

# Doctors, Patients, and the Racial Mortality Gap: What Are the Causes?

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## Abstract

Research in the last twenty years has uncovered persistent racial differences in health care access, utilization, and outcomes. This is the first study to systematically discuss and test the various hypotheses explaining these differences by using the same patient population. It takes advantage of a unique dataset from the Department of Veterans Affairs. Measures of patient response to therapy and the quality of clinical care are developed and their contributions are evaluated in the health production function in general and with respect to the racial mortality gap. Differences in socio-economic status, facility and physician quality are shown to have little effect on the racial gap in an equal access health care system. Explicit tests for physician discrimination in therapy prescriptions are carried out and the hypothesis refuted. Extensive analysis of doctor-patient matching reveals that it has little effect on quality of care received by minorities and may act as a mediator of the mortality gap. The marginal productivity of quality care is shown to differ across racial groups. Further investigation reveals that the mortality gap is driven by differences between African American patients with low adherence to prescribed therapy and the rest of the population. Considerable reductions in medical costs could be achieved by more effective counseling of minority patients. In particular, targeted programs to increase adherence to clinical therapy may reduce the racial mortality gap by two thirds.

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## Introduction

Research in the last twenty years has uncovered persistent racial differences in health care access, utilization, and outcomes. Despite the large number of observational studies verifying the existence of disparities, little has been done to identify their sources. Several explanations are possible. First, blacks may face systematically different and inferior health care, manifested in worse quality of facilities, fragmented access to care, and worse clinicians. Second, institutional or provider discrimination may result in different treatment. Finally, minorities may respond differently to identical conditions of care. This is the first study to systematically develop and test these hypotheses using the same patient population.

Surveys documenting unequal access to treatment, unequal treatment, and unequal quality of care available to minorities have led to speculation that spatial segregation and selection into worse quality health care providers could be the underlying causes for the observed differences (e.g. Bach (2004), Skinner (2005)). Evidence showing that black patients who visit segregated facilities fare worse is hard to interpret, because between-facilities differences in outcomes may reflect the selection of healthier blacks into facilities with fewer minorities. Moreover, it is impossible to distinguish whether the health facilities are bad, or systematic discrimination within facilities leads to worse average outcomes. Differences in provider behavior will manifest in within-, as well as between-facility gaps in outcomes, provided that there is less than full racial segregation on the clinic level. Despite the extensive attempts to document *between*-facility differences no study has investigated what happens *within* facilities. This study finds that *within*-facility differences between blacks and whites are the main contributor to the racial gap in mortality in an equal-access health care system.

While research has revealed that minorities are served by a small subset of physicians<sup>2</sup>, there is no empirical evidence showing that this sorting leads to inferior outcomes. If there are no differences in clinical competency, racial specialization on behalf of providers may be beneficial, especially if differences in culture and communication contribute to the racial gap. Determining whether minorities sort into worse quality doctors is a major issue for public policy, and one of the focal points of this paper. This study presents evidence that clinician quality is of foremost importance for patient survival. It is also demonstrated that differences in outcomes exist even when patients are subjected to the same clinical quality of care.

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<sup>2</sup> Bach et al. (2004) report that 80% of black patient visits were to 20% of the physicians surveyed

The patient input in the maintenance of his or her health is a frequently ignored but potentially important component of the racial gap in survival. Though own effort is likely to differ between individuals and groups of different socio-economic standing, a survey of the empirical literature identified 35 studies reporting institutional racial bias in procedure use, nine studies claiming differences due to physician attitudes, and only two studies surveying patient attitudes and responses to treatment (Kressin, 2001). This study finds that the largest difference in health inputs between blacks and whites is in the patient's own effort.

Two major obstacles have impeded previous work on the racial mortality gap. The first is methodological. Many health conditions do not have clear treatment guidelines and it is impossible to construct measures of physician competence against an objective benchmark. Similarly, patient effort is unobservable and hard to conceptualize, and usually left out of the discussion altogether. The second main challenge is empirical. There is wide variation in access to medical care between racial groups and across conditions, as well as large unobserved differences between private care providers. This paper overcomes some of these obstacles by studying patients suffering from a common condition who are served in an integrated, equal access medical care system.

There are also several significant advantages of the data used here. First, the data come from the Veterans Health Administration (VHA), which equalizes access to health care for minorities and implements a fixed salary to limit physicians' financial incentives to over- or under-provide treatment. VHA facilities provide free care to all veterans. This institutional set-up eliminates health care access differences between minority and white patients. Second, the same cohorts of patients are followed through outpatient and pharmacy encounters for up to six years. Directly observing the pharmacological therapy prescribed to patients allows the construction of measures of both patient adherence to physician recommendations and the quality of clinical care provided by individual doctors. It also provides a convenient way to examine the effect of physician quality on patient survival. It is demonstrated that within-clinic differences in doctor quality significantly influence patient outcomes. Cross-referencing with evidence from clinical trials of the effect of recommended pharmacological therapy lends support to the empirical validity of this result.

This study documents a significant difference in survival between blacks and whites even though the VHA operates an equal-access health care system. It cannot be attributed to inferior access to care for black patients. This difference is about two thirds of the gap reported in private care, indicating that equalizing access and financing across facilities could reduce the black-white gap by

about thirty percent. Socio-economic status accounts for only 20 per cent of the remaining gap. Differences in the quality of care within facility are small but significant and account for about 5 per cent of the survival gap. Doctor-patient matching results in lower average doctor quality for minorities, but is beneficial for patient adherence to therapy. The marginal product of doctor quality differs between blacks and whites, and this disparity accounts for the disparity in outcomes. Yet it is shown that within the VHA, doctors treat African American and white patients the same. The largest difference between races is in patients' adherence to recommended clinical therapy. There is no difference in survival among patients who mostly observe therapy prescriptions, so that the recorded racial gap is entirely due to racial differences among non-adherent patients.

The next section examines previous attempts to explain the black-white differences in mortality and some hypotheses discussed in the literature. I describe the data and outline the empirical model in Sections 3 and 4. Section 5 presents the results and discusses their applicability to the general population. While the VHA presents an excellent environment for the study of the mortality gap, it is an institution catering to a selected part of the population. Implications for the general population should thus be considered in light of this fact. Section 6 outlines some implications for policy. Section 7 concludes.

## **2. Background and previous literature**

### **2.1 Factors contributing to the racial gap**

The hypotheses explaining the racial gap can be grouped into three broad categories: institutional barriers to obtaining good health care, disparate returns to seeking care, and differences in patient health investment or responses to care. The vast majority of medical and public health studies have concentrated on documenting institutional and provider-induced barriers to equalizing health outcomes between races. Using data from the Veterans Health Administration gets around many of the differences stemming from unequal access or financial motives for over- or under-providing care to minorities. Institutional barriers to health care provision are minimal and any disparities remaining within the VHA are most likely due to other causes.

#### **Institutional barriers to obtaining quality care**

As a result of residential segregation and lower socioeconomic status, the quality of facilities, equipment and personnel may be worse in areas predominantly populated by minorities. In addition,

blacks are more likely to be priced out of the insurance market and face provider level financial disincentives to better care. Consequently, African Americans are more likely to experience discontinuities of care and concentrate in an inferior subset of facilities and physicians (Oster and Bindman, 2003).

Institutional barriers to obtaining quality care may manifest in minority patient matching into worse facilities, into worse providers within facilities, or both. In order to pin down the mechanism one needs to know the qualifications of physicians and patterns of physician-patient matching within facilities, and observe patient outcomes. Studies have found that doctors who treat primarily black patients are less likely to be board certified and more likely to report not being able to provide high quality care to their patients. African Americans have less access to high-quality specialists and non-emergency hospitalizations. In particular, poorer African Americans are treated by lower-quality and lower-volume cardiac surgeons (Bach et al., 2004; Mukamel et al., 2000; Rothenberg et al, 2004). Yet, there are no studies relating this differential matching to inferior outcomes. This paper argues that in an equal-access environment, physician-patient matching has little effect on the quality of care received by minorities and may *improve* their outcomes.

Previous studies diverge in their assessment of the relative contributions of within- and between-facility racial differences in care to the survival gap. This is the result of two main obstacles. First, data are rarely recorded for the physician-patient pairs which form during an encounter. This reduces the analysis to assigning the gap remaining after controlling for clinic quality (clinic fixed effects) to within-clinic differences.

Second, studies concentrating on cardiac care use data on patients who suffer heart attacks (acute myocardial infarctions, or AMI) and use 30-day, 6-month or 1-year mortality rates (Bradley et al. 2004; Barnato et al. 2005; Skinner et al., 2005). The trouble with using short-term mortality rates from AMI is that patients being treated in emergency conditions are assigned doctors randomly at least in the first (and crucial) hours after the AMI. Hence the differences in mortality rates are largely driven by the differences in average doctor and equipment quality between hospitals. It is harder to pick up the effects of subsequent, post acute-stage patient sorting into different providers and variations in the response to treatment. Concentrating on a chronic condition and a longer time horizon, which requires regular interactions and follow-up between doctors and patients is one way to capture the effect of these processes. The data used here allow the construction of physician-patient pairs within facilities and evaluate what part of the mortality gap is attributable to factors within the facility.

### **Disparate treatment**

Statistical discrimination, clinical uncertainty or stereotyping may result in differential treatment across racial groups (Balsa and McGuire, 2002). Clinical uncertainty might contribute to over- or under-prescription of therapies to black patients because doctors are less aware of the severity or appropriate treatment in the minority group. Stereotyping refers to attributing certain qualities to patients based on expectations about the average behavior of members of their group. For example, Bogart et al. (2001) demonstrate that doctors are less likely to prescribe certain medications to minority patients because they expect worse patient adherence to therapy. Using data from doctor-patient encounters his study shows that there is no evidence of such statistical discrimination in the VHA.

A substantial advantage of this paper is that the data allow tracking the therapeutic decisions taken by doctors over time and across patients. All patients in the sample have a primary diagnosis of chronic heart failure (CHF, or congestive heart failure, or heart failure) - a chronic and eventually fatal condition. It is a plus that the treatment guidelines for this condition are well publicized. Comparing the treatment of black and white patients treated by the same physician allows direct tests for the presence of disparities in the therapeutic approach.

### **Differences in patient response to care**

Previous research shows that minorities differ in their attitudes towards health and the health care system. There are several ways in which attitudes may influence health outcomes. First, systematic differences in health investment over the life cycle will result in disparities in health outcomes. Charles, Hurst and Roussanov (2007) demonstrate that blacks spend about 56% less on health care than whites. They show that about 14 per cent of that gap is explained by differences in consumption preferences.

Second, they can manifest in discrepancies in adherence to prescribed clinical therapy and lifestyle changes. Goldman and Smith (2002) show that patients' adherence to prescribed therapy varies significantly with race. Blacks are more likely to experience lapses in treatment as a result of non-adherence to physician recommendations. These lapses are especially important for chronic conditions where strict adherence to prescribed therapy can significantly prolong life. This study

confirms that racial differences in compliance with therapy exist and that these differences are an important component in explaining the racial mortality gap.

Mistrust in the health care system is a potential source of the difference in attitudes. Black patients with cardiac conditions are less satisfied with the health care they receive and more likely to mistrust the system overall (LaVeist et al., 2000). Studies have shown that lower use of contraceptives among African American women can be related to perceived individual or group discrimination (Bird and Bogart, 2003). There may be differences in satisfaction with care and physician-patient cooperation based on racial matching. For example, Saha et al. (1999) find that minority patients who see minority physicians are more likely to rate physicians highly and to report receiving preventive care. Patients holding negative stereotypes about their physicians are less likely to be satisfied with the care they receive and less likely to adhere to physician therapy recommendations (Bogart et al., 2004).

An alternative explanation for differences in patient response are different beliefs about the substitutability of medical care and own effort. If physicians are not able to clearly convey to a group of patients the importance of patient involvement in treatment, patients in the group will behave differently from those who have received proper counseling from their doctors. In such a scenario, the health knowledge of the individual per se becomes extremely important – those that possess high health knowledge capital could substitute physician counseling with own knowledge. Those with low levels of health knowledge capital will rely more on their health care providers.

## **2.2 Chronic Heart Failure**

The paper focuses on racial differences in death rates after a diagnosis of chronic heart failure (CHF). There are several reasons to focus on this condition. First, heart disease is the leading cause of death in the elderly and is the most costly single condition in Medicare in recent years (33.2 billion dollars in 2007)<sup>3</sup>. Cardiovascular disease is a major contributor to the mortality difference between white Americans and African Americans, accounting for over 40 per cent of the racial gap. Approximately 10 per cent of all inpatient admissions are for CHF and hospitalizations are about twice as frequent in black males as in white males<sup>4</sup>. Third, heart disease is an Ambulatory Case Sensitive Condition, which makes it particularly susceptible to policy. It has been shown that expensive hospitalizations and re-hospitalizations can be avoided with adequate preventive care and disease

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<sup>3</sup> According to the AHA statistical abstract, 2007  
([http://www.americanheart.org/downloadable/heart/1166711577754HS\\_StatsInsideText.pdf](http://www.americanheart.org/downloadable/heart/1166711577754HS_StatsInsideText.pdf))

<sup>4</sup> In the population over 65 (Alexander et al., 1999)

management. Finally, heart failure is rarely misdiagnosed, and there are clear guidelines for pharmacologic treatment. This study relies on the guidelines to construct a measure of doctor quality and test whether doctors provide the optimal therapy to both racial groups.

### **3. Data**

The data in this study were drawn from the VHA Medical SAS inpatient and outpatient datasets, the Beneficiary Identification Records Locator Subsystem (BIRLS) death files, the VHA Enrollment files, and the Veterans Service Support Administration (VSSA) clinic performance measures database. The data cover all outpatients who were diagnosed with chronic heart failure in the VHA between October 1998 and October 2004<sup>5</sup>.

Currently, the majority of veterans belong to the age cohorts who served in World War II, the Korean War, and the Vietnam War. The median age of all veterans is 55, with veterans comprising the majority of all civilian males older than 65. The proportion varies by race. Table 1 presents means of variables used in the analysis. The sample is restricted to patients who utilized community based outpatient clinics at least twice in the first year after CHF diagnosis. These people could be credibly identified as outpatients served by the Veterans Health Administration. Individuals who did not have complete information on their race that could be verified either across visits and/or by using the inpatient datasets and Medicare data are excluded. There were 2487 patients whose race could not be determined because the different datasets reported it differently. The sample consists of male veterans only. Female veterans comprise less than 2 per cent of the veteran population in this age group and are arguably different from the average female in that age group. The final sample consists of 48972 VHA patients. CHF disproportionately affects elderly people and the military had restrictions on enrolling African Americans until the Korean War. This means that blacks are underrepresented in this sample compared to the overall veteran population and to the US population in general. Black patients comprise about 7.6 per cent of the sample<sup>6</sup>.

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<sup>5</sup> All outpatient visits are recorded in the outpatient files. Hospitalizations in a VA or related hospital are recorded in the inpatient files. The Enrollment files use Social Security administration data, as well as the VA's internal accounts to record death. The BIRLS files pool data from the veterans benefits administration (including death/burial benefits) as well as notifications from hospitals (through the inpatient files), relatives/acquaintances, cemeteries or any other branch of the veterans system. Death data were initially extracted from the VA BIRLS files, double checked against the VA enrollment files, and then checked again against data from Medicare. The triple-checking of the death data ensures the use of accurate vital status records.

<sup>6</sup> LaVeist (1994) among others points out that race is a poorly measured variable whose designation varies depending on the reporting body. I use race data from Medicare and the VA. Nearly 90% of the patients have a record in Medicare. For



VHA data record income, which offers a substantial advantage in controlling for socio-economic status. Previous studies control for income using mean or median zip-code income data from the Census bureau. However this measure can be misleading especially when the emphasis is on the effect of minority status or SES on health. Segregated neighborhoods have wide variations in income. Median income would over-estimate the financial means of the minority population and at best provide a crude measure of the SES of the zip-code as a whole.

Because minorities on average have lower socioeconomic status (SES) and tend to delay seeking health care, it is likely that private and university-affiliated hospitals seeing a higher proportion of black patients are also "sicker" or poorer hospitals. The centralized budgeting system of the VHA is government-sponsored, hence the SES of the patients does not influence the resources of the clinic. Resources are distributed on the basis of the patient load. Clinics that serve a larger proportion of patients get more funding. In the VHA physician visits, procedures and hospitalizations are virtually free, and prescription drugs heavily subsidized at prices lower than Medicare prices<sup>7</sup>. Co-payments are still in the process of being introduced and are required only from enrollees with the highest SES and no service-related conditions. Patients can only obtain prescription medications at subsidized prices if those medications are prescribed by a VHA physician. Patients must maintain a primary care physician in the VHA. Primary care physicians are assigned at the clinic level when the patient makes his first outpatient visit. While it is possible for a patient to request a certain doctor, assignment usually happens on the basis of physician availability.

Congestive heart failure is a progressive disorder with fatal outcomes. Mortality rates in the first year after diagnosis are about 10 per cent. However, if care is managed well, patients' chances of living longer and their quality of life can be improved significantly. The recommended medical therapy is well publicized. Once the first year of treatment has passed successfully, chances of longer-term survival increasingly depend on the patients' and doctors' ability to adapt the treatment and lifestyles to counter the progression of the disease. Short-term (one-year) mortality is more likely to be influenced by the patient's initial physical condition at diagnosis, while longer-term survival would be more sensitive to medical therapy and the ability of the patient and the doctor to coordinate the

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the remaining 10% I use the data from the Veterans Affairs administration, where I cross-check race with data from different encounters. S. Arday et al. (2000) show that the Medicare race variable corresponds very closely to self-reported race. For the part of the sample which has a record both in Medicare and in the VA, I find that 3% of the patients had a difference in the coding of race between Medicare and VA. This discrepancy can be attributed to coding errors on both sides and is unavoidable in administrative data. Overall I believe the race designation which I use in the analysis is very close to self-reported race.

<sup>7</sup> As of November 2007, the price of a refill for any medication was 8 dollars.

management of the disease. Appendix A discusses the medical condition and treatment options in more detail.

The largest estimate of the racial mortality gap in CHF was reported by the CDC - 7.8%<sup>8</sup>. This is a very crude benchmark of the yearly mortality rate, unadjusted for the number of years since diagnosis or differences in access and co-morbidities. The closest estimate of the gap to the one I find (and the only other estimate using horizons longer than a year) is reported using Medicare data by Dries et al (1999). They find a 3.1 percentage points higher probability of survival for white patients after two years of follow-up. The present study finds that at least two thirds of this mortality gap is attributable to factors other than variations in quality, physician discrimination, or institutional barriers to accessing health care.

Table 1 also shows that black patients are, on average, about 25 per cent poorer. The differences in income reported in the sample are close to those observed in Census data for the same age group<sup>9</sup>. White patients are also more likely to be married. Being married is an indicator of stronger social support. Elderly males in particular benefit from having a living spouse. White patients are more likely to have a stronger social network as proxied by marital status. Whites in the sample are on average they are six years older.

The VHA outpatient datasets contain data on all coexisting health conditions. I select controls for co-existing health problems to correspond closely to the conditions used in constructing the Charlson-Deyo index of co-morbidities, which is the standard reference in the health literature [Charlson, 1987]<sup>10</sup>. This study includes the conditions as separate controls. The data do not supply an indicator of CHF severity, which is likely to differ across patients. However, there is significant information on other cardio-vascular co-morbidities. CHF usually occurs as a result of, or in conjunction with some of these conditions. I therefore include indicators for other cardiovascular diseases as proxies for the severity of CHF.

The sample covers the period from October 1998 to October 2004. Patients join the sample throughout this period. The largest numbers of new patients enter in years 2001 and 2002. This

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<sup>8</sup> MMWR Weekly, August 7, 1998; 47(30), 663-7

<sup>9</sup> About 15% of income values every year were coded as 0s. Whenever possible, I impute income by assigning the mean value of income for the years in which it is available. A regression of zero income on other observables did not produce significant correlations.

<sup>10</sup> I include controls for old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

coincides with the period of largest expansion of the VHA health care system. There was a significant increase in the number of patients per clinic over the examined period. The average number of patients per clinic goes up from 33 in 1999 to 117 in 2003. The years 1998 and 2004 are incomplete, since 1998 includes data from the last three months of the year and 2004 ends in September. A potential concern is that the patients joining the VHA health system after 1998 could have an advanced stage of CHF at the time of first diagnosis *within* the VHA. This bias should be alleviated by including cohort dummies. Most of the new patients who joined the VHA after 1998 are white patients with higher income. Therefore, any discrepancy in severity at first diagnosis would work against finding racial differences in survival and would bias the coefficient on black race in the survival regressions downwards.

A physician-patient pair is defined as a match between a patient and a doctor for who have more than two interactions in the data. An interaction is a new prescription written by the doctor for the patient. Patients see a number of doctors over the course of treatment. African Americans see more doctors, but they get fewer prescriptions per doctor, implying that the intensity of their relationship with any given physician is lower. Another dimension of this lower intensity of interaction is that it takes black patients on average two months longer to first encounter their main physician, who is the physician who wrote the largest number of prescriptions for them. The chances that the main doctor leaves the clinic in any given month are the same for both racial groups.

Clinics vary in size from 1000 visits per year to 300000 visits per year. In this study clinics are divided into small (below 10000 visits per year), medium (between 10000 and 20000 visits per year) and large (above 20000 visits per year) categories. The ratio of black patients in the clinic is defined as the ratio of visits by black patients in a year divided by the total number of visits to the clinic in that year<sup>11</sup>. Black patients are more likely to be treated in large urban clinics (92% in urban and 55% in large clinics), while white patients are more likely to go to small and medium-sized clinics. Table 1 breaks down the racial profile of the clinic by clinic size and race of the patient.

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<sup>11</sup> The data allow the construction of two measures of clinic racial mix. The other possibility is the ratio of black to total patients. The proportion of visits is a measure of the intensity of black patients' presence at the clinic. It can be understood as the likelihood of meeting a black patient in the waiting room. While there may be significant number of blacks registered at the clinic, they may not utilize it as much as the rest of the patients. Using the alternative measure of blackness based on the proportion of black patients corresponds to the question "What is the probability that I will select a black patient if I randomly pick a name from the clinic's patient list?" There may be a number of black patients who showed up once at the clinic and never came back, who will be accounted for in the patient-based measure. Having more black patients without more black patient visits does not add to the "blackness" of the clinic.

The key new variables used in the empirical analysis are indicated in bold in Table 1. In the next subsections I define those variables that have not been used in the literature before.

### **3.1 Measuring doctors' adherence to treatment guidelines**

I use the prescriptions data and the clinical guidelines set out by the American College of Cardiology to evaluate physicians' prescription patterns. The clinical guideline recommends prescribing Angiotensin Converting Enzyme inhibitors (ACE inhibitors, or ACEIs) and beta blockers (BBs) to all patients with chronic heart failure. Widely publicized clinical trials in the 90s showed that patients with CHF benefit from these medications. It has been demonstrated that these drugs improve the function of the heart and slow down the progression of the condition. Further discussion of the clinical trials and the medical evidence is presented in Appendix A.

In the early 2000s the VHA issued clinical guidelines suggesting to all providers that ACEIs and BBs must be considered in the course of therapy. All patients in this sample are eligible because they are diagnosed with congestive heart failure. The only exceptions may come from allergies. There is no evidence that black patients are more likely to suffer from allergies to ACEIs and beta blockers<sup>12</sup>.

The rate of prescribing the recommended drugs provides an independent benchmark against which I can assess the doctor's clinical abilities. The measure of providers' adherence to clinical guidelines is constructed as the ratio of patients who encountered the provider in the year and were prescribed ACE inhibitors and beta blockers by that doctor over the total number of patients seen by the doctor.

$$\text{Compliance ratio} = ((N \text{ patients with ACEIs-BBs}) / (\text{Total } N \text{ patients}))$$

Since all patients who visit the doctor and have this diagnosis should be prescribed these medications, a higher compliance ratio indicates stricter observance of the recommended therapy. Summary statistics by clinic size and race of patient are presented in Table 1. I use the compliance ratio as a proxy of doctor quality. Doctor quality and doctor competence are used interchangeably in the text. This measure is directly estimated from data, and it is based on the actual decisions taken by the physician. While it is a popular measure in constructing hospital quality indices, it has not been

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<sup>12</sup> However, at least one guideline suggests that finding the correct dosage may be harder with African American patients and hence more careful patient monitoring is advised.

used in outpatient data before. It is a better proxy for quality than, for example, indexes based on patient outcomes or board certification scores, because the former reflect biases from the patient mix and the latter are divorced from the practical side of physician competence. Another salient feature of the adherence ratio is that doctor quality measured in this way can be affected by policy. “Quality” in the sense used here thus refers to the doctor’s abilities as a clinician, and does not explicitly measure other possibly relevant, but unmeasurable doctor characteristics such as cultural competence.

#### *Measuring mean doctor quality per patient*

Patients see more than one doctor every year. I calculate the weighted mean of doctor quality for every patient. The weights are based on the number of prescriptions written by the doctor for the patient. For example, if a patient has seen two doctors, and he has 5 prescriptions from the doctor of quality 1 and 2 prescriptions from the doctor with quality 0, his mean doctor quality is  $5/7$ .

The relative importance of the quality of clinical care for patient health has not been explored in outpatient context despite numerous clinical trials showing that medicines recommended in clinical guidelines have a significant impact on mortality and morbidity. Most medical care studies are based on inpatient data, where it is impossible to identify the treating physician(s). In a hospital setting, a patient is seen by a multitude of doctors and it is very problematic to disentangle the parts of the therapy directed by different individuals. Moreover, medical therapy is highly personalized and depends on the idiosyncratic health needs of the patients. Few medical conditions have developed clinical guidelines at the level of CHF. These two problems make measuring the quality of health care difficult in the general population. Here I take advantage of the outpatient management of the health condition and demonstrate that doctor quality is of foremost importance for patient survival.

#### *Robustness of the doctor quality measure*

A problem arises if doctors of higher quality are matched to patients of better health along dimensions not captured by the controls. The coefficients on doctor quality would then be biased upwards. Positive matching of doctors to patient populations is more likely at the clinic level, i.e. doctors choose a clinic based on the clinic population. It is less likely that doctors would choose patients within the clinic. The upward bias on the doctor quality coefficient arising from doctor-clinic matching is addressed by including clinic fixed effects. The inclusion of clinic fixed effects guarantees that the effects on patient survival are identified only by the variation across groups of doctors within

the same clinic, and not by how doctors are distributed among clinics. However, it is still possible that doctors are non-randomly matched to patients within clinics. This is more likely to happen over time, i.e. in the course of patient tenure with the clinic both patients and doctors learn about each other's characteristics. I use the quality of the *first* doctor who prescribed medication for CHF to alleviate the effects assortative matching between doctors and patients *within* clinic<sup>13</sup>.

### 3.2 Patient compliance measures

A major criticism of the health literature is that while studies evaluate the effect of doctor inputs, they rarely account for the effect of patients' response to physicians' efforts. Leonard and Zivin (2005) provide one of the few models of health production that explicitly accounts for patient input. Patient response could be especially important for chronic conditions such as chronic heart failure that are managed on an outpatient basis, and that require an investment of daily effort by the patient. If there is little substitutability between doctor and patient effort, no therapy would work without the patient's active participation.

I use data on prescription refills to define a measure of patient adherence to therapy. The VHA pharmacy data contain a "days supply" variable attached to each prescription, as well as the time when the first dose was dispensed and the time of subsequent refills. Using the "days supply" variable I can determine whether the prescription was refilled on time. I define a refill as "compliant" if it was picked up within 3 days of the expiration of the previous days' supply<sup>14</sup>. The adherence measure is defined as the number of prescriptions which were not re-filled on time over the total number of prescriptions. The same technique is used to formulate aggregate patient adherence per year and individual patient adherence for every patient-doctor pair.

Compliance ratio = ((N prescriptions filled on time)/(Total N prescriptions))

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<sup>13</sup> The education literature offers the closest type of problem to the one discussed here. Studies attempt to estimate the importance of teacher quality on students' performance independently from the effect of schools, selection into schools, and students' family background. Rivkin, Hanushek and Kain (2005) provide an excellent review of the problem in the education context and discuss the challenges to obtaining robust empirical estimates of the effect of teacher quality.

<sup>14</sup> I choose 3 days because I do not observe opening hours of pharmacies in VA medical facilities. Patients whose previous supply expires on a Friday would not be able to obtain a re-fill until the following Monday (or Tuesday, for long weekends), even though they may have called it in on time. Even if pharmacies maintain weekend hours, some patients may be unwilling to go and pick up medications on Saturday or Sunday. Different time windows were considered ranging between 1 and 7 days. The results were very similar across measures.

Patient adherence is the only signal of patient response that could be constructed from data. While it is an imperfect marker of the actual involvement by each patient in their health maintenance, it provides a crude measure of the effects of patient response on outcomes. Further discussion of the different ways to define patient adherence and the effects of adherence on mortality and hospitalizations found in the medical literature are presented in Appendix B. According to the most comprehensive study of adherence measures, the one defined here is ranked the best (Ostenberg and Blaschke, 2005).

Table 1 shows the summary statistics. The average adherence rate in the sample is 50%, and black race is associated with a 3% -5% lower rate of compliant refills. In a study of HIV patients Goldman and Smith (2002) find that black race is associated with a 33% decrease in the probability of strict adherence to therapy. However, their measure of adherence is much stricter. They consider a patient “compliant” if she had taken all of her HIV medications correctly in 7 out of the past 7 days. The measure I use is less stringent. To the extent that I do not observe whether medication was taken correctly on the occasions when it was taken, my measure overestimates adherence for all patients. This implies that the estimates of the effect of compliance on outcomes reported here are more likely attenuated towards zero.

#### **4. Determinants of survival: Empirical Strategy**

The goal of this study is to offer empirical evidence that will lend credit to some hypotheses explaining the racial mortality gap and refute others. After controlling for age, socioeconomic variables, and health, individual survival is influenced by the quality of the clinic, the quality of the doctors, and the patient’s own effort (the patient response to therapy).

$$\text{Survival} = F(\text{patient characteristics, clinic quality, provider input, patient response})$$

There are three types of variables in this model: 1) patient characteristics and doctor quality which change across patients and time; 2) clinic characteristics such as the clinic location which are constant over time; 3) clinic characteristics which change over time.

Let  $X_{gtm}$  be a vector of characteristics for patient  $m$  who goes to clinic  $g$  at time  $t$ , including an indicator for black race. Let  $B_{gt}$  be a vector of clinic characteristics which vary between clinics and

across time, but affect equally patients in the same clinic-year cell, and  $\mu$  be the clinic fixed effect. All patients who visit the same clinic across time are subjected to the same common clinic quality<sup>15</sup>.

The basic model relating patient characteristics and co-morbidities to outcomes is:

Model 1:

$$y_{gtm} = \alpha + \beta X_{gtm} + \rho * \text{black} + \varepsilon_{gtm}$$

Here the coefficient on race ( $\rho$ ) would capture some of the omitted variables' influence on survival outcomes and will be biased downward (i.e., more negative) if black patients are treated in worse clinics or by worse doctors.

Next, the basic model is expanded by adding clinic fixed effects to capture the unobserved clinic characteristics which do not vary by year. In addition, the ratio of black patient visits per year and the total number of patient visits per year are added as controls. Patient cohort dummies are included to control for the differing characteristics of patients being diagnosed in different years and for changes in the aggregate technology of treatment which affect all patients.

Model 2:

$$y_{gtm} = \alpha + \beta X_{gtm} + \rho * \text{black} + \delta B_{gt} + \mu_g + \eta_t + \varepsilon_{gtm}$$

The model is further complicated by adding the mean doctor quality per patient ( $D_{gm}$ ). The coefficient on the doctor quality variable measures the effect of clinical quality on survival or the marginal product of doctor quality. If differences in survival are due to systematic matching of black patients into worse quality doctors, controlling for doctor quality should reduce the magnitude of the race coefficient  $\rho$ .

A different hypothesis is that the efficacy of quality care may differ along racial lines. The interaction term between doctor quality and black race would capture differences in the marginal productivity of quality care between black and white patients. The following model aims to empirically test these hypotheses.

Model 3:

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<sup>15</sup> The vast majority of patients (over 80 per cent) went to the same clinic throughout the observed period. Those who changed clinics did so because they moved residence. The VHA strategically locates outpatient clinics so that they serve a population within a geographic area.



$$y_{gtm} = \alpha + \beta X_{gtm} + \delta B_{gt} + \rho * \text{black} + \gamma D_{gm} + \theta * \text{black} * D_{gm} + \mu_g + \eta_t + \varepsilon_{gtm}$$

Finally, patients' adherence to medical therapy is brought into the empirical analysis. The effect of patient effort on survival depends on the complementarity between patient effort and physician quality. The degree of complementarity between these two inputs into health production likely differs across health conditions. For example, patient effort has little impact on immediate outcomes from surgery, while it is of crucial importance for the management of HIV. This is the first time the issue has been raised in the context of CHF and it is an empirical question where this particular condition falls in the distribution of diseases. Patient effort could both substitute for and/or strengthen the benefits of physician competence.

An important hypothesis is that differences in patient effort contribute to the racial mortality gap. If this is the case then controlling for patient adherence in the survival regression will reduce the magnitude of the race coefficient  $\rho$ . In addition, the marginal product of patient effort may correlate with race. For example, if drugs designed to treat elderly white males do not work as well for elderly blacks, the effect of patient compliance will differ with race. Model 4 introduces patient adherence  $E_{gtm}$  into the survival model as follows:

Model 4:

$$y_{gtm} = \alpha + \beta X_{gtm} + \delta B_{gt} + \rho * \text{black} + \gamma D_{gm} + \theta * \text{black} * D_{gm} + \pi * E_{gtm} + \pi * \text{black} * E_{gtm} + \mu_g + \eta_t + \varepsilon_{gtm}$$

The empirical analysis concentrates on survival three years after initial diagnosis conditional on surviving two. Medical studies that find a racial difference in survival report such differences emerging after the second year of treatment (Croft and coauthors, 1999; McCullough and co-authors, 2003). While one-year survival probability is a common benchmark in the literature, it is more appropriate for acute conditions such as stroke or AMI (acute myocardial infarctions, or heart attacks). Unlike AMIs, CHF is a chronic condition which may be contained or worsen over time given the prescribed therapy and the patients' compliance with it. Longer-term survival horizons are better suited to capture the effect of quality of care over time.

## 5. Results

### 5.1 Survival

### *Basic model*

Table 2 reports the results of a linear probability regression of the probability of surviving the third year after initial diagnosis, conditional on surviving the first two<sup>16</sup>. Estimating three-year survival probability conditional on two-year survival is intended to partially offset potential differences in severity at first diagnosis. Taking a group of patients who have already survived two years of treatment selects those patients who have had less severe conditions at first diagnosis. Appendix A discusses findings in the medical literature that lend support to this approach. They also show racial differences in mortality first appear around the 20<sup>th</sup> month after initial diagnosis.

Columns (1)-(4) report results from different specifications. Column (1) shows estimates from a basic model including only controls for age and co-morbidities, similarly to many studies using private care data. On average, black patients are 2 per cent less likely to survive the 3<sup>rd</sup> year of treatment. Subsequent specifications add the extra controls available in these data and test additional models.

### *Additional socio-economic factors*

Controls for socio-economic factors are added in the model estimated in Column (2). Differences in socio-economic status account for about 22 per cent of the difference in survival. The magnitude of the coefficient on the race dummy is reduced. However, a significant negative correlation between black race and medium-term survival still exists.

### *Clinic quality*

Model 3 controls for clinic quality and time-variant clinic characteristics - the ratio of black patients in the clinic in every year, the number of visits to the clinic, and a clinic fixed effect. The coefficient on the race dummy becomes larger in absolute value and maintains a negative sign. Differences in clinic quality do not explain the difference in the survival rate between blacks and whites. In fact, blacks in the VHA appear to be visiting *better* clinics on average. Numerous studies using data from the private health care system have found the opposite result. The difference with

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<sup>16</sup> One- and two-year survival estimates are available from the author. Different specifications were estimated including the square of age, as well as using age cohorts rather than a continuous measure of age. These yielded similar results. In robustness checks I also ran the estimation excluding different cohorts. The obtained results were similar. A logistic regression for model (1) was also estimated and revealed identical estimates.

those studies is not surprising. Because of geographic segregation, which is also related to differences in SES among residential areas, hospitals in predominantly black neighborhoods are underfunded and often understaffed. In the VHA clinics are funded on the basis of their patient load. These estimation results confirm that using VHA data effectively controls for differences in access to quality care and care provision in explaining the black/white mortality gap. They can also be interpreted as suggestive evidence that equalizing access and funding across private care facilities would eliminate the fraction of the racial gap due to geographic segregation.

### *Physician quality measures*

Physician quality matters. Going to a top-quality doctor improves survival by two months in any year. The model in Column (4) includes a measure of mean doctor quality per patient. The effect of quality is large and statistically significant<sup>17</sup>. Physician competence levels do vary within clinics, and they have an independent effect on survival. However, including controls for doctor competence reduces the coefficient on black race by only 5 per cent, implying that blacks and whites are subjected to similar average doctor quality in the VHA.

African Americans see different doctors, who are of slightly lower quality, but this does not explain the difference in survival. Figure 1 shows a histogram of the distribution of black and white patients within doctor quality quintiles. Blacks are more likely to see doctors in the bottom and third quintile, and less likely to see doctors in the top 2 quintiles. Still, differential sorting is not the driving factor behind lower survival rates.

The marginal product of doctor quality differs across races. Column (5) adds an interaction term between doctor quality and black race. The difference in the marginal productivity of quality care seems to explain away the racial mortality gap. Black patients benefit from quality doctors half as much as white patients do. The question is whether this effect is linear in quality. Figure 2 plots the coefficients on doctor quintile dummies. The omitted category is the lowest quintile. Blacks receive lower benefits at all levels of doctor competence, but the largest difference occurs in the middle range of the doctor quality distribution. This suggests that great doctors and great for all, bad doctors are bad for all, but middle-range doctors have differential impact across races.

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<sup>17</sup> Reassuringly, the results reported here correspond closely to findings in clinical trials where patients were randomized into ACEIs and/or BBs and a placebo. The effect of having doctors who prescribe the recommended therapy to all their patients closely corresponds to the mortality advantage found in patients randomized to the recommended therapy in clinical trials. Appendix A offers further discussion.

In practical terms this means that reassigning a white patient from doctors with average quality mix in the lowest quintile (<0.2) to doctors with average quality in the top quintile (>0.4) will increase his chances of survival by 8 per cent. An equivalent exercise for a black patient will increase his chances of survival only by 4 per cent.

Physician-patient matching could be behind this result. Unobserved characteristics of doctors, patients, and the doctor-patient pair may determine selection into doctors over the course of 3 years. This selection could influence blacks and whites differently and drive the result. The quality of the first doctor, however, is less likely to be influenced by a selection process<sup>18</sup>. In Table 3 Columns (3) and (4) the controls include the quality of the first doctor instead of the mean doctor quality per patient. The results are the same. Black patients benefit from quality about half as much as whites do.

There are two potential reasons why this is the case. First, doctors may treat minority patients differently – a hypothesis tested in the next subsection. In this case, doctor quality wouldn't matter because it does not signal the same quality of care for the two groups. Second, black patients may react differently to the same doctor quality. This hypothesis is also tested below.

## **5.2 Do doctors treat black and white patients differently?**

Tests for differences in treatment use data on doctor-patient pairs. The sample size increases significantly because patients have more than one doctor. Table 4 reports a series of linear probability regressions estimating the probability that a patient would be prescribed a combination of ACE inhibitors (ACEIs) and beta blockers (BBs) by a doctor. Column (1) reports the basic specification controlling for black race and co-morbidities only. Based on this specification there are no differences in treatment of black patients across doctors. Column (2) adds controls for income and marital status. After controlling for SES, on average black patients appear less likely to be prescribed the recommended therapy. There are two possibilities. First, they may be treated differently by all doctors. Second, they may be seeing a different mix of doctors.

If all doctors treat blacks and whites differently, there will be differences in the prescription rates of ACEIs and BBs within doctor. Doctor fixed effects are included in the specification in Column (3). After controlling for doctor fixed effects, blacks and whites are equally likely to be prescribed the same treatment regimen. Two patients visiting the same physician are treated equally regardless of

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<sup>18</sup> The VHA assigns primary care physicians to all incoming patients. The patient may ask to be assigned to a primary care doctor, but in most cases they are sent to the first available physician at the time of their first visit.

race. VHA physicians prescribe the same therapy to blacks and whites, but blacks go to doctors who are less likely to prescribe the therapy to anyone. This is not surprising given the average differences reported in Figures 1 and 2.

### **5.3 The role of patient adherence to treatment**

Several levels of patient adherence are examined. Average yearly adherence to therapy across all doctors and all medications is the most aggregated measure of patient response. Doctor- and medication-specific adherence rates are also investigated. If patient response varies with the physicians' skill in inspiring adherence, patients could match into different doctors on the basis of these unobserved skills. For example, doctors with minority backgrounds may be better at motivating a response in black patients, but not so good with white patients and vice versa. If minority doctors were scarce and black patients were forced to see white doctors, then their average compliance would be lower. A measure of patient compliance was constructed for every patient-doctor pair to capture such differences in the effectiveness of doctor-patient interaction.

Black patient comply less with prescribed therapy. Tables 5 and 6 report a series of regressions estimating the effect of demographic characteristics on yearly and doctor-specific patient compliance. Within the same clinic, and after controlling for health and SES, blacks are 3.6 percentage points less likely to pick up medications on time (Column (3)). Again, differences in clinic unobservables in fact increase the magnitude of the race coefficient, suggesting that minority patients visit clinics with better average patient adherence.

Table 6 focuses on individual doctor-patient pairs. It is possible that unobserved differences between doctors account for the observed black/white differences in the aggregate. But racial differences in adherence difference persists after controlling for unobserved doctor characteristics in Model (3). In the specification with doctor fixed effects in Column (3) black patients have 5.6 percentage points lower compliance than whites.

Within patients seeing the same physician, minorities have even lower relative compliance with therapy than on average. If blacks and whites were forced to see the same doctors, they would receive the same treatment, however minorities would be about 40 per cent (1.8 percentage points) less compliant than if they were allowed to self-select physicians. Differential sorting is associated with lower mean doctor quality for blacks, but it leads to improved patient response to treatment. Sending

blacks and whites to the same doctors may *increase* the survival gap through its negative effect on compliance.

Patient response may vary across different types of medication and the patterns of non-compliance may differ with race. For example, more educated patients with more health knowledge capital (who are more likely to be white) may selectively adhere more to clinical guidelines therapy. A separate measure of compliance with ACE inhibitors and beta blockers is constructed to test this hypothesis.

Not all patients received prescriptions for these medications. An estimation of average compliance with all medications using the subsample of patients who were treated with ACE inhibitors and beta blockers yielded a coefficient on black race  $-0.035$ , which is very similar to the coefficient obtained from the identical specification in Table 6 Panel I Column (3) with the whole sample. Table 6 Panel II reports the coefficients from linear regressions of average yearly patient compliance with ACEIs and BBs. It also shows average compliance with the physicians who prescribed the recommended therapy. The minority patients who were prescribed these drugs were even less likely to pick up their refills on time as compared to whites. The preferred specification in Panel II Column (3) yields a 5.8 percentage points lower compliance estimate for blacks, which in relative terms is more than 11 per cent lower than compliance for whites. There are two possible reasons. First, African Americans are less likely to comply with therapy-prescribing physicians compared to other doctors. Second, there could be doctor-specific unobserved characteristics which make blacks less likely to comply with some high quality doctors.

Table 7 reports the results using patient-doctor pairs. Column (1) reports coefficient estimates for adherence with all medications for the subsample of patients who got prescribed ACE inhibitors and beta blockers and those physicians who prescribed them. The coefficient on black race is  $-0.062$ , i.e. minorities comply even less with therapy-prescribing physicians for *all* medications that those physicians prescribe. Minority patients show lower compliance with high quality doctors than with others. This is one of the potential reasons why they benefit less from interactions with high quality doctors, who are more likely to prescribe such drugs. This result suggests that black patients to higher quality doctors may in fact *worsen* patient response to therapy.

The measure of patient compliance used here is fairly broad since it only captures whether a patient called in a re-fill on time. But there are many aspects of compliance. Patients might be taking the wrong doses, taking the wrong medication, missing doses, or they could be over-medicating. Being

late in requesting a refill might not be as important as *how late* the patient is. For example, missing one day of therapy is less likely to have disastrous consequences than missing one week. This is why in addition to the broad patient compliance measure introduced above I report the average lapsed time by race in Table 1. When late, black patients are on average one more week behind their therapy regimen than whites. It is important to note that the same level of non-compliance implies a much larger lapse in treatment for blacks.

#### **5.4 The effect of patient adherence**

If differences in adherence explain the black-white mortality gap, including a measure of adherence with prescribed therapy should reduce the gap in survival. The problem is that adherence may in itself depend on unobserved factors that correlate with doctor quality. Adherence in the first year after diagnosis should be less affected by physician-patient matching, since assignment to physicians is more likely to be random. The patient's rate of adherence with the first doctor who prescribed CHF medication is included as a control in the survival regression.

Studies in the medical literature define patients as “compliant” or “adherent” if they obtain more than 80 per cent of re-fills on time (Rossack, 2004; Ostrop et al, 2000). This suggests that the effect is not linear and only the patients who are at the top levels of adherence do better than the rest. An indicator equal to one if the patient has an adherence rate of over 90 per cent was included in the survival regressions. Column (2) in Table 8 reports the regression estimates. The model in Column (3) includes an interaction term of the adherence indicator with black race, intended to test whether the marginal returns to adherence are smaller for blacks. This is also an indirect test of the hypothesis that medications have different effects across race. The interaction of full adherence with black race is positive and important in magnitude, even though it is not precisely estimated. If there is a differential impact of adherence across races, it is in favor of black patients.

Minority patients who are at the top levels of adherence appear especially likely to benefit from strictly following the medication regimen. However, including a measure of patient adherence does not reduce the effect of doctor quality and the magnitude of the coefficient on black race. Differences in adherence do not explain differences in survival between blacks and whites.

One way to think about patient adherence is as a complement to doctor quality. Pills don't work on patients who don't take them. Even if a patient is getting the best possible prescription, if they don't follow it, there will be no effect. An alternative hypothesis is that patient adherence to medication and

the quality of medical care are substitutes. Another way to think about this is that good doctors don't matter for "good" (or adherent) patients. But they may matter for those that are sporadically adherent. For example, it may be better to be sporadically adherent with the most potent therapy than with the most basic one.

Differences in patient adherence may be driven by differences in patient perceptions about the substitutability of medical care and their own efforts. Patients' levels of adherence to medication will settle at different levels depending on the perceived marginal costs and benefits of adherence. If the marginal cost of own investment in health is high, and the patient perceives the two inputs as substitutes, he will tend to rely more on medical care and less on his own effort. For example, those who find it too painful to change lifestyle and diets would tend to substitute into more potent medication or more frequent hospitalizations. If there is a high degree of substitutability between the two, the effect of doctor quality should be stronger for less adherent patients. Depending on the degree of substitutability between patient effort and doctor quality, higher quality medical care may or may not be able to compensate for lower patient effort.

Next I divide the sample into compliant and non-compliant patients based on where their compliance levels fall relative to the mean<sup>19</sup>. This is also a crude way to test for the degree of substitutability between patient adherence and provider quality. If they are substitutes, then the coefficient on doctor quality in the non-adherent sub-sample should be larger. Dividing the sample according to adherence also allows to test whether the degree of substitutability differs between blacks and whites. Conditional on being treated the same, the relative efficiency of medical care with respect to the patient's own effort may differ across races. Medical care may be more efficient for whites, while own effort may be more beneficial for blacks. Should this be the case, one expects to find racial differences in the marginal product of quality care regardless of the level of patient effort.

Table 9 reports the results a series of regressions on the samples of compliant and non-compliant patients. Dividing the sample in this fashion reveals that the reduced marginal product of doctor quality for minority patients is isolated to the non-compliant part of the population. In fact, there are no differences in survival between blacks and whites who adhere to prescribed therapy more than 50 percent of the time and there are no differences in the efficacy of medical care across races.

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<sup>19</sup> A potential concern is that selection into compliance is influenced by doctor quality. A probit regression of the binary compliant/non-compliant indicator on observables shows no significant effect of mean doctor quality on selection into compliance. In fact, mean doctor quality for non-compliant patients is higher at .285, while for compliant patients it is .28.



The coefficient on doctor quality in the non-compliant sub-sample is slightly larger than the respective coefficient in the compliant subsample (models 1.2 and 2.2). This suggests that the marginal product of medical care may be higher among non-compliant patients. One interpretation is that the degree of substitutability between own effort and medical care is higher when effort is low. However the estimates are not precise enough to draw any strong conclusions.

A valid question is why this low effect of medical care is restricted to non-adherent black patients. There are several possible reasons. First, non-adherence in whites may be different from non-adherence in blacks. For example, when late picking up a medication, black patients take longer than whites. This would matter for survival as long as the lag between filling prescriptions bears additional negative association with survival. Another dimension that is not directly picked up by the measure of non-adherence is the difference in extent of non-adherence across medications. As demonstrated earlier, non-adherence to clinically recommended therapy (ACEIS and BBs) is even more pronounced in minorities than non-adherence with the average medication pick-up.

Second, it is possible that non-compliance is common for the most physically active whites and the least active blacks and so the reasons for non-compliance may be different in the two samples. For example, whites are late picking up a medication because they are feeling well, while blacks are late because they don't have the strength to go to the clinic. Third, lower income and weaker social support may play a significant role. For example, a white non-compliant patient may have more alternative venues of obtaining the medication. All of these alternatives hinge on the assumption that the costs or the extent of non-adherence for non-adherent whites are lower than those for blacks and the measure of non-adherence used here is not able to pick up this difference.

But even with the same costs and extent of non-adherence across patients, the benefits from adherence may differ depending on differences in the unobserved knowledge capital about health and CHF. This difference will also manifest in the efficacy of quality medical care. Low effort whites with high levels of health knowledge capital are able to substitute quality care for own effort, e.g. by selectively complying with medication groups. Low effort blacks are not. When subjected to the same quality of health care provided, different groups will have varying marginal returns to quality care. Differences in the ability of quality doctors to relate the importance of own effort and/or therapy component to blacks and whites will result in similar effects. This does not contradict the results in Table 8, since the most adherent blacks may also have the highest levels of health knowledge capital or because at high levels of compliance counseling has little added benefit.

A comparison between adherent and non-adherent patients by race is presented in Table 10. Both black and white patients of low compliance are less likely to be diabetic. Less compliant blacks have fewer cases of some forms of cancer, but more incidence of ischemic heart disease. It is unlikely that non-compliance in black patients is due to poverty – the average annual income for low-compliant black patients is 17,710 dollars, compared to 17,450 in the compliant group. They do not appear any more infirm than the rest of the population and are generally younger by about 2 years. Overall, across all patients, those who suffer from other chronic conditions such as diabetes and/or pulmonary failure are more compliant. The only significant observable difference between non-compliant blacks and whites is in the extent of the social support network, as proxied by marital status. A promising venue for future work is to investigate in more detail the mechanisms leading to suboptimal patient response to therapy and whether they differ across groups.

The results in this section have several important implications. First, minority patients are less adherent regardless of who their doctor is. Second, strict patient adherence to the prescribed medication regimen yields positive results. Third, should a black patient fall below the mean level of patient adherence, he also experiences lower benefits from doctor quality. In practice this means that sending a non-adherent black patient to the top doctor would result in the same survival benefit as sending an adherent black (or white) patient to doctors with mean quality in the second quintile.

### **5.5 Decomposing the survival gap**

The difference in raw three-year survival conditional on two year survival between whites and blacks is -0.008. This does not appear a large difference at first, but it should be pointed out that minority patients are significantly younger (by 6 years) in this sample. Table 11 reports the results of Oaxaca-Blinder decompositions of the survival gap by race and patient adherence level. Coefficients for white patients are taken as the base. Using white patients as the base asks the question: How well would blacks do if they responded to the medical encounter in the same way as whites but also had the same characteristics? Negative signs denote an advantage for blacks, positive signs denote advantage for whites. Adjusting for age and co-morbidities yields a 2.8 per cent *unrealized* survival advantage for African American patients. If all were equal, and there were no differences by race in the benefits from the various factors affecting survival, they would have a 2.8 percentage points higher probability of survival than whites. The 2 percentage points unrealized survival potential for blacks after adjusting for age and co-morbidities is more meaningful than the raw difference in survival.

The effects of socio-economic status account for 30 per cent of this difference. If African Americans had the same rates of marriage and the same income as whites, and responded similarly to factors influencing survival probabilities, they would have 2.2 per cent higher chance of survival than whites. Whites also have higher returns to marriage and income, suggesting that the social support network operates better for whites than for blacks.

Adding clinic fixed effects reveals that on average black patients go to better clinics. Mean doctor quality is not significantly different between the two groups and in itself does not contribute to the black-white survival gap. After accounting for all factors except patient compliance, there is a 1.7 per cent difference in black-white mortality which is attributable to differences in ways blacks and whites respond to different conditions influencing health.

The raw difference in survival between races in the compliant sample is 1.5 percentage points in favor of blacks. After accounting for all observable differences between black and white compliant patients, there remains a very small difference of 0.5 percentage points in favor of whites and attributable to coefficients. This suggests that there is essentially no difference in the way black and white compliant patients respond to factors influencing survival. The important policy implication here is that patient compliance serves as a marker that can be used when designing interventions. Low patient compliance should be used as a signal that something is not working in the way health care is delivered to the patient, and that break in the process is likely to influence minorities more negatively than whites.

A very different scenario emerges from the sample of non-compliant patients, where African Americans and whites show significantly larger differences attributable to coefficients. The raw difference in survival probabilities is only 0.3 percentage points in favor of blacks. However, adjusting for age and co-morbidities suggests that the difference should instead be over ten times larger in favor of minority patients. Adding controls for income and marital status eliminates about 14 per cent of the difference due to coefficients. Non-compliant blacks go to better clinics, but they see worse doctors. They benefit less from being married, and from clinic and doctor quality. After accounting for all patient, doctor and clinic characteristics, the part of the survival gap attributable to coefficients for non-compliant patients is more than one and a half times larger than the overall survival gap.

In summary, there are almost no differences in the way patients from the top half of the compliance distribution react to the medical encounter. The observed difference in survival rates associated with black race is entirely accounted for by black patients in the lower half of the

compliance distribution. These patients should be the focus of policy interventions intended to reduce the racial mortality gap.

### **5.6 Applicability for the general population**

How would the general population fare if they were subjected to VHA care? While military service is likely to have influenced blacks and whites in a similar fashion with respect to health and health habits, veterans who use the VA health care system are different from the general population along two dimensions. First, they have self-selected into military service except for a tiny fraction of Vietnam veterans who were drafted. Second, they have chosen to use the VHA rather than private care for their health needs. The more troubling possibility is that the selection may have happened differently among whites and minorities. Data from the National Survey of Veterans and the CPS are used to assess the potential bias in the mortality gap induced by selection. Appendix C presents the evidence discussed in this section.

More than half of the male population (56%) over the age of 65 had veteran status in 2000. Correlations between veteran status, marital status and education for blacks and whites in the population over 65 and in the general population are reported in Table C.1. Veteran status captures the top of the socio-economic distribution of blacks and the middle of the socio-economic distribution of whites. Veteran status serves as a mediator of the education gap between blacks and whites. It closes about one third of the gap (see Table C.1). There are no significant differences in marital status or income between veteran and non-veteran blacks. Higher education has been found in numerous studies to positively influence health and correlate positively with adherence to therapy. Hence if the effects of selection into VHA care are negligible, the selection into veteran status by African Americans would bias the black-white mortality gap *downwards*.

The National Survey of Veterans (NSV) is used to assess the potential bias arising from the selection into VHA care conditional on being a veteran. Table C.2 in Appendix C reports some suggestive evidence. The 2001 NSV is a nationally representative survey of veterans that asks several questions related to the use of VHA care as well as veterans' health status and chronic conditions. Within the veteran population of patients over 65, relatively better educated blacks chose VHA, while better educated whites chose Medicare. Married individuals were less likely to use VA care across races. There were no significant differences in income between VHA and Medicare patients across races. Similar comparisons apply to the sample of patients who report having a heart condition. An

interesting picture emerges – the best educated blacks and the average whites are likely to end up in VHA care for CHF. Selection on the basis of marital status and income affect blacks and whites the same. The double selection would likely bias downward the mortality gap observed among veterans using VA health care.

## **6. Policy implications**

An interesting policy question is how much of the racial disparity is accounted for by different access and facility financing. If patients were universally insured and there was a central health care budget, how would the racial mortality gap react. This study presents evidence that quality of facilities and physicians in an equal-access medical care system does not influence the racial mortality gap. At least one third of the gap measured in private care could be accounted for by disparate access and quality due to financial constraints.

The most sizeable contribution to diminishing disparities would come from changes in physician and patient inputs into the health production function. Designing and implementing policies that improve physicians' awareness of clinically recommended therapies and patients' response to therapy will have first-order effect on overall mortality and the racial gap in survival. Numerous techniques for improving patient compliance have been suggested. However, few offer a cost-benefit analysis of the proposed interventions. Two dimensions of such an analysis are offered here – the efficiency gain from better drug regimen compliance, and the gains in value of statistical life-years.

A well-known quantification of the benefits of better compliance comes from the town of Asheville, North Carolina. The Asheville project involved patients with diabetes mellitus, another chronic, common, and potentially fatal disease associated with high hospitalization costs and decrease in quality of life. The project recruited pharmacists to monitor and assess the compliance of diabetic patients over 12 months<sup>20</sup>. During the next 12 months inpatient claims went down by 40 per cent.

The annual hospital costs of CHF have been estimated at \$8 billion dollars and the overall annual cost of managing CHF at \$12 to \$20 billion dollars (Alexander et al., 1999). Achieving the efficiency of the Asheville project would reduce inpatient CHF costs by \$3.2 billion dollars per year. About 550000 new CHF cases are diagnosed annually. The cost of an identical program for heart

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<sup>20</sup> Pharmacists were compensated to initially assess patient compliance, evaluate intermediate outcomes and perform routine visits lasting no more than 20 minutes. They were paid 75\$ for the first pharmacy consultation, 45\$ for the intermediate, and 20\$ for routine visits.

failure patients would be about 400 dollars per patient in the first year of treatment, and the effect could last much longer than the initial 12 months. If *every* patient is given the type of pharmacy counseling used in Asheville, the total bill would be 220 million dollars, which is less than 10 per cent of the total savings from preventable hospitalizations *only*.

Closing the survival gap requires equalizing black and white therapy compliance rates. Increasing black patient compliance by 5 per cent and equalizing it with white patients' compliance will reduce absolute medium-term black mortality by 1.5 per cent. Values of statistical life-years range between fifty thousand dollars and one hundred and fifty thousand dollars. Increasing mean black compliance to the level of white patients could result in expected savings ranging from one to three thousand dollars per black patient per year. There are about 700000 African Americans with heart failure in the US, and this number is expected to grow to 900,000 by 2010. Potential reductions in the cost of care and benefits to society are in the order of billions of dollars.

## **7. Conclusions**

Equalizing access for patients and financial incentives for physicians is not sufficient to close the racial mortality gap in elderly patients with chronic heart failure. Several reasons for this phenomenon are examined. Differences in socio-economic status account for less than one third of the remaining gap in survival. While doctor quality is a significant factor in improving survival probabilities, there is little evidence of sorting of minorities into lower quality doctors and it explains only five per cent of the difference in outcomes. Patient-doctor matching is efficient in improving patient compliance and may counter the effect of lower doctor quality through increased patient compliance. I also show that physicians' prejudice does not account for the observed disparity. Rather, divergent patient responses to provider input appear to trigger some of the differences in survival.

The largest differences between minorities and whites exist in patient adherence with prescribed therapy. One obvious policy recommendation is to invest in changing the compliance patterns of minority patients. Clearly, more work is needed to identify the reasons behind diverging responses to health care and why they affect whites and minorities differently. The key to solving the predicament of racial disparities in health, beyond the effects of unequal supply of care, lies in the patient response to the medical encounter.

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## Appendix A

### Medical evidence on the progression and the pharmacological management of CHF

The progression of Chronic Heart Failure is divided into four stages depending on the extent of damage to the left ventricular ejection function of the heart muscle. Early diagnosis (within stages I or II) and subsequent therapy may prevent further deterioration of the heart function, and a patient will not proceed to stages III or IV. Heart failure becomes a primary diagnosis when CHF has progressed to a later stage of development (such as III or IV).

#### Therapy guidelines

The American College of Cardiology guideline for CHF treatment in 2005 states: “Beta-blockers are indicated in all patients without a recent history of MI (myocardial infarction) who have a reduced LVEF (left ventricular ejection function) with no HF symptoms. Angiotensin converting enzyme inhibitors should be used in patients with a reduced EF (ejection function) and no symptoms of HF, even if they have whether or not they have experienced MI...Angiotensin converting enzyme inhibitors are recommended for all patients with current or prior symptoms of HF and reduced LVEF, unless contraindicated”.

In an overview of the clinical trials literature for the treatment of CHF, Bristow (2000) reports that “Based on combined evidence from a number of clinical trials, a combined ACEI and BB treatment is expected to decrease 1-year mortality by 46%”. Silke (2006) concludes “In the major beta-blocker trials in CHF, a reduction in mortality of about 35% was consistently demonstrated with beta-blockade” and Senni et al (1998) show that the positive effects of ACEIs on survival do not abate with the progression of the disease. These estimates are in the vicinity of the ones obtained in the present study, with the effect of full doctor compliance with guidelines ranging between 30 and 40% reduction in mortality.

Non-compliance with guidelines is not restricted to US physicians. For example, Murphy and co-authors (2004) found that in a cohort of Scottish patients with CHF, ACEIs were prescribed to 39% and beta blockers to 21% of the group.

#### Mortality patterns

Levy and co-authors (2002) report 18% mortality rate within the first year in men surviving 30 days after an index hospitalization, and 54% mortality in a 5-year period. McCullough et al (2002) report similar findings of the one- and two-year survival rates, with the survival curve flattening in the years after. Both of these studies report mortality rates in the same ballpark as the ones found in the sample presented here.

Croft et al (1999) find much higher mortality rates, in excess of 30% in the first year after diagnosis. They also report a flattening of the survival curve in later years, suggesting that the most infirm patients at the onset perish first. Senni et al (1998) find 23% combined 3-year mortality among those treated with ACEIs and 26% among those who were given a placebo. They also observe higher mortality rates in the first two years of follow-up.

## Appendix B

### Patient adherence to therapy

In an overview of the available measures and evidence for patient adherence to medication therapy, Ostenberg and Blaschke conclude that “rates of refilling prescriptions are an accurate measure of overall adherence in a closed pharmacy system (e.g., health maintenance organizations, the Department of Veterans Affairs Health Care System, or countries with universal drug coverage), provided that the refills are measured at several points in time. A medical system that uses electronic medical records and a closed pharmacy can provide the clinician or research scientist with readily available objective information on rates of refilling prescriptions that can be used to assess whether a patient is adhering to the regimen and to corroborate the patient's responses to direct questions or on questionnaires.”

The effect of poor adherence on hospitalizations and costs is high “Of all medication-related hospital admissions in the United States, 33 to 69 percent are due to poor medication adherence, with a resultant cost of approximately \$100 billion a year. Participants in clinical trials who do not follow medication regimens or placebo regimens have a poorer prognosis than subjects in the respective groups who do. Adherence to medication and placebo regimens, therefore, both predict better outcomes, and collecting adherence data from subjects is now considered an essential part of clinical trials. Given the magnitude and importance of poor adherence to medication regimens, the World Health Organization has published an evidence-based guide for clinicians, health care managers, and policymakers to improve strategies of medication adherence.”

## Appendix C

### Veterans vs. non-veterans and selection into VHA

This appendix provides comparisons between veterans and non-veterans based on data from the 2001 March CPS and the 2001 National Survey of Veterans

Table C.1 Differences in education and marital status between veterans and non-veterans

	<i>All CPS</i>	<i>Over 65</i>	<i>All CPS</i>	<i>Over 65</i>	<i>All CPS</i>	<i>Over 65</i>
	<i>Education</i>		<i>Married</i>		<i>Income</i>	
Black	-0.921*** (0.052)	-2.681*** (0.215)	-0.196*** (0.009)	-0.175*** (0.028)	-4759*** (361)	-2685*** (721)
Veteran	0.255*** (0.032)	1.142*** (0.082)	0.167*** (0.005)	0.024** (0.011)	8407*** (324)	10645*** (413)
Black*Veteran	0.397*** (0.117)	0.945*** (0.310)	0.032 (0.020)	-0.023 (0.041)	-813 (1109)	-1494 (1604)
Constant	9.947*** (0.015)	8.642*** (0.065)	0.581*** (0.003)	0.745*** (0.008)	23258*** (112)	9070 (217)
Observations	48747	7422	48747	7422	48747	7422
R-squared	0.009	0.062	0.033	0.012	0.01	0.04

Standard errors in parentheses  
 \* significant at 10%; \*\* significant at 5%; \*\*\*significant at 1%

Table C.2 Probability of using VHA among veterans; OLS linear probability models

	<i>All veterans</i>	<i>Veterans on Medicare</i>	<i>Veterans with a heart condition</i>	<i>Veterans on Medicare with a heart condition</i>
Black	0.061 (0.043)	0.031 (0.062)	0.086 (0.098)	0.166 (0.120)
Education	-0.081*** (0.004)	-0.081*** (0.005)	-0.086*** (0.008)	-0.087*** (0.009)
Income	-0.012*** (0.001)	-0.011*** (0.002)	-0.011*** (0.002)	-0.007*** (0.003)
Married	-0.131*** (0.009)	-0.082*** (0.014)	-0.112*** (0.020)	-0.072*** (0.024)
Black*married	-0.026 (0.027)	0.003 (0.045)	0.011 (0.063)	-0.029 (0.084)
Black*educ	0.039*** (0.014)	0.039* (0.022)	0.041 (0.031)	0.027 (0.039)
Black*income	-0.002 (0.004)	0.002 (0.006)	-0.007 (0.008)	-0.010 (0.010)
Constant	0.734*** (0.014)	0.742*** (0.019)	0.837*** (0.028)	0.803*** (0.033)
Observations	15159	7398	3614	2518
R-squared	0.071	0.057	0.062	0.052

Standard errors in parentheses  
 \*significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

## Tables and Graphs

Table 1: Variable definitions and means; variables not used in previous studies and introduced in this paper are in **bold**

Variable	White patients			Black patients		
	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
<b>Yearly income</b>	<b>45512</b>	<b>24890</b>	<b>20000</b>	<b>3460</b>	<b>18644</b>	<b>10500</b>
Age	45512	73	9	3460	67	12
<b>Married</b>	<b>45512</b>	<b>0.70</b>	<b>0.46</b>	<b>3460</b>	<b>0.50</b>	<b>0.50</b>
<b>Patient compliance (all)</b>	<b>41436</b>	<b>0.49</b>	<b>0.28</b>	<b>3074</b>	<b>0.53</b>	<b>0.28</b>
<b>Patient compliance (ACEIs-BBs)</b>	<b>32716</b>	<b>0.56</b>	<b>0.29</b>	<b>2611</b>	<b>0.51</b>	<b>0.29</b>
N days late with refill	39929	17	18	3152	22	22.5
Outcomes						
% Survived the first year	45512	84%	0.37	3460	87%	0.34
% Survived the 2nd year surviving 1st	26365	86%	0.43	2141	88%	0.41
% Survived the 3rd year Surviving 2nd	17681	89%	0.46	1566	90%	0.44
Clinic characteristics						
Ratio black in clinic	45167	5.57%	7%	3455	15.13%	12%
% in Small clinics	45512	25.53%	44%	3460	16.82%	37%
% in Large clinics	45512	34.63%	48%	3460	54.57%	50%
% in Rural clinics	45314	11.77%	17%	3385	7.79%	14%
Patient-doctor matching						
Doctor ratio black	40639	0.06	0.078	3243	0.245	0.18
<b>Mean doctor quality</b>	<b>40639</b>	<b>0.29</b>	<b>0.09</b>	<b>3243</b>	<b>0.28</b>	<b>0.09</b>
<b>First doctor's quality</b>	<b>40639</b>	<b>0.34</b>	<b>0.08</b>	<b>3243</b>	<b>0.33</b>	<b>0.08</b>
Time to meeting main doctor	40639	254	421	3243	303	478
doctors /year	40639	1.6	0.2	3243	1.8	0.2
prescriptions/doctor	40639	8.5	0.3	3243	8.2	0.4
main doctor absent	40639	2.8	3.87	3243	2.8	3.66
Small clinics						
Doctor ratio black	10631	0.04	0.06	545	0.28	0.24
Mean doctor quality	10631	0.3	0.09	545	0.3	0.1
Medium clinics						
Doctor ratio black	15775	0.05	0.06	896	0.19	0.008
Mean doctor quality	15775	0.29	0.087	896	0.28	0.04
Large clinics						
Doctor ratio black	14233	0.09	0.09	1802	0.26	0.17
Mean doctor quality	14233	0.29	0.09	1802	0.27	0.09

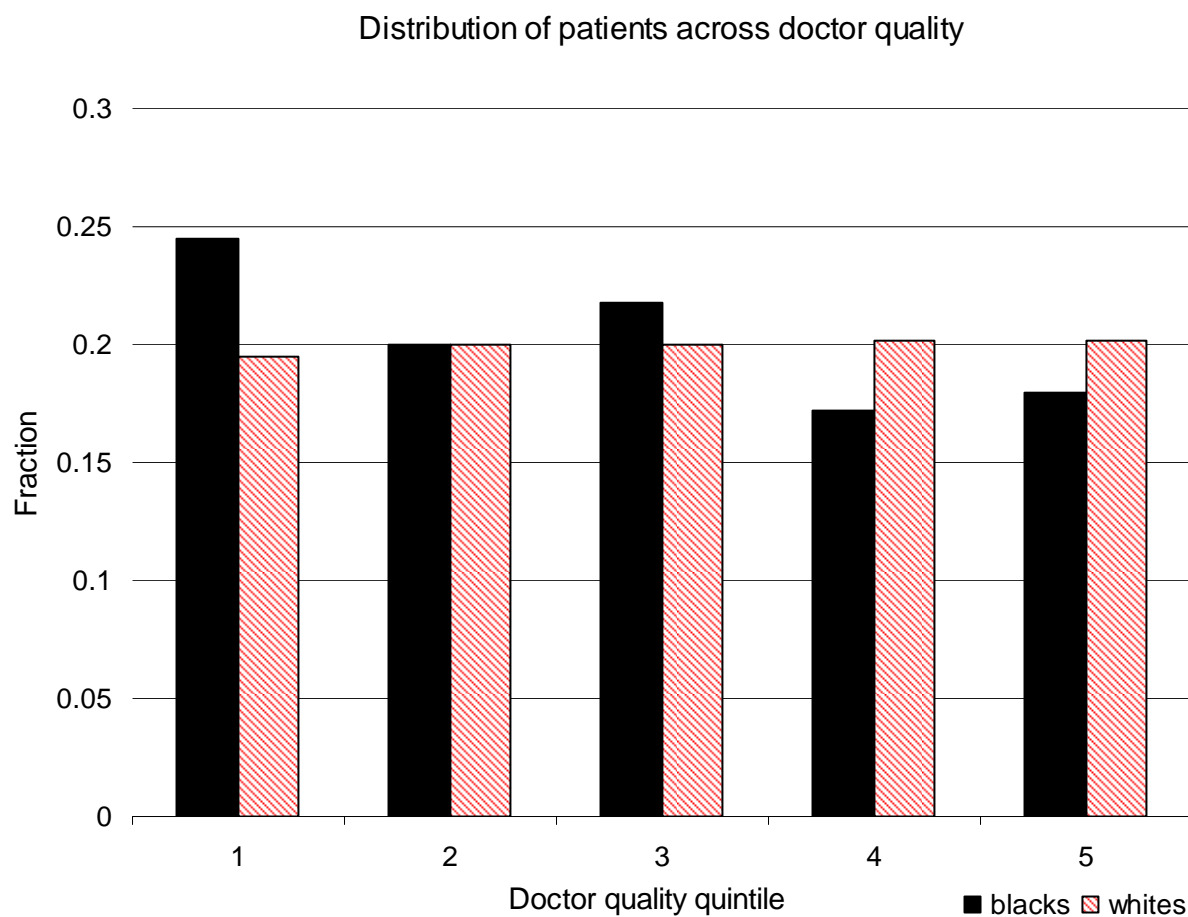
Table 2: Three-year survival probability conditional on two-year survival. Linear probability models. The dependent variable equals one if the patient survived the third year after diagnosis. All standard errors are adjusted for clinic-level clustering.

Outcome: Three year survival conditional on two year survival					
	(1)	(2)	(3)	(4)	(5)
Black	-0.022** (0.009)	-0.017* (0.009)	-0.019** (0.009)	-0.018* (0.009)	0.036 (0.034)
Age	-0.005*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)
Income		0.002 (0.002)	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)
Married		0.029*** (0.007)	0.029*** (0.007)	0.026*** (0.007)	0.026*** (0.007)
Mean_doc_quality				0.375*** (0.051)	0.398*** (0.052)
Black*doc_quality					-0.193* (0.107)
Co-morbidities	YES	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES	YES
Clinic FE	NO	NO	YES	YES	YES
Constant	1.284*** (0.026)	1.251*** (0.021)	1.230*** (0.037)	1.127*** (0.041)	1.121*** (0.041)
Observations	11463	11542	11463	11463	11463
R-squared	0.032	0.034	0.033	0.039	0.039
Robust standard errors in parentheses					
* significant at 10%; ** significant at 5%; *** significant at 1%					

Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.



Figure 1: Mean doctor quality by patient race. Shaded red indicates white patients, black denotes black patients. Doctor quality is measured as the weighted average of the individual adherence measures of all doctors who treated the patient during the period. Adherence to clinical guidelines is constructed as the N of patients who were prescribed ACEIs and beta blockers/ total N patients treated by the doctor.



The following were used as cut-off points for doctor quality quintiles:

1. mean doctor quality  $\leq 0.21$
2.  $0.21 < \text{mean doctor quality} \leq 0.26$
3.  $0.26 < \text{mean doctor quality} \leq 0.3$
4.  $0.3 < \text{mean doctor quality} \leq 0.35$
5.  $0.35 < \text{mean doctor quality}$

Figure 2: Effect of doctor quality on patient survival. The top line (red) indicates white patients. The lower line (in black) indicates African American patients. Doctor quality is measured as the weighted average of the individual adherence measures of all doctors who treated the patient during the period. Adherence to clinical guidelines is constructed as the N of patients who were prescribed ACEIs and beta blockers/ total N patients treated by the doctor. Large markers indicate significance of 80% and above.

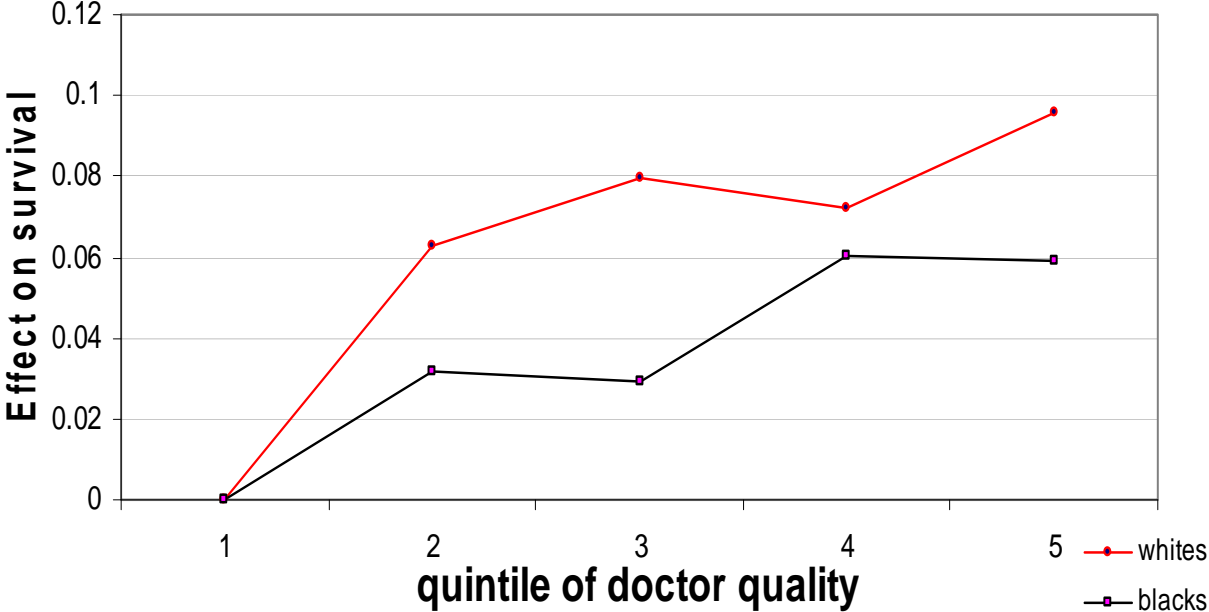


Table 3: Three-year survival conditional on two-year survival. Linear probability models. The dependent variable equals one if the patient survived the third year after diagnosis. All standard errors are adjusted for clinic-level clustering.

Outcome: Three year survival conditional on two year survival				
	(1)	(2)	(3)	(4)
Black	-0.018*	0.036	-0.019**	0.054
	(0.009)	(0.034)	(0.009)	(0.04)
Age	-0.005***	-0.005***	-0.005***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)
Married	0.026***	0.026***	0.027***	0.028***
	(0.002)	(0.002)	(0.007)	(0.007)
Income	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.001)	(0.001)
Mean_doc_quality	0.375***	0.398***		
	(0.051)	(0.052)		
Black*doc_quality		-0.193*		
		(0.107)		
First_doc_quality			0.37***	0.4***
			(0.046)	(0.048)
Black*first_doc_quality				-.21**
				(0.11)
Constant	1.127***	1.121***	1.125***	1.12***
	(0.041)	(0.041)	(0.04)	(0.041)
Co-morbidities	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES
Clinic FE	YES	YES	YES	YES
Obs	11463	11463	11463	11463
R-squared	0.039	0.039	0.036	0.036
Robust standard errors in parentheses				
* significant at 10%; ** significant at 5%; ***significant at 1%				

Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

Table 4: Probability of being treated with recommended therapy of ACE inhibitors and beta blockers by a doctor. The unit of observation is the doctor-patient pair. Linear probability models. Controls for co-morbidities and year fixed effects included, coefficients not reported. Standard errors are clustered at the patient level.

Outcome: Probability of being treated with ACEIs and BBs; patient-doctor pairs			
	(1)	(2)	(3)
Black	-0.003 (0.004)	-0.009* (0.005)	0.003 (0.006)
Age		-0.003*** (0.000)	-0.003*** (0.000)
Married		0.005* (0.0026)	0.002 (0.002)
Income		0.003*** (0.000)	0.001 (0.0006)
Co-morbidites	YES	YES	YES
Cohort FE	YES	YES	YES
Doctor FE	NO	NO	YES
Obs	157469	157469	157469
R-squared	0.0116	0.029	0.027
Robust standard errors in parentheses			
* significant at 10%; ** significant at 5%; *** significant at 1%			

A patient-doctor pair is a match between a patient and a doctor which produces more than 2 prescriptions for the patient. Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

Table 5: Patient compliance with therapy. All medications, all doctors. Yearly measures. The dependent variable is the ratio of compliant re-fills (re-fills which were picked up within 3 days of expiration of the supply of medication from the previous re-fill) for all medications. Standard errors are clustered at the clinic level.

Outcome: Patients' average yearly compliance; all doctors, all medications			
	(1)	(2)	(3)
Black	-0.024*** (0.008)	-0.023*** (0.008)	-0.036*** (0.005)
Age	0.000 (0.00)	0.000 (0.00)	0.000*** (0.00)
Income		-0.001 (0.001)	-0.000 (0.000)
Married		0.008*** (0.0018)	0.006*** (0.0016)
Co-morbidities	YES	YES	YES
Cohort FE	YES	YES	YES
Clinic FE	NO	NO	YES
Constant	0.079*** (0.014)	0.076*** (0.014)	0.042*** (0.012)
Obs	43578	43578	43578
R-squared	0.026	0.028	0.032
Robust standard errors in parentheses			
* significant at 10%; ** significant at 5%; ***significant at 1%			

Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

Table 6: Patient compliance with therapy. Patient-doctor pairs. The dependent variable is the ratio of compliant re-fills for every patient-doctor match. Standard errors are clustered at the patient level.

	Outcome: patient compliance with doctors; all medications; patient-doctor pairs			Outcome: patients' average yearly compliance with ACEIs and BBs		
	Panel I			Panel II		
	(1)	(2)	(3)	(1)	(2)	(3)
Black	-0.037*** (0.004)	-0.038*** (0.005)	-0.056*** (0.005)	-0.041*** (0.011)	-0.042*** (0.01)	-0.058*** (0.009)
Age	-0.000 (0.000)	-0.000 (0.000)	0.000*** (0.000)	0.001*** (0.00)	0.001*** (0.00)	0.001*** (0.00)
Income		-0.002*** (0.001)	-0.001** (0.001)		-0.003** (0.001)	-0.002* (0.001)
Married		0.000 (0.003)	0.002 (0.002)		0.008** (0.003)	0.005 (0.0037)
Co-morbidities	YES	YES	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES	YES	YES
Doctor FE	NO	NO	YES	NO	NO	YES
Constant	14.811*** (1.511)	14.314*** (1.516)	12.391*** (1.604)	0.514*** (0.023)	0.515*** (0.024)	0.486*** (0.018)
Obs	121368	121368	121368	34928	34928	34928
R-squared	0.004	0.004	0.005	0.005	0.005	0.006
Robust standard errors in parentheses						
* significant at 10%; ** significant at 5%; *** significant at 1%						

A patient-doctor pair is a match between a patient and a doctor which produces more than 2 prescriptions for the patient. Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

Table 7: Patient compliance with therapy. Patient-doctor pairs. The dependent variable is the ratio of compliant re-fills for every patient-doctor match. Column (1) shows compliance with all medications for the sub-sample of doctors who prescribed ACE inhibitors and beta blockers. Columns (2)-(4) have compliant with ACEIs and BBs as an outcome variable. Standard errors are clustered at the patient level.

Outcome: patient compliance with doctors; patient-doctor pairs; model (1) has all medications; models (2)-(4) are for ACEIs and beta blockers only				
	All medications (1)	ACEIs-BBs (2)	ACEIs-BBs (3)	ACEIs-BBs (4)
Black	-0.062*** (0.005)	-0.041*** (0.006)	-0.042*** (0.006)	-0.064*** (0.006)
Age	0.001*** (0.000)	0.000 (0.000)	0.000 (0.000)	0.001*** (0.000)
Income	-0.001** (0.001)		-0.002*** (0.001)	-0.001** (0.001)
Married	0.003 (0.003)		0.002 (0.003)	0.003 (0.003)
Co-morbidities	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES
Doctor FE	YES	NO	NO	YES
Constant	9.548*** (1.746)	17.130*** (1.826)	16.661*** (1.835)	13.292*** (1.990)
Obs	76853	76853	76853	76853
R-squared	0.006	0.004	0.004	0.005
Robust standard errors in parentheses				
* significant at 10%; ** significant at 5%; *** significant at 1%				

A patient-doctor pair is a match between a patient and a doctor which produces more than 2 prescriptions for the patient. Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.

Table 8: The effect of patient compliance on medium-term survival. Three-year survival conditional on two-year survival. All standard errors are adjusted for clinic-level clustering.

Outcome: three year survival probability conditional on two-year survival			
	(1)	(2)	(3)
Black	-0.018* (0.009)	-0.017* (0.009)	-0.021** (0.009)
Age	-0.005*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)
Income	0.002 (0.002)	0.002 (0.002)	0.002 (0.002)
Married	0.026*** (0.007)	0.026*** (0.007)	0.026*** (0.007)
Mean_doc_quality	0.375*** (0.051)	0.378*** (0.051)	0.379*** (0.051)
Full_compliance		0.018** (0.008)	0.015* (0.009)
Black*Full_compliance			0.042 (0.026)
Co-morbidities	YES	YES	YES
Cohort FE	YES	YES	YES
Clinic FE	YES	YES	YES
Constant	1.127*** (0.041)	1.124*** (0.041)	1.124*** (0.041)
Observations	11463	11463	11463
R-squared	0.039	0.039	0.039
Robust standard errors in parentheses			
* significant at 10%; ** significant at 5%; *** significant at 1%			

Controls for co-morbidities include: old myocardial infarction, lymphoma, leukemia, pulmonary failure, diabetes, renal failure, colon cancer, angina, cardiomyopathy, ischemic heart disease, prostate cancer, liver disease, dysrhythmias, other cardiovascular disease, other cancers.



Table 9: The effect of different levels of patient compliance by race. Non-compliant is 1 if the patient was below the mean level of compliance with his first doctor. Three-year survival conditional on two-year survival. All standard errors are adjusted for clinic-level clustering.

Outcome: Three year survival probability conditional on two-year survival						
	Non-compliant patients			Compliant patients		
	(1.1)	(1.2)	(1.3)	(2.1)	(2.2)	(2.3)
Black	-0.036** (0.014)	-0.034** (0.014)	0.057 (0.048)	-0.004 (0.016)	-0.005 (0.017)	0.006 (0.045)
Age	-0.005*** (0.000)	-0.006*** (0.000)	-0.006*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)	-0.005*** (0.000)
Income	-0.000 (0.003)	-0.000 (0.003)	-0.000 (0.003)	0.003 (0.002)	0.003 (0.002)	0.003 (0.002)
Married	0.022** (0.009)	0.020** (0.009)	0.020** (0.009)	0.037*** (0.010)	0.034*** (0.010)	0.034*** (0.010)
Mean_doc_quality		0.394*** (0.076)	0.447*** (0.075)		0.358*** (0.061)	0.361*** (0.065)
Black*doc_quality			-0.326** (0.162)			-0.040 (0.146)
Co-morbidities	YES	YES	YES	YES	YES	YES
Cohort FE	YES	YES	YES	YES	YES	YES
Clinic FE	YES	YES	YES	YES	YES	YES
Constant	1.239*** (0.045)	1.137*** (0.050)	1.123*** (0.051)	1.220*** (0.048)	1.121*** (0.052)	1.120*** (0.052)
Obs	5194	5194	5194	6269	6269	6269
R-squared	0.035	0.041	0.042	0.036	0.042	0.042

Robust standard errors in parentheses

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%

Table 10: Observable characteristics of compliant and non-compliant patients by race for the sample of patients who survived two years after diagnosis.

Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
	White patients			Black patients			White patients			Black patients		
				Compliant						Non-compliant		
Income	6044	22930	16900	392	17450	9080	4639	23250	16630	700	17710	9460
Marital	6044	0.669	0.470	392	0.474	0.500	4639	0.703	0.457	700	0.501	0.500
Age	6044	70.89	9.413	392	67.19	11.372	4639	71.47	9.27	700	65.31	11.43
Colon cancer	6044	0.008	0.091	392	0.013	0.112	4639	0.008	0.089	700	0.009	0.092
Old AMI	6044	0.049	0.217	392	0.046	0.210	4639	0.057	0.232	700	0.063	0.243
Angina	6044	0.047	0.211	392	0.046	0.210	4639	0.060	0.238	700	0.067	0.250
Hernia	6044	0.025	0.157	392	0.041	0.198	4639	0.025	0.155	700	0.016	0.124
Pulmonary disorders	6044	0.318	0.466	392	0.260	0.439	4639	0.287	0.452	700	0.270	0.444
Lymphoma	6044	0.001	0.036	392	0.000	0.000	4639	0.002	0.039	700	0.003	0.053
Leukemia	6044	0.013	0.114	392	0.023	0.150	4639	0.015	0.122	700	0.016	0.124
Other_cancers	6044	0.055	0.228	392	0.071	0.258	4639	0.055	0.229	700	0.059	0.235
Prostate Cancer	6044	0.060	0.237	392	0.059	0.235	4639	0.059	0.236	700	0.073	0.260
Skin/bone cancer	6044	0.010	0.102	392	0.015	0.123	4639	0.012	0.108	700	0.001	0.038
Liver disorders	6044	0.031	0.174	392	0.033	0.179	4639	0.029	0.168	700	0.031	0.175
Renal disorders	6044	0.143	0.350	392	0.161	0.368	4639	0.134	0.341	700	0.154	0.361
Diabetes	6044	0.374	0.484	392	0.406	0.492	4639	0.356	0.479	700	0.367	0.482
Other Cardiovascular	6044	0.106	0.308	392	0.133	0.340	4639	0.100	0.300	700	0.107	0.310
Dysrhythmias	6044	0.282	0.450	392	0.173	0.379	4639	0.292	0.455	700	0.200	0.400
Cardiomyopathy	6044	0.074	0.261	392	0.125	0.331	4639	0.077	0.267	700	0.130	0.337
Ischemic heart disease	6044	0.539	0.499	392	0.398	0.490	4639	0.544	0.498	700	0.453	0.498
Cohort	6044	1999.5	0.681	392	1999.4	0.662	4639	1999.5	0.674	700	1999.4	0.692

Table 11: Oaxaca-Blinder decompositions of the survival gap by race and compliance level. Coefficients for white patients taken as base. A negative sign means advantage for blacks, a positive sign indicates advantage for whites. Decompositions based on the sample of patients who survived two years of treatment.

All patients			
Factors	Total racial survival gap	Amount attributable to endowments	Amount attributable to coefficients
1. Age, co-morbidities	-0.008	-0.028	0.02
2. Line (1) plus income, marital status	-0.008	-0.022	0.014
3. Line (2) plus clinic FE	-0.008	-0.025	0.017
4. Line (3) plus mean doc quality	-0.008	-0.025	0.017
Compliant patients			
1. Age, co-morbidities	-0.015	-0.023	0.008
2. Line (1) plus income, marital status	-0.015	-0.016	0.001
3. Line (2) plus clinic FE	-0.015	-0.02	0.005
4. Line (3) plus mean doc quality	-0.015	-0.02	0.005
Non-compliant patients			
1. Age, co-morbidities	-0.003	-0.031	0.028
2. Line (1) plus income, marital status	-0.003	-0.027	0.024
3. Line (2) plus clinic FE	-0.003	-0.034	0.031
4. Line (3) plus mean doc quality	-0.003	-0.032	0.029