth, high levels of risk and evidence of minimal disease for blacks has been noted previously (25,49,72,73). However, most of these studies have employed coronary disease mortality and morbidity as endpoints and have not used arteriographic indices. Pearson et al. (70,78) used arteriographic measures of disease in blacks, and found the extent of

disease to be similar in blacks and whites. After adjustment for relevant clinical characteristics as well as risk factors, Oberman and Cutter (49) reported that whites were three times as likely to have two or more vessel disease than were blacks. No studies, to our knowledge, have reported such low levels of disease in the presence of such high levels of risk as has CASS.

Some have suggested the presence of protective factors which might explain this paradox (25). Some of these protective factors include higher levels of HDL, higher work exercise levels, lower triglyceride levels, higher alcohol intake, lower prevalence of type A personality, and a genetic dispostion which protects blacks from coronary atherosclerosis. Since HDL readings were not obtained, and since alcohol consumption was not measured, it was not possible to evaluate their protective function in CASS. Although triglycerides were much lower for blacks in CASS than they were for whites, the fact that less than half of the blacks had readings made it difficult to evaluate the usefulness of the association with coronary disease risk.

Although type A personality was not measured in CASS, an examination of the occupational structure in CASS should allow one to make some conclusions about the

impact of certain psychosocial factors on risk for coroanry disease (72,73,79). What is remarkable about the occupational distribution in CASS is the high percentage of black males and females who were laborers and the relatively low percentage of black females who were housewives. On the other hand, almost 30% of white males were professionals and over half of white females were housewives. The fact that almost two-thirds of black males were laborers, and that the majority of black females was employed outside the home suggests that blacks in CASS were in stressful work situations. Those black women working outside the home were possibly more often single parents, who were the sole providers for their children. What James (73) calls "John Henryism" may be relevant to blacks; that is that when individuals cope actively with stressful situations for long periods of time under unfavorable conditions, the susceptibility to stress related diseases such as coronary artery disease is increased. Nevertheless, it appears that in CASS stressful work under unfavorable conditions i.e. manual labor, single parenting, did not result in increased levels of disease for blacks. Because of these unfavorable conditions, it is unlikely that the kinds of work done by blacks in CASS protected them from coronary artery disease.

Given the high levels of risk factors for blacks in CASS, it is difficult to explain the low levels of disease. It is possible that increased risk due to hypertension and cigarette smoking has resulted in death due to stroke and cancer, which in turn may have precluded blacks from being studied for coronary atherosclerosis. It may also be that the risk factors relevant for whites are not so for blacks, although in CASS, the risk factors for the two groups were similar. Again, it may be that unmeasured factors such as HDL protect blacks from their high levels of risk. The conclusion, however is that in CASS, for whatever reasons, being black was associated with absence of atherosclerotic disease.

Finally, it is possible that differential selection of patients for angiography at the 14 CASS clinical sites that enrolled blacks may have resulted in a biased sample of disease free blacks. To determine if blacks were selected differently than whites, clinical sites that enrolled at least five black patients were ranked with respect to the percentage of normal (zero vessel disease) black and white patients studied. The order of ranks between blacks and whites did not differ substantially. The site that had the highest percentage of white normals also had the highest percentage of blacks normals,

whereas the institution that had the lowest percentage of white normals had the third lowest percentage of black normals.

Although there did not appear to be differential institutional selection for blacks with respect to disease, the contention that this is a biased sample of blacks can not be disproved. In at least one sense, the blacks in CASS were exceptional in that they had symptoms or some other reason for undergoing angiography for the evaluation of proven or suspected coronary disease. Data from the National Center for Health Statistics indicate that the ratio of cardiac catheterization among whites to blacks is 1.7 (1.93 per 1000 vs. 1.15 per 1000) (8). It is evident that blacks are less likely to be included in data registries of patients who have undergone coronary arteriography. For example, blacks comprised only 2.4% of the CASS patient population and were only 4.2% of the University of Alabama in Birmingham registry (49).

Yet, in other ways, the blacks in CASS may not be so different from other blacks. A comparison of the distribution of the three major risk factors in CASS and NHANES II blacks indicates that these two groups were very similar with respect to risk for coronary disease. In addition, the occupational distribution of blacks in

CASS, characterized by a high percentage of male laborers and working mothers, is probably similar to that of U.S. blacks of the same age. It is likely that blacks in CASS had health insurance to cover the cost of angiography. Unfortunately, income and health insurance information was not obtained in CASS, so it was not possible to evaluate the influence of these factors in defining the black population in CASS.

In examining the relationship between risk factors and disease in CASS, Vlietstra et al. (69) have raised a number of important issues which should be considered in the current context. First, it important to realize that the indicator of coronary artery disease employed in this study is angiographic as opposed to clinical. Second, the data on risk factors were obtained shortly before angiography, and might not truly reflect the patient's condition in the months and years before angiography. For example, laboratory values (serum cholesterol) and clinical history data were taken only at one point in time and may not be representative of the patient's level of risk. However, the estimates of risk level do accurately represent the data available to physicians evaluating the likelihood of disease in patients with chest pain. Third, there was no standardization of cholesterol readings, and in a sizeable percentage of

patients, cholesterol readings were not obtained. Additional discriminant analyses of the relationship between risk factors and coronary disease indicated that the most important risk factors did not change for either blacks or whites when cholesterol was not included in the analysis. Fourth, as has been mentioned, other important risk factors such as type A personality and HDL were not measured. Fifth, it is important to realize that this was a selected group of patients who had chest pain and underwent angiography for its evaluation. Finally, we may have missed blacks, who due to other manifestations of the disease, eg. MI and sudden death, or death from other conditions, eg. stroke and cancer, were not available for angiography.

It is important to consider the clinical importance of some of the findings of this study. First, further efforts must be made to reduce cigarette smoking and control hypertension in the black population. There is evidence from NHANES that from 1971 to 1980 blacks did reduce cigarette smoking and were better able to control their hypertension (28). Clearly, public health education programs must be targeted to black populations, and physicians must educate their black patients concerning the cessation of cigarette smoking and the control of hypertension. The results from NHANES are

encouraging, but the fact that 6 of 10 black females and 7 of 10 black males have one or more risk factors indicates that innovative efforts are required to make these numbers more favorable.

Second, it is apparent that the diagnosis and treatment of the black patient with chest pain can be problematic in that many blacks have chest pain despite the presence of normal coronary arteries. In fact, the finding of normal coronary arteries may lend a false sense of reassurance to both doctor and patient. Clearly, better understanding of the etiology of chest pain in blacks is needed. Some have hypothesized that there may be a differential incidence of coronary vasospasm in blacks, although no studies to date have reported this (80). Others have noted the existence of blacks with angina pectoris, marked left ventricular hypertrophy, and normal coronary arteries, and have emphasized aggressive control of hypertension as the key aspect in the effective treatment of these patients (81). Studies of predominantly black populations from different regions of the country are needed to clarify these findings from CASS, as well as those from other large clinical trials (49,82,83,84). Such studies would provide much needed understanding of the epidemiology and effective treatment of coronary disease in blacks.

Chapter 3
Clinical Decision Making

In chapter 1, it was made apparent that the the question of who receives surgical therapy for the treatment of coronary artery disease is complicated by the fact that clinical and angiographic factors alone do not explain variation in surgical rates across medical institutions (45,46). Demographic, economic, social, interpersonal, and organizational factors have been suggested as possible determinants of clinical decision making for a variety of medical conditions (41,42,44).

The purpose of this chapter is to examine the role of race in clinical decision making for coronary disease in the Coronary Artery Surgery Study. In examining this issue, several key questions will be addressed. First, what are the crude and adjusted rates of coronary artery bypass graft surgery (CABG) for blacks and whites in CASS? Second, is there a racial differential in crude rates, and if so, does this differential persist after adjustment for clinical and angiographic factors known to be predictive of surgery. Third, if adjusted rates do differ with respect to race, why is this the case? This is a complex question which can not be fully answered

given existing data, although suggestions will be made as to the kinds of data required to aid in understanding the possible racial differential concerning CABG. Furthermore, possible reasons for the differential will be discussed and their likelihood will be assessed.

Data and Methods

Patient Population-Data analyzed for this study are from the CASS registry (63) which contains extensive demographic, clinical, and angiographic information on all consecutive patients, who giving informed consent for angiography and data collection, underwent coronary angiography for proven or suspected coronary disease. The CASS, which enrolled patients from July 1974 to May 1979, included 14 clinics in the United States and one in Canada. This analysis includes 13,307 of the 24,959 patients who were enrolled in CASS. Patients with previous bypass surgery and/or those who were of other races were not included in the analysis. There were 573 blacks and 23,008 whites who did not have previous CABG. Furthermore, to be included in this study, patients had to be considered candidates for bypass surgery in that they had to have at least one significantly diseased vessel (70% or greater diameter narrowing in one or more coronary arteries or 50% left main coronary artery stenosis) and also had to be graded as having at least

Class I angina (mild symptoms) by the Canadian Cardiovascular Society classification (76). Also, patients who were part of the CASS randomized trial were eliminated, because their therapy was randomly assigned. In the end, 202 blacks and 13,105 whites were eligible for inclusion in this study.

Study Variables-Numerous demographic, clinical, and angiographic variables were recorded at baseline. Patients were followed through time, and the date of bypass surgery was recorded. Demographic variables collected included age, sex, race, employment status, and occupation. The observed race was recorded as "white," "black," or "other," with the choice of category being left to the interviewer.

Employment status referred to the amount of time the patient was working at baseline; the categories included (1) full time or 40 hours per week, (2) part time or less than 40 hours per week, (3) retired or stopped working when retirement age was reached, (4) quit or forced to quit prior to retirement age because of cardiac symptoms, with or without the recommendation of a physician, and (5) other or currently unemployed (by economic circumstances or choice), on temporary sick leave, or disabled secondary to non-cardiac illness.

Occupation was categorized as (1) manual or work that includes routine performance of heavy manual labor and/or physical exertion, (2) clerical or any form of employment not regularly associated with heavy manual labor that does not involve stressful decision making responsibility, (3) professional or work that requires advanced training and involves mental rather than physical tasks, as well as a definite amount of stress and responsibility associated with decision making, (4) homemaker or tasks associated with the management of a household, and (5) other or any occupation that does not meet the above criteria.

In an earlier report of the determinants of CABG in CASS (45), variables predictive of bypass surgery were identified. These variables were related to coronary anatomy and left ventricular function, as well as to angina. The analysis of Alderman et al. (45) was updated, and the six most important predictors of surgery were identified as (1) the index of myocardial jeopardy, (2) number of diseased proximal vessels, (3) the number of operable vessels, (4) angina severity, (5) unstable angina, and (6) the use of a beta blocking agent.

Myocardial jeopardy relates the functional status of left ventricular segments to the presence or absence of significant coronary disease (70% diameter narrowing) in the major arteries supplying left ventricular segments. Myocardial jeopardy was defined as (1) nonexistent because of akinetic or dyskinetic segments or because of normal or minimally diseased arteries supplying those segments, (2) inferior in that only the diaphragmatic or posterobasal segments were jeopardized, (3) anterior in that the anterobasal, anterolateral, or apical segments were affected, and (4) both in that anterior and inferior aspects of the left ventricle were in jeopardy.

The number of diseased proximal vessels measured the number of arteries in which the proximal portions had diameter narrowing of 70% or greater, while the number of operable vessels was dependent on the location of lesions (50% or greater stenosis) and the morphology of vessels distal to the lesions so that the vessels were sufficiently well visualized and of adequate size to be graft recipients. Both variables were measured on a scale from 0 to 3.

The severity of angina was measured by the Canadian Cardiovascular Society classification (76); Class I angina occurs only with strenuous, rapid or prolonged

exertion, whereas in Class IV angina the patient is prevented from doing any activity without developing angina. Unstable angina was defined as new or changing patterns of ischemic pain occurring two months before angiography. Finally, use of a beta blocking agent within two months of enrollment was identified as a predictor of surgery.

To further investigate the role of clinical site in determining surgical rates, information concerning physicians and institutions was collected. Surgeons performing operations at CASS sites were identified, and the number of years of surgical experience since board certification in general surgery was obtained from the Directory of Medical Specialists (85) for each surgeon. Whether bypass surgery was performed on an emergency basis was defined for each patient; emergency surgery was defined as bypass surgery occurring within 24 hours of an unscheduled hospitalization. In addition, the percentage of surgical cases referred by CASS institutions to outside hospitals was also obtained. From a special survey of CASS principal investigators conducted in 1979, two additional variables were obtained. First, principal investigators were asked to identify which physician (i.e. cardiologist, surgeon, family physician, housestaff) was most likely to be responsible for

determining whether a patient should receive surgery. Second, investigators were asked to estimate the percentage of cases at their institutions that were urgent and emergent transfers from other hospitals.

The major endpoint in this study, therapeutic decision, was defined as medical or surgical. The definition of a surgical patient was as follows; the number of days from enrollment to surgery was calculated for all patients having surgery within the first year. The medical group was comprised of those patients who did not have CABG or whose times from enrollment to surgery were so long that they did not fall within the 95th percentile of days from enrollment to surgery within the first year for that clinical site and were also greater than 90 days. The surgical group consisted of those patients whose times from enrollment to surgery were within the 95th percentile and/or within 90 days for the clinic under study. One feature of this definition is that it adjusts in part for hospitals with extensive surgical backlogs. A second indicator of therapeutic decision, recommended therapy, was also employed. This variable indicated whether bypass surgery was recommended to the patient by his or her physician.

Statistical Methods—The predictors of surgical therapy were identified from a list of clinical and angiographic variables by linear discriminant analysis. Regression coefficients for the six most important predictors of surgical therapy were estimated with logistic regression (86). Logistic regression was used, because linear discriminant coefficients for discrete variables are likely to be biased (87). The expected number of surgeries for clinical sites and occupational groups was calculated with the logistic function. The Spearman rank correlation coefficient (88) was employed to examine the degree of association between institutional variables and the percentage of blacks receiving surgery.

In order to determine the joint effect of occupation and clinical site on the percent of black patients receiving surgery, logistic regression analysis was used. First, the expected probability of surgery was computed for each patient, and second, a series of probability levels (varying from .4 to .6) to distinguish correct from incorrect classifications was established. The therapy expected on the basis of the probability levels was compared with the actual therapy, and the maximum percent cases correctly classified was obtained. The process was employed with clinical and angiographic

variables alone, with occupation added, and finally, with clinical site added to the previous two classes of variables. Analysis was carried out with the BMDP stepwise logistic regression program (89).

Results

Clinical and Angiographic Predictors of Therapy—The six most important predictors of therapy are listed in order of entry into the linear model in table 7. Clinical and angiographic features which increased the likelihood of surgery for all patients were (1) increased levels of myocardial jeopardy, (2) greater number of operable vessels, (3) greater anginal severity, (4) greater number of diseased proximal vessels, (5) the presence of unstable angina, and (6) the use of beta blocking drugs. Other clinical and angiographic variables were also statistically significant, but these six variables were the most important predictors given their F statistics and p values. Regression coefficients and their standard errors for only these 6 variables were estimated with logistic regression and are listed in table 7.

Key clinical and angiographic features of medical and surgical patients according to race are listed in table 8. In the medical group, a higher percentage of

Table 7
Clinical and Angiographic Predictors of Surgical Therapy

Variable	Regression Coefficient (SE)	P
Myocardial Jeopardy (0-3)	.466 (.018)	<.0001
Number Operable Vessels (0-3)	.383 (.023)	<.0001
Angina Severity (1-5)	.226 (.021)	<.0001
Number Diseased Proximal Vessels (0-3)	.335 (.023)	<.0001
Unstable Angina (1=no, 2=yes)	.554 (.044)	<.0001
Beta Blocking Agent (0=no, 1=yes)	.479 (.039)	<.0001
Constant	-3.17	

Dependent Variable:
Surgery (0=no, 1=yes)

Table 8
Characteristics of Medical and Surgical Patients by Race

Variable N	Medicine Black (127)	Medicine White (5529)	P	Surgery Black (75)	Surgery White (7576)	P
Male Sex	74.8%	82.7%	.02	72.0%	83.9%	.006
Age	52	54	NS	53	55	<.02
Occupation			<.0001			.002
Laborer	65.1%	34.7%		50.7%	34.1%	
Clerical	12.7%	24.3%		16.0%	23.9%	
Professnl	7.1%	24.5%		10.7%	26.1%	
Homemaker	10.3%	9.7%		12.0%	8.7%	
Other	4.8%	6.8%		10.7%	7.2%	
Full Time Employment	56.7%	60.6%	NS	56.0%	63.6%	NS
Myocardial Jeopardy			NS			NS
None	43.3%	42.4%		21.3%	18.6%	
Inferior	27.6%	21.8%		12.0%	17.2%	
Anterior	18.1%	23.3%		42.7%	31.9%	
Both	11.0%	12.5%		24.0%	32.3%	
Number Operable Vessels			NS			NS
Zero	7.8%	9.1%		4.0%	2.1%	
One	33.1%	33.3%		24.0%	19.0%	
Two	35.4%	33.9%		30.7%	35.8%	
Three	23.6%	23.7%		41.3%	43.1%	
Angina Severity			.004			.005
Class I	.8%	8.2%		0.0%	3.5%	
Class II	32.3%	36.6%		10.7%	20.4%	
Class III	35.4%	33.5%		41.3%	42.9%	
Class IV	17.3%	11.0%		41.3%	24.6%	
Unrltd to Exertion	14.2%	10.6%		6.7%	8.7%	
Number of Diseased Proximal Vessels			NS			NS
Zero	48.8%	40.6%		22.7%	21.4%	
One	35.4%	38.8%		44.0%	36.6%	
Two	11.8%	15.0%		22.7%	27.0%	
Three	3.9%	5.6%		10.7%	15.0%	
Unstable Angina	44.9%	29.1%	.0001	60.0%	47.2%	.027
Beta Blocker	42.5%	47.7%	NS	60.0%	59.3%	NS

whites was male and professional than was the percentage of blacks. 65.1% of the black medical group were laborers, whereas only 34.1% of the white medical group were in that occupational category. In the medical group, there were no statistically significant differences with respect to angiographic variables such as myocardial jeopardy, the number of operable vessels, or the number of diseased proximal vessels. However, with respect to chest pain, a higher percentage of blacks had Class III and IV angina ($p=.004$), and a higher percentage of blacks had unstable angina than did whites ($p=.0001$).

Black white differences in the surgical group were similar to those in the medical group. White surgical patients were slightly older than blacks ($p=.02$), although the difference was only two years. Again, there were no differences between groups with respect to angiographic variables. As in the medical group, a higher percentage of black surgical patients had Class III or IV angina than did white surgical patients ($p=.005$), and a higher percentage of blacks had unstable angina ($p=.027$). Occupational differences were again evident in that half of the black surgical group was comprised of laborers, whereas the distribution was more even in the white group. Black white occupational

differences were not as pronounced in the surgical group as they were in the medical group.

Observed and Recommended Therapy-From table 9 it is evident that of the 202 black patients who were potential surgical candidates, only 75 or 37.1% had surgical therapy as it was earlier defined. On the other hand, 57.7% of potential white surgical candidates had surgical therapy. The difference between percentages of blacks and whites receiving surgery was highly statistically significant ($p<.0001$). Of the 127 black, medically defined patients, 16.5% eventually had surgery, whereas of the 5529 white, medically defined patients, 16.8% eventually had surgery. The therapy recommended by the physician to the patient was also examined. As can be seen from table 9, it is apparent that surgical therapy was recommended to a smaller perentage of blacks than whites ($p=.0002$), although a slightly higher percentage of blacks had surgery recommended than did have the surgery. Of those blacks and whites who had surgery recommended to them, 80.5% and 90.4%, respectively, actually had surgical therapy as defined in this analysis. For blacks and whites who had surgery recommended and eventually had surgery, the mean time from enrollment to surgery was 35 and 36 days, respectively.

Table 9
Race and Therapy: Observed and Recommended

	Percent Observed Surgery	N	Percent Recommended Surgery	N
Black	37.1%	(202)	46.1%	(191)
White	57.7% *	(13,040)	59.3%	(11,565)**

* Black white difference for observed surgery P<.0001
** Black white difference for recommended surgery P=.0002

Expected Number of Surgeries-Using the regression coefficients for the clinical and angiographic predictors of therapy, it was possible with the logistic model to calculate an expected number of surgeries for black patients. This is the number of surgeries expected given the clinical and angiographic status of black patients. The 75 observed surgeries for blacks was 68% of the surgeries predicted for blacks given their clinical and angiographic features. Since whites comprised over 98% of the potential pool of surgical candidates, then according to the logistic model, their ratio of expected to observed surgeries would have to be very close to 1.0, which it was.

Race, Occupation, and Therapy-In tables 10 and 11, the relationship between race and therapy for various occupational groups is presented. From table 10, it is evident that a lower percentage of black laborers received surgery than did white laborers ($p<.0001$), and similarly, a lower percentage of black laborers was recommended surgery ($p=.0005$). Statistically significant differences were not found for the other occupational groups, although the numbers of blacks in the remaining categories were small in comparison to the laborers. For whites, there were no significant occupational differences in the observed and recommended groups.

Table 10
Race, Occupation, and Therapy: Observed and Recommended

	Percent Observed Surgery			Percent Recommended Surgery		
	Black	White	P	Black	White	P
Laborer	31.7%	57.4%	<.0001	42.3%	59.0%	.0005
(N)	(120)	(4503)		(111)	(3927)	
Clerical	42.9%	57.5%	.12	46.7%	58.9%	NS
(N)	(28)	(3151)		(30)	(2748)	
Professnl	47.1%	59.3%	NS	57.2%	59.7%	NS
(N)	(17)	(3328)		(14)	(2952)	
Homemaker	40.9%	55.1%	NS	57.2%	57.6%	NS
(N)	(22)	(1195)		(22)	(1072)	
Other	57.1%	59.1%	NS	61.5%	62.5%	NS
(N)	(14)	(920)		(13)	(867)	

Table 11
Adjusted Number of Surgeries by Occupation and Race

Occupation	Observed Surgeries	Expected Surgeries	O/E	N
Blacks				
Laborer	38	64.13	.59	120
Clerical	12	15.86	.76	28
Professnl	8	8.49	.94	17
Homemaker	9	12.95	.69	22
Other	8	8.06	.99	14
Total	75	109.49	.68	201
Whites				
Laborer	2570	2527.11	1.02	4484
Clerical	1803	1818.24	.99	3140
Professnl	1959	1909.82	1.02	3308
Homemaker	653	693.54	.94	1187
Other	538	543.07	.99	913
Total	7522	7491.78	1.00	13032

When adjustments for clinical and angiographic characteristics were made, occupational differences for whites were still minimal. With the exception of the homemaker group, all white groups had an observed to expected ratio of around 1.0. The situation with respect to blacks was much different. In particular, black laborers received only 59% of the surgery expected given their clinical and angiographic characteristics. Similarly, black clerical workers and homemakers had fewer operations than expected. However, small numbers in these categories require caution; the addition of two or three more surgeries to the clerical and homemaker groups would have produced O/E ratios close to unity. Nevertheless, it was the case that black laborers received far less surgery than expected.

Race, Clinical Site, and Therapy—Since only 15 clinics participated in CASS, and since only 9 clinics enrolled more than 5 black patients who were potential surgical candidates, it was difficult to analyze the relationship among race, clinical site, and therapy. The percentage of blacks receiving surgical therapy did differ among the nine hospitals enrolling black patients ($p=.003$ by chi-square). When adjustments were made for clinical and angiographic characteristics, O/E ratios for black patients ranged from 0.32 to 1.26, whereas for

white patients, O/E ratios ranged from 0.76 to 1.27. In order to determine the likelihood of the chi-square statistic for black patients, a Monte Carlo simulation was run. The simulation produced 1000 different tables of surgical therapy by clinical site given the observed marginal totals and the assumption of independent traits. The likelihood of the observed outcome for the nine clinical sites was less than one in a thousand.

The relationship between the four institutional and physician variables described earlier and the percentage of blacks receiving surgery was further investigated for the nine clinics enrolling more than 5 black patients. Neither mean years of surgical experience, the percentage of surgical cases referred to other institutions, nor the specialty of the physician responsible for clinical decision making were associated with the percentage of blacks receiving surgery. However, the estimated percentage of urgent and emergent transfers from other hospitals was related to the percentage of blacks receiving surgery (Spearman rank correlation r=.68, p=.05). The same relationship was also true for white patients, although the other three institutional variables were not related to the percentage of whites receiving surgery. The percentages of whites and blacks receiving emergency surgery were statistically the same

(3.1% vs 1.8%, respectively). The small numbers of blacks receiving emergency surgery precluded institutional comparisons. Finally, there was no relationship between the percentages of whites and blacks receiving surgery at the various institutions ($r=.20$, $p>.05$), nor was there an association between O/E ratios for blacks and whites ($r=.13$, $p>.05$).

Occupation and Clinical Site-The percent correct classification of black patients was obtained using three different sets of variables. First, with knowledge of the clinical and angiographic variables listed in table 1, it was possible to correctly classify 75.9% of black patients. When whether the patient was a laborer was added to clinical and angiographic features, the model correctly classified 78.6% of black patients. Finally, with knowledge of clinical and angiographic features, occupational group, and where patients received treatment, 81.8% of black patients were correctly classified. With a priori knowledge of the distribution of medical and surgical therapy, correct classification could be achieved 62.9% of the time by predicting medical therapy for blacks. Clearly, clinical and angiogrpahic characteristics added considerable predictive power (13%) to the model. However, occupation and clinical site increased the percent correctly classified another 6%

with both groups of variables making approximately equal contributions.

Discussion

A key finding of this chapter was that in CASS there existed a large black white differential with respect to the percentage of potential surgical candidates who received bypass surgery as defined in this study. Other investigators (8,49,50) have also reported that a lower percentage of black patients had bypass surgery than did whites. In CASS, this differential persisted even after adjustment for key clinical and angiographic characteristics. A second result was that black and white surgical patients were similar with respect to coronary anatomy and left ventricular function as measured by the index of myocardial jeopardy, number of diseased proximal vessels, and the number of operable vessels. However, black surgical patients had more severe chest pain and were more likely to have unstable angina than were their white counterparts. In addition, there were clear occupational differences in that blacks were predominantly laborers, whereas whites were more evenly distributed among the clerical, laborer, and professional occupational groups. Third, the percentages of white patients receiving and recommended surgery were virtually the same, whereas for blacks, a smaller

percentage had surgery than was recommended. Fourth, while occupation was not a determinant of surgery for whites, it was for blacks. Occupational differences were such that black laborers received only 59% of the surgery expected given their clinical and angiographic features. Fifth, for both blacks and whites institutional variation in both the observed percentage receiving surgery and the O/E ratio was evident.

Before discussion of possible explanations for these findings, it is important to recognize several important facts. First, in CASS black white differences in the percentage receiving CABG were not due to differences in angiographic and clinical characteristics. Second, the numbers of blacks in this study were very small: the highest number of black surgical candidates, as defined by chest pain and coronary anatomy, enrolled by any one clinic was 39 over the five years of patient enrollment. Consequently, CASS physicians were seeing few black patients with significant coronary artery disease and chest pain symptoms. Third, all blacks in CASS underwent coronary angiography for the evaluation of proven or suspected coronary disease. From this fact, it is likely that these blacks were very much part of the medical care system in that they most likely had seen several physicians before referral to a cardiologist. In at

least one sense, these blacks were exceptional given the low rate of cardiac catheterization of blacks in the U.S. population (8). It also seems reasonable to assume that blacks in CASS had some form of health insurance to cover the cost of cardiac catheterization. Given the relative youth and employment status of blacks, and the fact that most bypass surgery is financed by private health insurance (90), it is unlikely that blacks received medical assistance from agenices of local, state, or federal governments.

There are at least three possible explanations for the observed differential in the percentages of blacks and whites receiving bypass surgery. The first possible explanation is that blacks were distrustful of the predominantly white medical care system, and recognizing their suspicions and doubts about the system, they chose not to undergo invasive procedures such as CABG. A second possible explanation is that physicians and institutions put up barriers to blacks receiving surgical therapy. In particular, in the clinical decision making process, physicians may have discouraged blacks from having surgery. Furthermore, institutional policies may have made it difficult for blacks to have surgery. A third possible reason for the differential is that blacks did not possess sufficient resources to have the

operation. In particular, blacks did not have sufficient health insurance for bypass surgery. The absence of important data (eg. type of health insurance) and the small numbers of blacks in CASS make it impossible to identify in an absolute sense the reason(s) for the differential. However, given the data from CASS and other sources, it is possible to evaluate the likelihood of each of these three hypotheses.

That blacks chose not to undergo surgery because of distrust seems an unlikely explanation given that blacks in CASS underwent coronary arteriography for proven or suspected coronary disease. The fact that these black patients were willing to undergo an invasive diagnostic procedure indicates at least some reliance on and cooperation with physicians and medical care institutions. Nevertheless, open heart surgery is a much bigger step than coronary angiography, and it is possible that blacks were reluctant to undergo surgery. Jackson (16), on the basis of available data, concludes that a large portion of urban blacks rely heavily and sometimes exclusively on the existing medical care system for diagnosis and treatment of a variety of diseases.

The second explanation that blacks were refused surgery because of the actions of physicians or the policies of institutions is unlikely given the fact that blacks in CASS had been seen by numerous physicians and had undergone several diagnostic procedures including angiography. It again is inconsistent that blacks would be denied surgery, when they had received the requisite diagnostic and treatment procedures which preceed bypass surgery. The fact that almost 20% of blacks who had surgery recommended did not have the procedure further weakens the argument that CASS physicians denied surgery to blacks patients. This is not to say that blacks are not the victims of racial discrimination on the part of physicians and institutions (47,48). However, in CASS, it is unlikely that racial discrimination on the part of physicians and institutions was responsible for blacks receiving less surgery than expected.

The third explanation that blacks received less surgery than expected because of insufficient resources seems the most plausible of the three. In particular, black laborers received much less surgery than expected, while there were no occupational differences among whites. Presumably, black laborers did not have the resources which white laborers had available to them. These resources include support from employers, labor

unions, and family. Support from employers and unions would include sufficient health insurance, financial support during the time of recovery from the operation, and support for the post recovery period in the form of future employment and/or retirement income. Family resources would include the presence of a spouse or other family members who could provide both financial and emotional support during the time of the operation and the period to follow. Although black laborers most likely had insurance to cover the cost of angiography, it is possible that their insurance was not sufficient to cover bypass surgery. If one assumes that black laborers were less likely to be union members than white laborers, then it is possible that black laborers did not have available to them comprehensive health insurance, retirement, or disability income, benefits often offered by large labor unions. Since no information on the marital status of CASS participants was available, it is difficult to say much about the availability of family resources for blacks in CASS.

It is essential to recognize that the hypothesis regarding insufficient resources of black laborers is conjectural given the lack of key information and the small numbers of black patients in CASS. Additional information regarding health insurance coverage, the type

of work, labor union membership, education, income, and marital status is required to evaluate this hypothesis. The explanation is offered as a possible reason for the observed black white surgery differential; it does seem a more likely explanation than the other two hypotheses which have been offered. However, the resources hypothesis does not readily account for the institutional variation in patients receiving surgery, nor does it explain why physicians recommended surgery to blacks less often than they did to whites. To understand these findings, considerable institutional and physician data would have to be collected. The resources required to collect such information would be considerable.

Chapter 4
Mortality, Morbidity, and Quality of Life

Coronary artery disease is the leading cause of death for both blacks and whites in the United States today, accounting for approximately one-third of all deaths (91). In the last decade, there has been a decline in the death rate due to cardiac causes, and this decline has benefited both blacks and whites (52). As seen in chapter 1, reasons for this decline have been discussed, and the relative contributions of risk factor reduction and improving medical care have been addressed (53, 54). A recent report (55) demonstrated a reduction in the incidence of coronary disease and identified the control of hypertension as an important factor in the decline. Although improved coronary care following myocardial infarction (MI) has been identified as a possible reason for the decline (92), change in disease incidence due to risk factor reduction has been postulated as the most likely reason for the decline in mortality.

In a somewhat different situation, data from the Coronary Artery Surgery Study (CASS) provide the opportunity to examine the effects of therapy, risk

factors, and race on mortality for a group of patients who had coronary angiography for proven or suspected coronary disease. Two questions are of particular interest; first, what is the role of medical and surgical therapy in the long term survival of black patients? Second, for medically and surgically treated patients is race a significant determinant of survival? In addition, the role of race in MI and hospitalization subsequent to cardiac catheterization will be discussed as will differences in the quality of life for white and black patients who had coronary artery bypass graft surgery (CABG).

Data and Methods

Patient Population-Data analyzed for this study are from the CASS registry (63) which contains extensive demographic, clinical, and angiographic information on all consecutive patients, who giving informed consent for data collection and angiography, underwent coronary angiography for proven or suspected coronary disease. The CASS, which enrolled patients from July 1974 to May 1979, included 14 clinics in the United States and one in Canada. Patients from these clinics were followed on an annual basis from the time of enrollment through May 1983, when follow-up stopped except for those patients enrolled in the CASS randomized trial. This analysis

includes 573 blacks and 23,008 whites who were enrolled in CASS and were followed from enrollment to date of death or last follow-up. Patients with previous bypass surgery and/or those of races other than black or white were not included in the analysis.

Study Variables-Numerous demographic, clinical, and angiographic variables were recorded at the time of enrollment. Demographic variables collected included age, sex, race, employment status, and occupation. The observed race was recorded as "white," "black," or "other," with the choice of category being left to the interviewer. Employment status referred to the amount of time the patient was working at baseline; the categories included (1) full time, defined as 40 hours or more per week, (2) part time or less than 40 hours per week, (3) retired or stopped working when retirement age was reached, (4) quit or forced to quit prior to retirement age because of cardiac symptoms, with or without the recommendation of a physician, and (5) other or currently unemployed (by economic circumstance or choice), on temporary sick leave, or disabled secondary to non cardiac illness.

Occupation was categorized as (1) manual, defined as work that includes routine performance of heavy manual labor and/or physical exertion, (2) clerical, defined as any form of employment not regularly associated with heavy manual labor that does not involve stressful decision making responsibility, (3) professional, defined as work that requires advanced training and involves mental rather than physical tasks, as well as a definite amount of stress and responsibility associated with decision making, (4) homemaker, defined as tasks associated with the management of a household, and (5) other, defined as any occupation that does not meet the above criteria.

Risk factors for coronary disease in the CASS population were also identified. Current smoking was defined as continued smoking within 3 months of entry into the study. Patients were also asked whether they had been treated by a physician for high blood pressure, or whether they had been told by a physician that they had high blood pressure. Serum cholesterol readings were obtained only for some patients at the time of study entry, since the analysis of serum cholesterol was not a primary goal of the study, and was only recorded if done clinically. For these reasons, serum cholesterol was not used in the analysis of survival.

Information on other risk factors and medical conditions was also collected. This included early family history of coronary disease, defined as angina or MI in parents, siblings, or aunts and uncles related by blood before the age of 55 years. History of diabetes and history of congestive heart failure were also noted as was the number of illnesses from among the following: hypertension, diabetes, cerebrovascular, peripheral arterial, valvular heart disease, chronic pulmonary disease, thrombophlebitis, hepatic, renal, gout, neoplastic, peptic ulcer, and other. Finally, the level of daily recreation and/or physical activity during the three months prior to enrollment was assessed as strenous, moderate, mild, or sedentary. Also the existence of a prior MI as reported by the patient and documented by medical record was noted.

In addition to risk factor assessment, information related to clinical and angiographic indicators of coronary disease was also obtained. The presence of chest pain was noted; the likelihood that the chest pain was angina was evaluated as definitely not, probably not, probable, or definite (63). The limitation of activity due to chest pain was measured by the Canadian Cardiovascular Society classification (76); the presence of unstable angina was also recorded. Whether there was

use of a beta blocking drug and/or nitroglycerin was also established; the use of a diuretic was also determined. The functional impairment due to congestive heart failure was evaluated, and the congestive heart failure score, which ranged from 0 to 4, was computed with one point for each of the following; (1) history of congestive heart failure, (2) use of digitalis at baseline, (3) use of a diuretic at baseline, and (4) the presence of basiliar rales on physical examination.

Also, several measures of the extent of coronary disease and left ventricular function were obtained. The number of diseased vessels, a measure of the extent of coronary disease based on interpretation of the coronary arteriogram, was calculated (53). The number of diseased proximal vessels measured the number of arteries in which proximal portions had diameter narrowing of 70% or greater, while the number of operable vessels was dependent on the location of lesions (50% or greater stenosis) and the morphology of vessels distal to the lesions, so that the vessels were sufficiently well visualized and of adequate size to be graft recipients. All three measures of the extent of coronary disease were measured on a scale from 0 to 3. Also, the presence of a 50% or greater stenosis in the left main coronary artery was noted. Finally, the product of the Canadian

Cardiovascular Society class and the number of diseased vessels was computed.

In addition, measures of left ventricular function were recorded. The left ventricular wall motion score, a measure of segmental left ventricular function based on interpretation of the right anterior oblique ventriculogram, was also determined (63). The score, summed from assessments from 5 different regions, ranged from 5 (totally normal) to 30 (never observed-the whole heart aneurysmal). The left ventricular end diastolic pressure was also obtained during the time of cardiac cathererization. Finally, the myocardial jeopardy score, which related the functional status of left ventricular segments to the presence or absence of significant disease (70% diameter narrowing) in the major arteries supplying left ventricular segments, was calculated. Myocardial jeopardy was defined as (1) none because of normal arteries, or akinetic or dyskinetic ventricular segments, (2) inferior in that the diaphragmatic or posterobasal segments were jeopardized, (3) anterior in that the anterobasal, anterolateral, or apical segments were affected, and (4) both anterior and inferior aspects of the the left ventricle were in jeopardy.

Besides these baseline variables, important endpoint data were obtained. Vital status was determined. For those who died, the cause of death was categorized as (1) cardiac, (2) cardiac contributing to the major cause, (3) sudden, (4) non-cardiac of atherosclerotic origin, (5) non-cardiac, not atherosclerotic, and (6) suicide. Applicable causes were also identified and included one or more of the following; MI, congestive heart failure, shock, arrhythmia, post operative death less than 24 hours after surgery, post operative death less than 30 days after surgery, cerebrovascular accident, malignancy, trauma, and sudden death. In addition, survival information for the United States population was also obtained (93).

Certain measures of morbidity including MI during the period 60 days prior to enrollment to the last date of follow-up and hospitalization were recorded. The MI status of all patients was monitored and was recorded on the annual follow-up form or the hospital discharge form. For MIs reported on the discharge form, whether the infarct was definite or probable was determined, as was the location (anterior, inferior, or subendocardial) and source of documentation (ST-T changes, Q wave changes, and/or cardiac enzymes). Only the first MI occurring during the study period was analyzed.

The number of hospitalizations during each follow-up year was reported for most patients. After the middle of 1979 for patients with normal coronary arteries and normal left ventricular function, only vital status and MI status were determined. Hospitalization data and quality of life data were not obtained for this group of patients after that time. The reasons for hospitalization were (1) coronary artery bypass graft surgery, (2) cardiac including MI, chest pain, heart failure, rhythmn disturbance, and cardiac catheterization, (3) valvular or myocardial surgery, and (4) other reasons including pacemaker surgery, pericardial surgery, peripheral vascular surgery, heart transplant, stroke, and non cardiac hospitalizations.

On an annual basis, quality of life data were reported for many of the patients enrolled in CASS. All variables recorded at follow-up were also recorded at baseline. For each follow-up year the Canadian Cardiovascular Society classification was reported as was whether the angina was definite or probable. Employment status as reported at baseline was also defined for each year of follow-up as was the level of recreational/physical activity. The use of beta blockers, diuretics, and nitroglycerin was noted at baseline and follow-up, and finally, cigarette smoking in

the years following enrollment was reported. In CASS, quality of life data, as well as hospitalization data, were reported for patients who had bypass surgery and for those who did not. If follow-up was not completed within a sixty day window of the anniversary date, quality of life and hospitalization data were considered to be unknown for that year. Due to incomplete follow-up for patients with normal coronary arteries and normal left ventricular function, quality of life comparisons were made only for surgical patients and for medical patients with one or more diseased vessels.

Statistical Methods-Black white differences for discrete variables were tested with the chi-square statistic. Stratified life table analysis (94) was used to examine black white differences in survival after adjusting for key baseline characteristics, and the log rank statistic (95) was employed to test for statistical differences in survival. The Cox proportional hazards model (96) identified the predictors of survival from baseline demographic, clinical, and angiographic variables. In order to examine the multivariate relationship among race, therapy, baseline variables, and survival, Cox regression was used in the following way. To examine the relationship of race to survival within the medical and surgical groups, all baseline variables

were allowed to compete for entry at the first level, and once the important predictors were selected, race was allowed to enter to ascertain if it had any additional predictive power. A similar strategy was employed in examining the relationship between therapy and survival for blacks. The relationship between survival and therapy for whites was not examined, due to the large number of subgroups (eg. left main, one vessel, mild angina) for which the relationship between therapy and survival differs. Survival differences in various subgroups have been the subject of numerous CASS registry studies. Similarly, the relationship between race and MI was examined for medical and surgical groups with Cox regression.

Survival times and medical and surgical groups employed in the life table analyses and Cox regression were defined as follows. For all patients having surgery during the first year, the number of days from enrollment to surgery was calculated. The surgical group consisted of those patients whose times from enrollment to surgery were within the 95th percentile of days from enrollment to surgery for that clinic and/or were within 90 days of enrollment. The medical group was comprised of those patients who did not have bypass surgery or whose times from enrollment to surgery were not within the 95th

percentile of days for that clinic and were also greater than 90 days.

Exposure time for the medical group was the number of days from enrollment to death or censoring minus the site specific mean number of days from enrollment to surgery, whereas exposure time for the surgical group was the number of days from surgery to death or censoring. Since medically treated patients were at risk for cardiac events before surgically treated patients, compensation was achieved by starting the exposure of medically treated patients at the site specific average number of days from enrollment to surgery. The exposure time for MI status was determined by calculating the number of days from enrollment to death, MI, or censoring.

Results

Mortality-Age specific probabilities of surviving five years are presented in table 12 for both the CASS and the general United States populations. In CASS, black males fared poorly in comparison to white males. Black males in the age groups 40-44 ($p=.004$) and 50-69 ($p=.017$) had significantly lower chances of surviving 5 years than did their white counterparts. There were fewer significant differences for females in that only white females ages 50-54 ($p=.027$) had a better chance of

Table 12
Probability of Surviving 5 Years in CASS and United States Population by Sex, Age, and Race

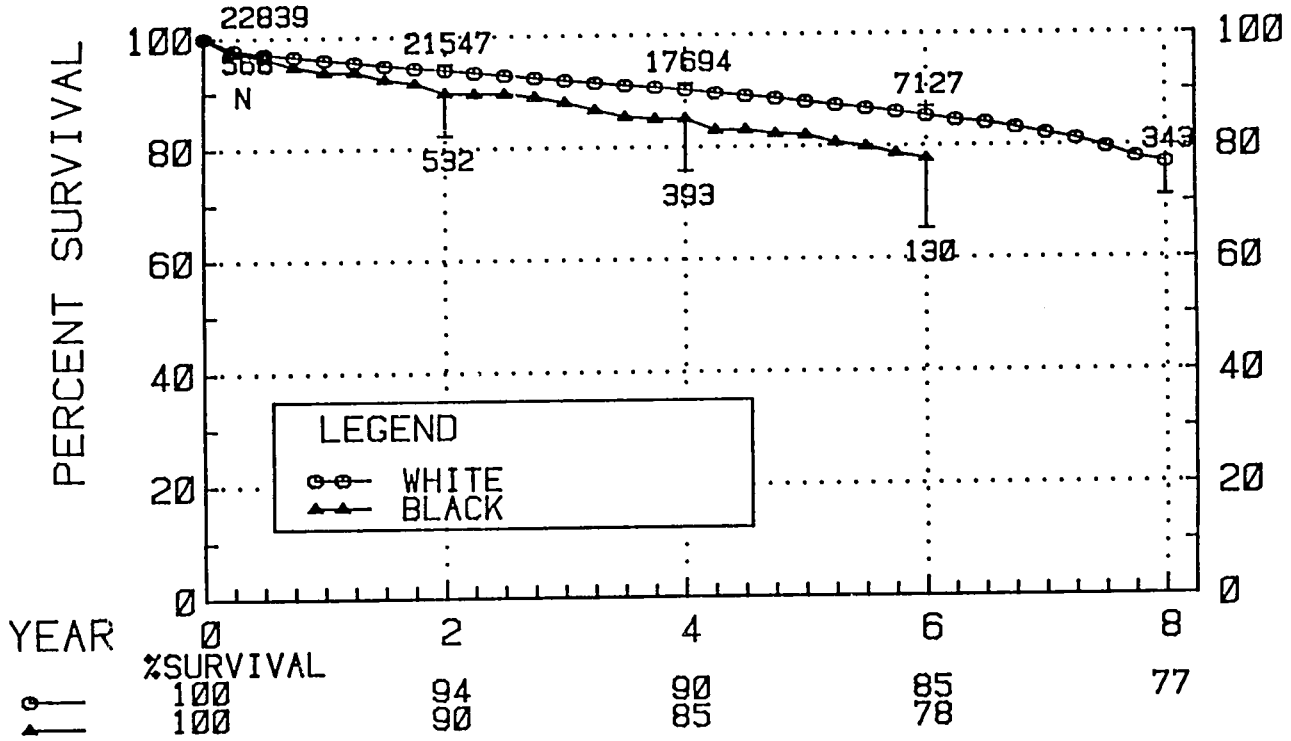
Age	CASS White	CASS N	CASS Black	CASS N	P*	U.S. White	U.S. Black
Males							
25-29	.922	110	.909	11	NS	.992	.982
30-34	.924	42	1.000	16	NS	.992	.980
35-39	.919	958	.958	28	NS	.989	.973
40-44	.922	1693	.838	67	.004	.984	.962
45-49	.904	2798	.864	64	NS	.973	.950
50-54	.890	3600	.820	65	.017	.956	.923
55-59	.851	3571	.742	52	.051	.932	.892
60-64	.809	2438	.685	34	.063	.890	.846
65-69	.748	1178	.571	14	.052	.843	.825
70-74	.646	363	.250	4	NS	.771	.739
Females							
25-29	.802	24	1.000	3	NS	.997	.994
30-34	.957	94	.875	8	NS	.996	.992
35-39	.959	255	1.000	21	NS	.994	.988
40-44	.941	505	.889	38	NS	.991	.981
45-49	.940	852	.913	40	NS	.985	.972
50-54	.922	1119	.841	45	.027	.976	.957
55-59	.911	1127	.901	32	NS	.965	.938
60-64	.863	850	.715	16	NS	.944	.911
65-69	.826	546	1.000	4	NS	.922	.898
70-74	.734	163	1.000	1	NS	.877	.818

* P for black white differences within CASS by the log rank statistic.

surviving 5 years. In the United States population, white survival was better than black for males of all ages. White female survival was better at all ages except in the 25-29 and 30-34 categories where there were no differences. Moreover, survival in the general population was considerably better than it was in the CASS population for both blacks and whites. Finally, the differences between black and white survival for the various age groups was greater in CASS.

The overall age and sex adjusted survival in CASS is presented in figure 2. The difference in survival between the two groups was highly statistically significant ($p<.0001$); overall 88% of whites survived 5 years from enrollment, whereas only 82% of blacks survived this long. Cause of death information was also examined and is reported in table 13. Approximately 80.4% of the 3099 white deaths and 85.3% of the 88 black deaths were due to cardiac causes. Differences in the 3 cardiac categories were not apparent with 11.6% of white deaths and 14.8% of black deaths attributed to sudden death. A minor difference was in the non cardiac categories where 19.6% and 14.8% of white and black deaths occurred. A slightly higher percentage of black deaths was due to arteriosclerotic causes than was the percentage of white deaths, although the difference was

Figure 2. Age and Sex Adjusted Survival.



P < .0001
Log Rank Stat = 20.885

Table 13
Cause of Death by Race

Cause	White		Black	
	Pct.	N	Pct.	N
Cardiac	60.6	1877	59.1	52
Cardiac Contributing	8.2	254	11.4	10
Sudden	11.6	359	14.8	13
Non Cardiac-Atherosclerotic	4.3	132	8.0	7
Non Cardiac-Not Atherosclerotic	14.6	454	6.8	6
Suicide	.7	23	0.0	0
Total		3099		88

Chi-square that causes are different, P=.12

not statistically significant. When conditions associated with death were listed, no significant differences were found for MI, congestive heart failure, shock, arrhythmia, post operative less than 24 hours, malignancy, trauma, or sudden death. However postoperative deaths less than 30 days were mentioned more frequently in blacks (10.2% vs. 5.4%, p=.052), and cerebrovascular accidents as a cause of or concomitant of death were also more common in blacks (10.2% vs. 5.8%, p=.08).

Occupational differences in survival were also investigated. There were no statistically significant white black differences in survival for clerical workers, professionals, homemakers, or members of other occupational groups. The major differences were concentrated in the laborer group where 5 year survival for whites was 87%, while that for blacks was 81% (p=.0002). Age adjustment decreased survival for black laborers to 79% and increased the statistical significance of the difference between black and white laborers (p<.0001).

In order to better understand the relationship among race, therapy, and survival, multivariate analysis with the Cox proportional hazards model was done. In table 14

are the results of the Cox regression for medical and surgical groups. In the medical group, after controlling for significant predictors of mortality, it was apparent that black race was associated with higher levels of mortality (p=.0006). After similar controls were instituted in the surgical group, it was evident that race was not associated with survival (p=.2791). The results of Cox regression analysis for blacks are presented in table 15. After controlling for significant predictors of survival, it was evident that surgical therapy was associated with longer survival in blacks (p=.0094).

Also of interest was the similarity of predictors of mortality in both groups. The wall motion score was the most important predictor of survival for both blacks and whites, while the congestive heart failure score entered second for whites and third for blacks. The number of diseased vessels entered third for whites and the interaction of the number of diseased vessels and the Canadian class ranked second for blacks. Advanced age and current cigarette smoking were also associated with higher mortality for both groups. An important difference between blacks and whites had to do with the role of hypertension in mortality. While hypertension was a significant predictor of mortality for both groups,

Table 14
Predictors of Survival for Medical and Surgical Patients in CASS

Medical N=14,141			Surgical N=8,144		
Variable	Beta	P at Entry	Variable	Beta	P at Entry
LV Score	.0998	<.0001	CHF Score	.2552	<.0001
No. Ves.	.3257	<.0001	LV Score	.0949	<.0001
CHF Score	.1954	<.0001	Age	.0364	<.0001
Age	.0325	<.0001	Illnesses	.1208	<.0001
Smoking	.2249	<.0001	No. Ves.	.1951	<.0001
LVEDP	.0165	<.0001	Smoking	.2537	<.0001
LMCA Sten.	.0058	<.0001	LVEDP	.0173	<.0001
Rcrtn Act.	.1873	<.0001	LMCA Sten	.0034	.0019
Illnesses	.0541	<.0001	Hypertension	.0888	.0210
Prxml Ves.	.1401	<.0001	Diabetes	.1010	.0177
NYHA Class	.1363	<.0001	Rcrtn. Act.	.0930	.0281
Sex	-.2823	<.0001	Race	.2835	.2791
Hyprtnsion	.0812	.0029			
Diabetes	.0966	.0029			
Race	.4301	.0006			

LV=Left Ventricular CHF=Congestive Heart Failure No. Ves.=Number of Diseased Vessels LVEDP=Left Ventricular End Diastolic Pressure Rcrtn Act.=Recreational Activity LMCA Sten.=Left Main Coronary Artery Stenosis Prxml Ves.=Number of Diseased Proximal Vessels NYHA=New York Heart Association

Table 15
Predictors of Survival for Blacks and Whites in CASS

Blacks N=543			Whites N=21742		
Variable	Beta	P at Entry	Variable	Beta	P at Entry
LV Score	.1299	<.0001	LV Score	.1089	<.0001
CHC-No. Ves.	.1177	<.0001	CHF Score	.1463	<.0001
CHF Score	.2767	.0013	No. Ves	.2534	<.0001
Age	.0376	.0162	Age	.0333	<.0001
Smoking	.2960	.0370	Smoking	.2541	<.0001
Hypertension	.2696	.0435	Illnesses	.0847	<.0001
Therapy	-.7925	.0094	LVEDP	.0176	<.0001
			Rcrtn Act.	.1500	<.0001
			LMCA Sten.	.0036	<.0001
			Nitro	-.1562	<.0001
			NYHA Class	.1186	.0002
			Diabetes	.0983	.0010
			Hyperten	.0855	.0009
			Sex	-.1756	.0022
			Digitalis	.1856	.0084
			Prfssnl	-.0969	.0357

LV=Left Ventricular CHC=Canadian Heart Class
No. Ves. =Number of Diseased Vessels
CHF=Congestive Heart Failure
LVEDP=Left Ventricular End Diastolic Pressure
LMCA Sten. =Left Main Coronary Artery Stenosis
NYHA=New York Heart Association
Rcrtn Act. =Recreational Activity
Prfssnl=Professional
Nitro=Nitroglycerin

it was more important for blacks than whites as can be seen from comparison of the two regression coefficients. The coefficient for hypertension for blacks (.2696) was 3 times that for whites (.0855), although the difference was not statistically significant.

To further examine the relationship between race and survival, stratified life table analysis was done for the most important predictors of mortality in table 15. For those with normal ventricles (wall motion score of 5), white five year survival of 94.5% was better than black survival of 90.9% (p=.0069), while white survival was also superior in the group with moderately impaired left ventricles (wall motion score 11 to 16) (73.1% vs. 65.9%, p=.0096). Black survival was poorer in all four categories of the number of diseased vessels, and was also worse in those with mild or moderate angina (Class I or II) (89.6% vs. 79.1%, p=.0004) and those with severe angina (Class III or IV) (84.5% vs. 77.1%, p=.0037). In the group without angina, black survival of 91.7% was slightly better than white survival of 88.7%, although the difference was not statistically significant. Black and white survival was equivalent for all categories of the congestive heart failure score. For current cigarette smokers, 86.3% of whites survived 5 years, whereas only 78.3% of blacks survived 5 years (p=.0003).

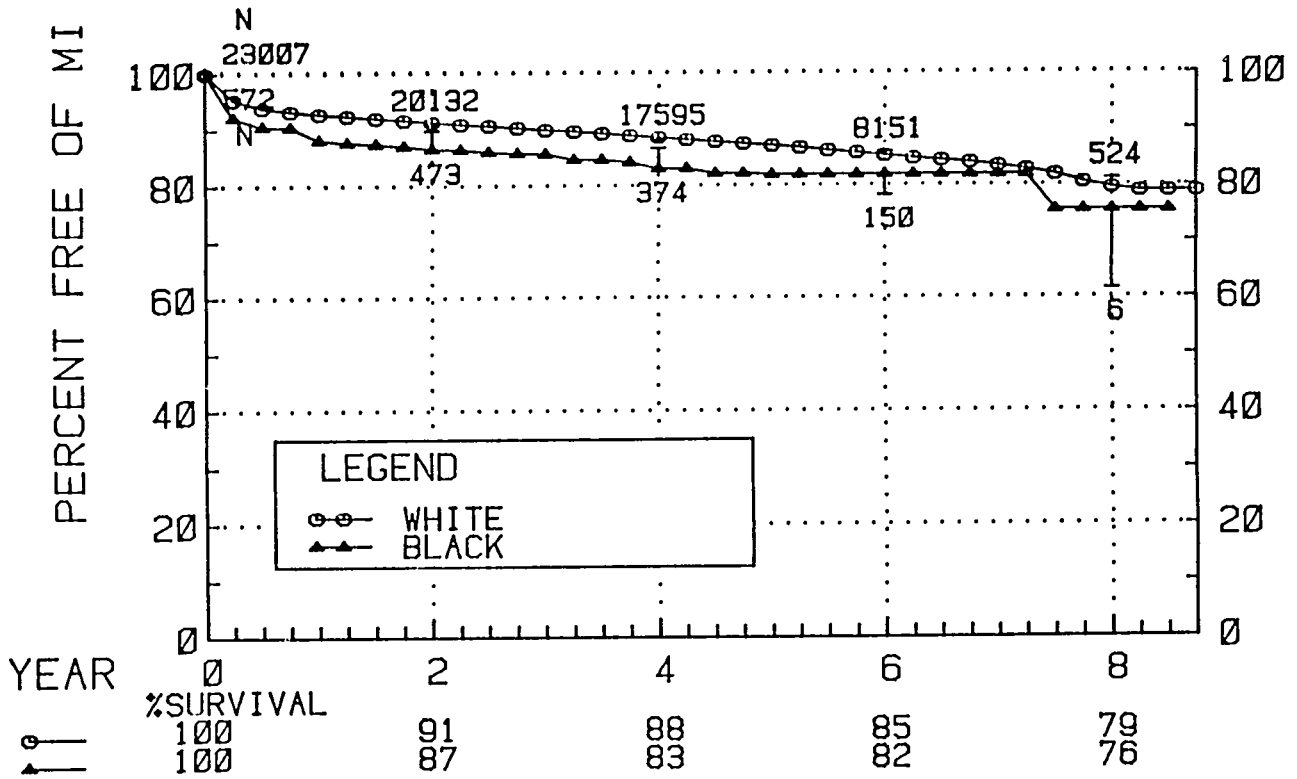
Survival for blacks who never smoked or who were former smokers was 91.9% and 85.2%, respectively, whereas survival for whites in the same categores was 89.3% and 86.7%. Racial differences were not statistically significant. Finally, for hypertensive patients, whites fared slightly better than did blacks, but the difference was not statistically significant (84.0% vs. 82.5%, p=.08).

Morbidity-Of the 572 black patients, there were 98 who had MIs during the course of the study. However, 32 patients had MIs which occurred in the 60 day period prior to enrollment. Of the 23,007 white patients, there were 3125 who had an MI, and 529 had an infarct in the 60 day period prior to enrollment. Sixteen or 2.7% of black patients had more than one MI, and 1.8% of white patients had more than one infarct (p=.042). First infarcts defined as definite occurred in 65.3% of blacks and 58.8% of whites (p=ns). Documentation by ST-T changes, new Q waves, and/or enzyme changes was accomplished in 91.8% of black patients and 86.6% of white patients (p=ns). The location of the infarct did not differ in the two groups; 37.8% of black MIs were anterior, 30.6% inferior, and 25.5% subendocardial, whereas for whites, 31.9% were anterior, 30.6% inferior, and 25.5% subendocardial. In the remaining infarcts, the location was unknown.

Life table analysis of the time to death, infarction, or censoring is presented in figure 3. The unadjusted difference with respect to infarction was statistically significant ($p=.0021$). Annual rates of infarction by age, sex, and race are presented in table 16. The overall rate of MI for blacks was 42.8 per 1000 per year, whereas that for whites was 28.8 per 1000 per year ($p<.0001$). The numbers of blacks in the ages 65-74 was very small, but the rates of infarction for these individuals was particularly high in comparison with whites of the same ages. Young black males and black females ages 55-64 exhibited rates of infarction which were significantly higher than white rates.

In order to determine the relationship of race to MI, Cox regression for both medical and surgical groups was employed. At the first step in the analysis, all relevant variables except race were allowed to enter; at the second stage, race was allowed to enter only after all predictors had entered. The results of the analysis are displayed in table 17. In both medical and surgical groups, race was a significant predictor of infarction after controlling for important predictors of MI. In the medical group, being black was associated with the presence of MI ($p<.0001$), as it was in the surgical group ($p=.004$).

Figure 3. Myocardial Infarction by Race.



P = 0.0021
Log Rank Stat = 9.493

Table 16
Annual Rates of Myocardial Infarction in CASS (per 1000)

	Males			Females		
Age	Black	White	P	Black	White	P
35-44	48.2	25.8	.01	19.0	13.8	NS
N	95	2660		61	761	
45-54	40.8	30.1	NS	25.3	16.2	NS
N	131	6438		85	1976	
55-64	41.6	32.8	NS	58.4	24.5	.008
N	87	6052		48	1988	
65-74	281.6	45.2	<.0001	107.1	33.7	NS
N	18	1576		5	725	

Table 17
Predictors of Myocardial Infarction for Medical and Surgical Patients in CASS

	Medical N=14,131			Surgical N=8,144	
Variable	Beta	P at Entry	Variable	Beta	P at Entry
No. Ves.	.3563	<.0001	Uns. Ang.	.2389	<.0001
Prior MI	.3063	<.0001	Rales	.5808	<.0001
Uns. Ang.	.3660	<.0001	Myo. Jep.	−.0898	<.0001
Hypertension	.1391	<.0001	Hypertension	.1110	.0001
NYHA Class	.0654	<.0001	Smoking	.1152	.0010
Smoking	.1542	<.0001	Prior MI	.1055	.0069
Diabetes	.1347	.0001	Prxml. Ves.	−.1138	.0040
LV Score	.0260	.0011	CHC-No. Ves.	.0314	.0008
Prxml Ves.	−.1046	.0031	Other Occ.	−.2662	.0284
Operable Ves.	.1034	.0019	Digitalis	−.1740	.0354
Rales	.3182	.0098	Race	.5415	.0112
Nitro	−.1140	.0420			
Race	.5629	<.0001			

No. Ves.=Number of Diseased Vessels MI=Myocardial Infarction Uns. Ang.=Unstable Angina NYHA=New York Heart Association Prxml. Ves.=Number of Diseased Proximal Vessels Operable Ves.=Number of Operable Vessels Myo. Jep.=Myocardial Jeopardy CHC-No. Ves.=Canadian Heart Class-Number of Diseased Vessels Other Occ=Other Occupation LV=Left Ventricular

Information concerning the hospitalization of blacks and whites in CASS is reported in table 18. As can be seen, blacks and whites did not differ with respect to hospitalizations except in the bypass surgery category, where a considerably higher percentage of whites were hospitalized during the first year of enrollment. This difference was also reflected in the total or all hospitalizations category. It should be recognized that for a significant proportion of blacks and whites that hospitalization status was unknown due to death or missing data. In the later years of follow-up, death was the more important reason for unknown hospitalization status.

Quality of Life-Indicators of quality of life were analyzed for both surgical patients and medical patients with at least one diseased vessel. The results of these analyses are presented in tables 19 and 20. In computing tests of significance, deaths were included, so that higher black mortality resulted in statistical significance despite similar distributions of quality of life characteristics in the two groups. In the surgical group, blacks had a higher percentage of severe angina, were more likely to have quit work, and were more sedentary than were whites. In the first year of follow-up, blacks had a higher percentage of smokers,

Table 18
Percentage of Patients Hospitalized During Follow-up Year

	Year 1		Year 3		Year 5	
	B	W	B	W	B	W
All	34.8	50.5*	19.2	18.5	22.6	19.8
Bypass Surgery	19.8	40.2*	0.0	1.1	.5	1.4
Cardiac including MI	19.1	18.7	15.2	13.2	16.8	13.3
Valvular, Myocardial Surgery	.2	.4	1.9	.02	0.0	.06
Other Cardiac Surgery	3.0	3.3	5.7	5.8	6.3	7.4
N	491	22,043	349	18,748	190	12,429
Unknown	14.3	.4	39.1	18.5	66.8	46.0

* P<.0001

MI=Myocardial Infarction

Table 19
Selected Indicators of Quality of Life for Blacks and Whites who ever had Surgery

	Baseline		Year 1		Year 3		Year 5	
	B	W	B	W	B	W	B	W
Dead	--	--	6.2	5.4	15.8	7.5	17.9	12.5
Def. or Prob. Ang.	90.9	92.7*	28.4	24.1*	34.7	31.1	32.0	32.2*
Mild or Moderate Angina	14.7	24.4	24.4	19.0	22.1	20.1	19.2	23.1
Severe Angina	70.4	60.3	10.0	6.9	9.5	9.5	15.4	7.1
Quit Work	22.7	13.9	34.6	20.7	37.9	21.8	29.5	21.8
Sedntry.	33.0	36.0*	27.2	15.4	16.8	11.8	12.8	9.3
Current Smoker	45.4	30.3	32.1	20.4	25.3	22.8	24.4	22.2*
Diuretic	45.5	23.4	34.6	23.0	43.2	27.2	52.6	28.5
Beta Blocker	54.6	57.2*	23.5	18.3*	33.7	25.3	37.2	28.5
Nitro	75.0	74.0*	24.7	15.7	29.5	20.7	24.4	22.9*
N	88	8550	81	7426	95	8937	78	7467
Follow-up Unknown			19.0	16.3	12.0	4.6	22.8	16.9

* P>.05. All other comparisons are significant at P<.05.

Prob. or Def=Probable or Definite Angina Sedntry=Sedentary Recreational Activity Nitro=Nitroglycerin

Table 20
Selected Indicators of Quality of Life for Black and White Medical Patients in CASS+

	Baseline		Year 1		Year 3		Year 5	
	B	W	B	W	B	W	B	W
Dead	--	--	18.5	9.5	25.4	16.6	41.2	28.0
Prob. or Def. Angina	76.9	74.6*	50.0	50.9	44.9	49.6	36.3	41.4
Mild or Moderate Angina	32.6	35.5	33.8	35.2	29.7	32.4	26.5	29.1
Severe Angina	39.6	31.4	19.3	15.3	15.9	11.2	10.8	8.2
Quit Work	18.9	15.2*	34.7	20.8	30.4	21.5	20.8	18.1
Sedntry.	44.4	35.2*	25.0	19.6	17.4	13.8	10.8	10.2
Current Smoker	56.2	35.7	38.7	30.8	31.2	29.8	24.5	25.1
Diuretic	39.6	24.9	36.3	26.2	39.8	25.2	29.4	22.5
Beta Blocker	38.4	42.4*	45.2	50.4	39.1	46.7	29.4	40.2
Nitro	63.3	58.7*	47.6	44.3	36.2	36.7	34.3	30.7
N	169	7843	124	6355	138	6820	102	5161
Follow-up Unknown			21.0	15.5	10.4	4.7	23.3	18.1

+ Patients with at least one diseased vessel and angina pectoris.

* P>.05. All other comparisons are significant at P<.05.

Prob. or Def.=Probable or Definite Angina Sedntry=Sedentary Recreational Activity Nitro=Nitroglycerin

although the percentages smoking were the same in year 5. A higher percentage of blacks was also using various medications in the years following enrollment; in particular diuretic use was significantly higher in all years of follow-up as it was at baseline, and nitroglycerin and beta blocker use was also significantly higher during certain years of follow-up. The percentage of patients with unknown follow-up was approximately the same in years 1 and 5, although blacks had a higher percentage of unknowns in year 3. The small number of blacks who had surgery, as well as a relatively high percentage of unknowns, resulted in small numbers for the purposes of comparison.

In the group of medical patients with at least one diseased vessel, black mortality was considerably higher at all three years. As in the surgical group, blacks had more severe angina, were more likely to have quit work, and were more sedentary than were their white counterparts. Smoking patterns were similar in that differences disappeared after the first year of follow-up. A higher percentage of blacks used diuretics, although a higher percentage of whites used beta blockers during years 3 and 5. Nitroglycerin use in the two groups was similar. The high percentage of deaths as well as the high percentage of unknowns resulted in small

numbers for these comparisons.

Discussion

The important and most discouraging finding of this study was that blacks in CASS experienced poorer survival, higher morbidity, and poorer quality of life than did their white counterparts. Age and sex specific survival was better for whites in both CASS and the general U.S. population. In CASS, a population of individuals with suspected or proven coronary artery disease, it was not surprising that a high percentage of both black and white deaths was due to cardiac causes. Multivariate analysis of the relationship between race and mortality showed that being black was related to higher mortality in medical patients, but was not related to survival for surgical patients. For blacks, after adjustment for key covariates, surgical therapy was found to be associated with increased survival. Not only were age and sex specific MI rates higher for blacks, but multivariate analysis revealed that race was associated with the occurrence of MI in both medical and surgical groups. Hospitalization rates were higher for whites, mainly because of increased levels of coronary artery bypass surgery. Finally, comparisons of life quality were clouded by higher percentages of incomplete follow-up for blacks, yet available information showed

that blacks fared poorly on several indicators of life quality.

Given the high level of risk of blacks in CASS documented in chapter 2, it is not altogether surprising that black survival was poorer than white. Black mortality was heavily concentrated in the laborer group and in those who were current smokers and/or reported a history of hypertension. Not only did blacks have a higher degree of risk with respect to smoking and hypertension which resulted in higher mortality, but among those who were current smokers, blacks had higher mortality. The combination of current smoking and hypertension was particularly problematic for blacks; this is supported by the fact that 27.8% of blacks were both current smokers and hypertensive, whereas 9.9% of the white group had this combination of risk factors. For individuals who had both of these risk factors, the 5 year survival was 84% for whites and 79% for blacks. Blacks in the U.S. have one of the highest coronary heart disease mortality rates in the world, despite myths that whites have much more coronary disease and that blacks are immune to coronary disease (20,97). Given high levels of risk in the U.S. black population, it is somewhat surprising that mortality from coronary disease is not higher for blacks (25). However, in CASS black

mortality rates were much higher than white rates and were consistent with higher levels of risk due to cigarette smoking and hypertension.

An important finding which qualifies the previous discussion was that after controlling for important demographic, clinical, and angiographic characteristics in the surgical group, race was found not to be associated with survival. For blacks, after adjustment for critical covariates, surgical therapy enhanced survival. It was reported in chapter 3 that blacks in CASS were underserved with respect to surgical therapy; that is blacks who were potential surgical candidates (at least one diseased vessel and mild or moderate angina) received bypass surgery less often than expected on the basis of clinical and angiographic characteristics. It is important to ask if the inaccessibility of surgical therapy has resulted in shorter lives for those blacks with coronary disease who did not receive surgery. Of blacks who had at least one diseased vessel and mild or moderate angina, 62.7% of the medical group and 78.6% of the surgical group survived 5 years. However, this comparison does not adjust for significant clinical and angiographic differences between the two groups. Nevertheless, the finding that after adjustment for covariates, surgical therapy enhanced survival in blacks

suggests that black medical patients with significant coronary disease and chest pain might have benefited from surgical therapy. Other investigators have reported no difference in the survival of black medical and surgical patients (49).

Although black survival improved with surgical therapy, quality of life was not as favorable for black surgical patients as for whites. Quality of life has been defined as "an individual's ability to perform a variety of social roles and to derive satisfaction from them (59)." Dimensions of life quality include (1) performance of social roles, (2) the physiologic state of the individual, (3) the emotional state of the individual, and (4) general satisfaction (60). Measures of quality of life in CASS were concerned primarily with the second dimension, although aspects of the other three dimensions are reflected in these measures (10). During the first year of follow-up, a higher percentage of black patients had severe angina, were on diuretics, were current smokers, were sedentary, and quit work. At the end of 5 years, some of these differences diminished as the sicker patients died. In short, a higher percentage of black surgical patients in comparison with their white counterparts continued to have severe chest pain, needed medication to control hypertension, and could no longer

work. However, it is important to recognize that blacks had higher baseline rates with respect to severity of chest pain, cigarette smoking, diuretic use, and having to quit work. Finally, and of some importance quality of life did improve for blacks who had bypass surgery.

The significant percentage of unknowns and the high percentage of deaths in black medical patients with at least one diseased vessel and chest pain made quality of life comparisons between black medical and surgical patients difficult. Since blacks were not randomly assigned to medical or surgical therapy, comparison of quality of life in the two groups was also problematic. Results from the CASS randomized trial showed that surgical patients had better quality of life with respect to relief of chest pain, improvement in both objective and subjective indicators of functional status, and diminished need for drug therapy, although no differences were reported for employment and recreational activity (10). Although it might seem reasonable to conclude that black surgical patients would have the same experience in relation to their medical counterparts, the available information is not adequate to support this conclusion.

Although the question of whether surgical therapy prevented MI in blacks was not investigated, it was discovered that race was associated with the presence of MI in both medical and surgical groups. Gillum (20) has reviewed population based studies which report MI incidence in blacks. Results from these studies serve to refute the myth that blacks seldom have MI. Since blacks in CASS were anything but a random sample, comparison of black MI rates in CASS with those of population based studies is unwarranted. MI rates for CASS blacks were high, given that almost 20% of the blacks enrolled had an infarct during the course of the study. That CASS blacks fared poorly with respect to MI is consistent with their high levels of risk and mirrors the findings for survival and quality of life.

The question of who are these blacks in CASS must be raised again. The picture of high levels of risk and minimal coronary disease has become clearer in that high levels of mortality and MI are consistent with higher levels of smoking and hypertension. The role of hypertension in deaths due to cerebrovascular and renal diseases must be considered in blacks (83), although the small numbers of blacks in CASS did not yield many deaths due to these causes. Others have indicated that black mortality from cardiac causes is lower than expected

given levels of risk (20,83), although in CASS this was not the case.

As was seen in chapter 2, blacks in CASS were in some ways similar to blacks in the general population in that they had high levels of risk as demonstrated by comparable levels of cigarette smoking and elevated blood pressure. Yet, evidence just presented in this chapter indicated that blacks had much higher mortality than did U.S. blacks of the same age and sex. As has been seen, blacks in CASS were different by virtue of having undergone cardiac catheterization, a relatively uncommon event for black Americans. Consequently, blacks in this study were very much part of the health care system; that is they most likely had a regular physician who referred them to a cardiologist who in turn recommended coronary angiography and bypass surgery in some cases. Yet, the fact that the majority of black males were laborers probably indicates that blacks in CASS were no better off economically than other black males of the same age. The same can be said of black females who were most likely single heads of families. It is difficult to say much more about blacks who enrolled in CASS.

Blacks in this study were subjected to the hazards of living in a society in which opportunities for blacks are not what they are for whites. Clearly, inequality affects black economic and social status (97), yet it also is very much associated with the health status of blacks (14). Greater cigarette use, excess hypertension, poor nutrition, obesity, relative exclusion from health promotion programs, and high levels of occupational and familial stress are characteristics common to too many black Americans. Blacks enrolled in CASS were characterized by high levels of risk factors and minimal coronary disease. Despite the high percentage of individuals with normal coronary arteries, black mortality was high when adjusted for extent of disease. In order to prevent mortality and morbidity, aggressive control of hypertension in blacks with normal coronary arteries and angina pectoris has been advocated (81). In CASS, black mortality might have been reduced by such therapy, although information concerning the effectiveness of hypertension control was not available. Undoubtedly, black mortality would have been reduced by cessation of cigarette smoking. A recent report from the National Health and Nutrition Examination Survey indicated that reduced levels of risk with respect to cigarette smoking and hypertension have resulted in lower

levels of mortality for U.S. blacks during the years 1971-1980 (28). In CASS it is apparent that these changes, if they were made, were not enough to offset other factors resulting in high mortality rates experienced by this small and perplexing group of black Americans.

Chapter 5
Conclusion

Before reviewing the significant findings of this thesis, it must be recognized that the Coronary Artery Surgery Study was designed as first a randomized trial of coronary artery bypass surgery and second a registry of patients undergoing coronary angiography for the diagnosis of proven or suspected coronary artery disease. The CASS was not designed to answer the questions put forth in chapter 1 of this study. Nevertheless, the existence of 573 blacks in the CASS registry presented a significant opportunity to examine the experience of a group of black patients who underwent coronary angiography. In particular, it was possible to investigate the general topics of risk factors and coronary artery disease, clinical decision making, and therapeutic outcome as measured by mortality, morbidity, and quality of life. These investigations answered many questions, left others unanswered, and raised several new questions as well.

In chapter 2 of this study, it was apparent that blacks in CASS had high levels of modifiable risk factors for coronary artery disease, yet low levels of disease as documented by coronary angiography. In particular, blacks in comparison to whites had higher levels of

hypertension and current cigarette smoking, yet considerably less coronary disease. It was demonstrated that after controlling for important covariates, black race was associated with the absence of significant coronary disease despite the presence of chest pain. It is difficult to account for this chest pain in the absence of significant atherosclerotic lesions. However, a sizeable percentage of black males and both black and white females exhibited this commonly encountered situation.

In chapter 3, the focus was on those blacks who were potential surgical candidates in that they had chest pain and at least one diseased vessel. After controlling for the clinical and angiographic predictors of surgery, it was discovered that blacks and in particular black laborers were underserved with respect to coronary bypass surgery. The possible reasons for this differential were explored; the small numbers of black surgical candidates and the dearth of information concerning income, marital status, education, and insurance coverage precluded an explanation for this finding. However, the differential in surgical rates was not due to clincical and angiographic differences between blacks and whites. Blacks as well as whites had a definite medical need for the operation, but it is likely that resources such as

health insurance, family support, and disability income were not sufficient to enable blacks to undergo the operation.

Finally, in chapter 4, the disappointing results of higher black mortality and morbidity as indicated by myocardial infarction, and poorer quality of life in blacks who were candidates for bypass surgery were noted. Mortality was concentrated in the laborer group and was higher for blacks who were current smokers and reported a history of hypertension. The role of hypertension in mortality was more important for blacks than it was for whites as indicated by proportional hazards analysis. The finding that blacks with normal coronary arteries had higher mortality than their white counterparts also points to the possibility that hypertension related conditions such as cerebrovascular and renal diseases may have been important causes of death in these individuals. However, the small numbers of deaths in blacks with normal coronary arteries made it difficult to evaluate this statement. Finally, the result that after controlling for important covariates, surgical therapy was associated with increased survival in blacks, yet was used less often in this group raises serious questions about the distribution of important medical resources.

An important question is to whom, beyond the blacks in the Coronary Artery Surgery Study, are these findings applicable? A major problem with this study has been to define who are the blacks that participated in CASS. It is known that these blacks were predominantly middle age males who were laborers. In addition, these individuals had high levels of modifiable risk for coronary artery disease as evidenced by high levels of current cigarette smoking and hypertension. These levels of risk were similar to those reported for a random sample of blacks in the National Health and Nutrition Examination Survey. However, the high mortality and myocardial infarction rates for blacks in CASS indicate that this was not a particularly healthy group of individuals. As was seen, the probability of five year survival was much lower than for U.S. blacks of the same age and sex. This is not altogether surprising given that CASS blacks were selected for coronary angiography.

What is unknown is how these blacks were selected for angiography. There exists no information on referral patterns to CASS institutions. It is likely that these blacks had a regular source of health care given that they were referred for cardiac catheterization. Yet, the fact that 14 centers saw a total of 573 black patients over a five year period indicates that CASS institutions

were seeing relatively few black patients. It is difficult to detemine in what ways blacks in CASS are representative of (1) blacks undergoing cardiac catheterization and (2) blacks of the same age and sex in the general population. Given that cardiac catheterization is a relatively uncommon procedure for blacks, it is likely that CASS blacks are in some way representative of blacks undergoing the procedure. In comparison to the general population, blacks in CASS were distinguished by having undergone the procedure. Yet, while they were similar with respect to levels of modifiable risk factors, they were much less healthy than their counterparts in the general population. Economically, they may have been relatively well off given that that they most likely had health insurance to cover the cost of cardiac catheterization. Unforunately, data on income and health insurance coverage were not available to assess the validity of this contention.

Furthermore, these findings raise questions about the character of coronary artery disease in blacks. As has been seen, the finding of chest pain in the absence of significant coronary artery disease has been reported by other investigators. However, it is difficult to explain the presence of this pain; some have speculated that it is due to coronary artery spasm, whereas others

feel that it may be due to left ventricular hypertrophy. Nevertheless, this pain is an important symptom which impedes daily functioning. Related to this question of chest pain and minimal coronary disease is the question do blacks have a lower incidence of coronary disease than do whites? In addition, are the risk factors for blacks the same as they are for whites. CASS, of course, was not designed to answer these questions, although evidence shows that CASS blacks did have less angiographic coronary disease and that risk factors for the disease were similar to those exhibited by whites.

An additional question raised by analysis in chapter 4 has to do with the role of hypertension in the black experience. For all blacks, uncontrolled hypertension is a particularly important factor in mortality due to cardiovascular, cerbrovascular, and renal causes. In CASS no information regarding the effectiveness of hypertension control was available, however evidence from NHANES and MRFIT indicates that blacks were willing participants in blood pressure control programs and that improved control of hypertension was responsible for a decline in cardiovascular mortality for blacks. It is also important to know if blacks delay in seeking preventive care for the identification of elevated blood pressure. Again, CASS was not designed to answer these

questions, but the results clearly show that hypertension was an important factor in black mortality.

A key assumption of this study has been that race is a social category which is related to important modifiable risk factors and indicators of coronary artery disease such as chest pain, myocardial infarction, mortality, and quality of life. This study has been hampered by the lack of important social and economic data beyond rudimentary occupational and employment status categories. The National Heart, Lung, and Blood Institute working conference on coronary heart diesase in black populations devoted considerable time to conceptual and methodological issues involved in studying the role of socioeconomic and sociocultural influences in coronary heart disease in blacks. The conference concluded that the definition and measurement of socioeconomic status has been too narrow and simplistic and that the concept has been treated as a descriptive variable rather than a multidimensional concept. The conference also stated that there was a tendency to specify direct unidirectional linkages between socioeconomic status and illness outcomes without showing direct linkages between social status and intervening variables such as preventive health behaviors and clinical decision making (99).

This dearth of information on socioeconomic status was particularly problematic in attempting to explain the deficit with respect to coronary artery bypass surgery for blacks. Basic information on health insurance coverage and income would have allowed evaluation of the hypothesis that blacks did not have surgery due to insufficient resources. Evaluation of the other hypotheses concerning black refusal to have the operation and discrimination on the part of physicians and institutions would have required additional information concerning the attitudes of blacks toward physicians and their perceptions of the quality of health care provided them. Concerning the discrimination hypothesis, assessment of physician and institutional performance for a variety of medical procedures would be necessary. Great effort would be required to obtain such information. Although much more needs to be done on this issue, an important finding of this study has been that blacks were underserved with respect to surgery. The data requirements necessary to reach this conclusion were considerable due to detailed angiographic and clinical data needed to adjust for differing patient populations.

Clearly, the topic of blacks and coronary heart disease is frought with many complexities. It is evident that more knowledge must be acquired if effective health

care is to be provided and delivered to blacks with coronary artery disease. This has been recognized by health care professionals who have met to discuss this critical issue. In the spring of 1983 a symposium on coronary heart disease in black populations was held and in the fall of that same year an important National Heart, Lung, and Blood Institute working conference on coronary heart disease in black populations was convened. The conference made recommendations in four major areas; epidemiology, risk factors, socioeconomic and sociocultural influences, and natural history, prevention, and medical and surgical treatment (100, 101, 99, 102). Many significant research needs identified at the conference have been mentioned throughout this study.

The resources required to satisfy such needs are considerable, yet given the competition for limited funding for biomedical research, it is evident that research needs will have to be carefully identified and prioritized. Issues such as the incidence and prevalence of coronary disease, risk factors including socioeconomic status, hypertension in the black experience, and health knowledge and attitudes of blacks are deserving of further attention. Also, questions concerning the distribution and quality of health care must be

addressed. Recent reports from the Institute of Medicine, the President's Commission, and a recent DHHS report on the health status of minorities, as well as this study have emphasized this.

Finally, this study has recognized the importance of social science approaches in studying health problems. In CASS, millions of dollars were spent to collect medical information, yet very little effort was devoted to gathering information about socioeconomic status. If such information had been available, more would be known about the epidemiology of angiographically determined coronary disease as well as the distribution of important health care technologies such as coronary angiography and coronary artery bypass surgery. Social science viewpoints (103) should be represented in the planning of cardiovascular research which evaluates new theraputic modalities such as percutaneous transluminal coronary angioplasty and thrombolysis in the treatmemt of acute myocardial infarction as well as in research concerned with the epidemiology of coronary artery disease. If more knowledge and understanding of the epidemiology, diagnosis, and treatment of the major diseases of the late twentieth century are to be gained, the perspective of the social scientist, who has a distinctive understanding of society and human behavior, must be

heard and appreciated.

List of References

1. National Center for Health Statistics: Mortality, United States, 1977. B. Numbers of Deaths. Washington, D.C.: U.S. Government Printing Office, 1981.

2. Charles, E.D, and Kronenfeld J.J. Introduction. in Charles, E.D., and Kronenfeld, J.J., editors. Social and Economic Impacts of Coronary Artery Disease. Lexington, Massachusetts: D.C. Heath and Company, 1980: 1-6.

3. Shapiro, S. Epidemiology of Ischemic Heart Disease and Cancer. in Mechanic, D., editor. Handbook of Health, Health Care, and the Health Professions. New York: The Free Press, 1983: 120-156.

4. Cohn, P.F., Adams, D.F., and Goldberg, S. Cardiac Catheterization and Coronary Arteriography. in Cohn, P.F., editor. Diagnosis and Therapy of Coronary Artery Disease. Boston: Little, Brown and Company, 1979: 163-190.

5. Russell, R.O., Mantle, J.A., Rogers, W.J., and Rackley, C.E. Medical Therapy of Angina Pectoris. in Charles, E.D. and Kronenfeld, J.J., editors. Social and Economic Impacts of Coronary Artery Disease. Lexington, Massachusetts: D.C. Heath and Company, 1980: 39-54.

6. Kouchoukos, N.T. Development and Application of Surgical Therapy in Charles, E.D. and Kronenfeld, J.J., editors. Social and Economic Impacts of Coronary Artery Disease. Lexington, Massachusetts: D.C. Heath and Company, 1980: 55-66.

7. Preston, T.A. Coronary Artery Surgery: A Critical Review. Raven Press: New York, 1977.

8. Graves, E. and Haupt, GJ. Detailed Diagnoses and Surgical Procedures for Patients Discharged from Short-stay Hospitals, United States, 1979. DHHS Publication No. (PHS) 83-1733. Washington, D.C.: National Center for Health Statistics, 1983.

9. CASS Principal Investigators and their Associates. Coronary Artery Surgery Study (CASS): A Randomized Trial of Coronary Artery Bypass Surgery, Survival Data. Circulation 68: 939-950, 1983.

10. CASS Principal Investigators and their Associates. Coronary Artery Surgery Study (CASS): A Randomized Trial of Coronary Artery Bypass Surgery, Quality of Life in Patients Randomly Assigned to Treatment Groups. Circulation 68:951-960, 1983.

11. European Coronary Surgery Study Group. Long-Term Results of Prospective Randomised Study of Coronary Artery Bypass Surgery in Stable Angina Pectoris. Lancet 2:1173-80, 1982.

12. Preston, T.A. Marketing an Operation. Atlantic Monthly 254:32-40, 1984.

13. Strauss, A., Fagerhaugh, S., Suczek, B., and Wiener, C. Social Organization of Medical Work. Chicago: University of Chicago Press, 1985.

14. Cooper, R. A Note on the Biologic Concept of Race and its Application in Epidemiologic Research. American Heart Journal 108:715-723, 1984.

15. Blackwell, J.E. The Black Community: Diversity and Unity. New York: Harper and Row, 1975.

16. Jackson, J.J. Urban Black Americans. in Harwood, A., editor. Ethnicity and Medical Care. Cambridge, Massachusetts: Harvard University Press, 1981:37-129.

17. Langford H.G. Is Blood Pressure Different in Black People? Postgraduate Medical Journal 57:749-754, 1981.

18. Hypertension Detection and Follow-up Program Cooperative Group: Race, Education and Prevalence of Hypertension. American Journal of Epidemiology 106:351-361, 1977.

19. Dawber, T.R., Moors, F.E., and Mann, G.V. Coronary Heart Disease in the Framingham Study. American Journal of Public Health 47:4-24, 1957.

20. Gillum, R.F. Coronary Heart Disease in Black Populations I. Mortality and Morbidity. American Heart Journal 104:839-851, 1982.

21. Cornoni J., Waller, L.E., Casel, J.C., Tyroler, H.A., and Hames C.G. The Incidence Study: Study Design and Methods. Archives of Internal Medicine 128:896-900, 1971.

22. Cassel, J., Heyden, S., Barterl, A.G., Kaplan, B.H., Tyroler, H.A., Cornoni, J.C., and Hames C.G. Incidence of Coronary Heart Disease by Ethnic Group, Social Class and Sex. Archives of Internal Medicine 118:901-906, 1971.

23. Shapiro, S., Weinblatt, E., Frank, C.W., and Sager, R.V. Incidence of Coronary Heart Disease in a Population Insured for Medical Care (HIP). American Journal of Public Health 59 (No. 6, suppl.):1-101, 1969.

24. McDonough, J.R., Hames, C.G., Stulb, S.C., et al. Coronary Heart Disease among Negroes and Whites in Evans County, Georgia. Journal of Chronic Diseases 18:443-468, 1965.

25. Gillum, R.F. and Grant, C.T. Coronary Heart Disease in Black Populations II. Risk Factors. American Heart Journal 104:852-864, 1982.

26. Tyroler, H.A., Knowles, M.G., Wing, S.B., et al. Ischemic Heart Disease Risk Factors and Twenty-year Mortality in Middle-age Evans County Black Males. American Heart Journal 108:738-746, 1984.

27. Keil, J.E., Loadholt, C.B., Weinrich, M.C., Sandifer, S.H., and Boyle, E. Incidence of Coronary Heart Disease in Blacks in Charleston, South Carolina. American Heart Journal 108:779-786, 1984.

28. Rowland, M.L., and Fulwood, R. Coronary Heart Disease Risk Factor Trends in Blacks Between the First and Second National Health and Nutrition Examination Surveys, United States, 1971-1980. American Heart Journal 108 771-778, 1984.

29. Becker, M.H., and Maiman, L.A. Models of Health Related Behavior. in Mechanic, D. editor. Handbook of Health, Health Care, and the Health Professions. New York: The Free Press, 1983:539-568.

30. McKinlay, J.B. Some Approaches and Problems in the Study of the Use of Services-An Overview. Journal of Health and Social Behavior 13:115-152, 1972.

31. Suchman, E.A. Social Pattern of Illness and Medical Care. Journal of Health and Social Behavior 6:2-16, 1965.

32. Suchman, E.A. Stages of Illness and Medical Care. Journal of Health and Social Behavior 6:114-128, 1965.

33. Suchman, E.A. Health Orientation and Medical Care. American Journal of Public Health 56:97-105, 1966.

34. Rosenstock, I.M. The Health Belief Model and Prevention Health Behavior. Health Education Monographs 2:354-386, 1974.

35. Kasl, S.V., and Cobb, S. Health Behavior, Illness Behavior, and Sick Role Behavior. II. Sick Role Behavior. Archives of Environmental Health 12:531-541, 1966.

36. Andersen, R. A Behavioral Model of Families' Use of Health Services. Chicago: Center for Health Administration Studies, 1968.

37. Aday, L.A., Fleming, G.V., and Andersen, R. Access to Medical Care in the U.S.: Who Has It, Who Doesn't. Chicago: Center for Health Administration Studies, 1985.

38. Pauker, S.G. Coronary Surgery: The Use of Decision Analysis. Annals of Internal Medicine 85:8-18, 1976.

39. Weinstein, M.C., Pliskin, J.S. and Stason, W.B. Coronary Artery Bypass Surgery: Decision and Policy Analysis. in Bunker, J.P., Barnes B.A., and Mosteller, F., editors. Costs, Risks, and Benefits of Surgery. New York: Oxford University Press, 1977:342-371.

40. Weinstein, M.C. and Finebery H.V. Clinical Decision Analysis. Philadelphia: W.B. Saunders, 1980.

41. Eisenberg, J.M. Sociologic Influences on Decision Making by Clinicians. Annals of Internal Medicine 90:957-964, 1979.

42. Elstein, A.S., Rovner, D.L. Holzman, G.B., Ravitch, M., Rothert, M.L., and Holmes, M.M. Psychological Approaches to Medical Decision Making. American Behavioral Science 25:557-584, 1982.

43. Bosk, C. Forgive and Remember, Managing Medical Failure. Chicago: University of Chicago Press, 1979.

44. Katz, P. How Physicians Make Decisions. in Hahn,

R.A., and Gaines, R.D., editors. Physicians of Western Medicine. Dordrecht: D. Reidel Publishing Company 1985: 155-175.

45. Alderman, E.L., Fisher, L.D., Maynard, C., et al. Determinants of Coronary Surgery in a Consecutive Patient Series from Geographically Dispersed Medical Centers. Circulation 66 (Suppl. I): I6-I15, 1982.

46. Maynard, C., Fisher, L.D., Alderman, E.L., et al. Institutional Differences in Therapeutic Decision Making in the Coronary Artery Surgery Study (CASS). Medical Decision Making (In press).

47. Institute of Medicine. Health Care in a Context of Civil Rights. Washington D.C.: National Academy Press, 1981.

48. President's Commission for the Study of Ethical Problems in Medicine and Biomedical and Behavioral Research. Securing Access to Health Care; The Ethical Implications of Differences in the Availability of Health Services, Volume 1. Washington, D.C.: United States Government Printing Office, 1983.

49. Oberman, A., and Cutter, G. Issues in the Natural History and Treatment of Coronary Heart Disease in Black Populations: Surgical Treatment. American Heart Journal 108: 688-694, 1984.

50. Young, L.Y. Who is Likely to Have Coronary Bypass Surgery. Paper Presented to the Annual Meeting of the American Statistical Association. August 1983.

51. McKeown, T. The Modern Rise of Population. New York: Academic Press, 1976.

52. Rosenberg, H.M., and Klebba, A.J. Trends in Cardiovascular Mortality with a Focus on Ischemic Heart Disease: United States, 1950-1976. Proceedings of the Conference on the Decline in Coronary Heart Disease Mortality. PHS Publication No. 79-1610. Bethesda, Maryland: National Institutes of Health, 1979.

53. Stern, M.P. The Recent Decline in Ischemic Heart Disease Mortality. Annals of Internal Medicine 91: 630-640, 1979.

54. Stallones, R.A. The Rise and Fall of Ischemic Heart

Disease. Scientific American 243: 53-59, 1980.

55. Pell, S., and Fayerweather, W.E. Trends in the Incidence of Myocardial Infarction and in Associated Mortality and Morbidity in a Large Employed Population, 1957-1983. New England Journal of Medicine 312: 1005-1011, 1985.

56. Multiple Risk Factor Intervention Trial Research Group. Multiple Risk Factor Changes and Mortality Results. Journal of the American Medical Association 248: 1465-1477, 1982.

57. Passamani, E., Davis, K.B., Gillespie, M.J., Killip, T., et al. A Randomized Trial of Coronary Bypass Surgery: Survival of Patients with a Low Ejection Fractions. New England Journal of Medicine 312: 1665-1671, 1985.

58. CASS Principal Investigators and their Associates. Myocardial Infarction and Mortality in the Coronary Artery Surgery Study (CASS) Randomized Trial. New England Journal of Medicine 310: 750-758, 1984.

59. McCullough, L.B. Concept of the Quality of Life: A Philosophical Analysis. in Wenger, N.K., Mattson, M.E., Furberg, C.D., and Elinson, J., editors. Assessment of the Quality of Life in Clinical Trials of Cardiovascular Therapies. New York: Le Jacq Publishing Inc., 1985: 25-45.

60. Levine, S., and Croog, S.H. What Constitutes Quality of Life? A Conceptualization of the Dimensions of Life Quality in Healthy Populations and Patients with Cardiovascular Disease. in Wenger, N.K., Mattson, M.E., Furberg, C.D., and Elinson, J., editors. Assessment of the Quality of Life in Clinical Trials of Cardiovascular Therapies. New York: Le Jacq Publishing Inc., 1985: 46-66.

61. Oberman, A., Maynard, C., Fisher, L., Mullin, S.M., Charles, E.D., and Tristani, F. Long Term Changes in Work Status Among Patients in the Coronary Artery Surgery Study Registry. in Walter, P.J., editor. Return to Work after Coronary Artery Bypass Surgery, Psychosocial and Economic Aspects. Berlin: Springer-Verlag, 1985: 137-147.

62. Connett, J.C., and Stamler, J. Responses of Black and White Males to the Special Intervention Program of the Multiple Risk Factor Intervention Trial.

American Heart Journal 108:839-849, 1984.

63. Principal Investigators of CASS and their Associates (Killip, T., editor., Fisher, L.D., and Mock, M.B. assoc. editors). National Heart, Lung, and Blood Institute Coronary Artery Surgery Study (CASS). Circulation 63 (Suppl I):I1-I81, 1981.

64. Inter-Society Commission for Heart Disease Resources: Primary Prevention of the Atherosclerotic Diseases. Circulation 42:A55-A95, 1970.

65. Keys, A. Seven Countries, a Multivariate Analysis of Death and Coronary Heart Disease. Cambridge, Massachusetts: Harvard University Press, 1980.

66. Kannel, W.B., McGee, D, and Gordon T. A General Cardiovascular Risk Profile: The Framingham Study. American Journal of Cardiology 38:46-51, 1976.

67. Rosenman, R.H., Brand, R.J., Jenkins, C.D., Freidman, M., Straus, R, and Wurm, M. Coronary Heart Disease in the Western Collaborative Group Study: Final Follow-up Experience of 8 1/2 Years. Journal of the American Medical Association 233:872-877, 1975.

68. Blackburn, H, and Gillum R.F. Heart Disease. in Last, J.M., editor. Public Health and Preventive Medicine. New York: Appleton-Century Crofts, 1980:1168.

69. Vlietstra, R.E. Frye, R.L., Kronmal, R.A., Sim, D.A., Tristani, F.E., and Killip, T. Risk Factors and Angiographic Coronary Artery Disease: A Report from the Coronary Artery Surgery Study (CASS). Circulation 62: 254-261, 1980.

70. Curry, C.L., Oliver, J., and Mumtaz, F.B. Coronary Artery Disease in Blacks: Risk Factors. American Heart Journal 108:653-657, 1984.

71. Tyroler, H.A. Overview of Risk Factors for Coronary Heart Disease in Black Populations. American Heart Journal 108:658-660, 1984.

72. Kasl, S.V. Social and Psychologic Factors in the Etiology of Coronary Heart Disease in Black Populations: An Exploration of Research Needs. American Heart Journal 108:660-669, 1984.

73. James, S.A. Socioeconomic Influences on Coronary Heart Disease in Black Populations. American Heart

Journal 108:669-672, 1984.

74. McDowell, A, Massey, J.T., Engel, A., and Maurer, K. Plan and Operation of the Second National Health and Nutrition Examination Survey, 1976-1980. Vital and Health Statistics, Series 1, No. 15. DHHS Publication (PHS) 81-1317. Washington, D.C.: National Center for Health Statistics, 1981.

75. Khosla, T. and Lowe, C.R. Indices of Obesity Derived from Body Weight and Height. British Journal of Preventive and Social Medicine 21:122-128, 1967.

76. Campeau, L. Grading of Angina Pectoris. Circulation 54:522-523, 1976.

77. Morrison, D.F. Multivariate Statistical Methods, 2nd Edition. New York: McGraw Hill, 1976:230-246.

78. Pearson, R.A., Bulkley, B.H., Kwiterovich, P.O., Achuff, S.C., and Gordis, L. Anatomically Defined Coronary Disease in Blacks: Importance of Hypertension as a Risk Factor. Circulation 59 (Abstract): II-14, 1979.

79. James, S.A. Coronary Heart Disease in Black Men, Suggestions for Research on Psychosocial Factors. American Heart Journal 108:833-838, 1984.

80. Haywood, L.J. Issues in the Natural History and Treatment of Coronary Heart Disease in Black Populations: Medical Treatment. American Heart Journal 108:683-687, 1984.

81. Curry, C.L., and Lewis, J.F. Cardiac Anatomy and Function in Hypertensive Blacks. in Hall, W.D., Sanders, E., and Shulman, N.D., editors. Hypertension in Blacks: Epidemiology, Pathophysiology, and Treatment. Chicago: Year Book Medical Publishers, 1985:61-67.

82. Haywood, L.J. Coronary Heart Disease Mortality/ Morbidity and Risk in Blacks. I: Clinical Manifestations and Diagnostic Criteria: The Experience with the Beta Blocker Heart Trial. American Heart Journal 108:787-793, 1984.

83. Neaton, J.D., Kuller, L.H., Wentworth, D., and Borhani, N.O. Total and Cardiovascular Mortality in Relation to Cigarette Smoking, Serum Cholesterol Concentration, and Diastolic Blood Pressure among

Black and White Males Followed up for Five Years. American Heart Journal 108:759-770, 1984.

84. Langford, H.G., Oberman, A., Borhani, N.O. Entwisle, G., and Tung, B. Black-White Comparison of Indices of Coronary Heart Disease and Myocardial Infarction in the Stepped-Care Cohort of the Hypertension Detection and Follow-up Program. American Heart Journal 108:797-801, 1984.

85. Directory of Medical Specialists, 20th edition. Chicago: Marquis Who's Who, 1981.

86. Kleinbaum, D.G., Kupper, L.L., Morgenstern H. Epidemiologic Research. Belmont, California: Lifetime Learning Publications, 1982:420-428.

87. Halperin, M., Blackwelder, W.L., and Verter, J.I. Estimation of the Multivariate Logistic Risk Function: A Comparison of the Discriminant Function and Maximum Likelihood Approaches. Journal of Chronic Diseases 24:125-158, 1971.

88. Siegel, S. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw Hill, 1956: 202-213.

89. Dixon, W.J., editor. BMDP Statistical Software 1981. Berkeley: University of California Press, 1982:330-344.

90. Cohen, H.A. Solnick, M, and Stephenson, A. The Financing of Coronary Artery Bypass Surgery. in Eliastim M., and Gastel, B., editors. Technology Assessment Forum on Coronary Artery Bypass Graft Surgery: Economic, Ethical, and Social Issues. Circulation 66 (Suppl.):III49-III52, 1982.

91. National Center for Health Statistics. Mortality, United States, 1977. B. Number of Deaths. Washington, D.C.: United States Government Printing Office, 1981.

92. Goldman, L., Cook, F., Hashimoto, B., Stone, P., Muller, J., and Loscalzo, A. Evidence that Hospital Care for Acute Myocardial Infarction has not Contributed to the Decline in Coronary Mortality between 1973-1974 and 1978-1979. Circulation 65:936-942, 1982.

93. National Center for Health Statistics. Vital Statistics of the United States, 1978, Life Tables. Washington D.C.: United States Government Printing

Office, 1980.

94. Breslow, N. Statistical Methods for Censored Survival Data. Environmental Health Perspectives 32: 181-192, 1979.

95. Kalbfleisch, J.D., and Prentice, R.L. The Statistical Analysis of Failure Time Data. New York: John Wiley, 1980: 10-19, 70-86.

96. Cox, D.R. Regression Models and Life Tables. Journal of the Royal Statistical Society (B) 31: 187-220, 1972.

97. Gillum, R.F., and Liu, K.C. Coronary Heart Disease Mortality in United States Blacks, 1940-1978: Trends and Unanswered Questions. American Heart Journal 108: 728-732, 1984.

98. Farley, R. Blacks and Whites. Narrowing the Gap? Cambridge, Massachusetts: Harvard University Press, 1984: 204.

99. Working Group on Socioeconomic and Sociocultural Influences. Summary of Workshop III. American Heart Journal 108: 706-710, 1984.

100. Working Group on Epidemiology. Summary of Workshop I. American Heart Journal 108: 699-702, 1984.

101. Working Group on Risk Factors. Summary of Workshop II. American Heart Journal 108: 703-706, 1984.

102. Working Group on Natural History, Prevention, and Medical and Surgical Treatment. Summary of Workshop IV. American Heart Journal 108: 711-715, 1984.

103. Shortell, S.M. The Contribution and Relevance of Sociology to Health Services Research. in Choi, T. and Greenberg, J.N., editors. Social Science Approaches to Health Services Research. Ann Arbor, Michigan: Health Administration Press, 1982: 21-52.

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