THE LINK BETWEEN PHYSICIAN PAYMENTS, PHYSICIAN BEHAVIOR AND PATIENT OUTCOMES

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Abstract

Understanding how physician behavior impacts patient outcomes has become a central concern in literature relating to the economics of healthcare. Using data from the 2010 U.S. Census and 2016 Hospital Compare Data, this paper analyzes how physician behavior impacts five different patient outcomes. We use the HCAHPS scores that a patient will submit following their hospital visit, as our proxy for physician behavior. We find that the HCAHPS scores that are associated with physician behavior such as, communication with physician, communication about medication, and discharge information are all statistically significant in impacting patient outcomes. Previous literature has proven that physician payment schemes influence physician behavior. Our study was able to prove that physician behavior impacts patient outcomes. Ultimately we conclude that physician payment schemes influence patient outcomes.

KEYWORDS: (Patient Outcomes, Quality of Care, Physician Behavior, Physician Payment Schemes, Healthcare)
JEL CODES: (I11, H41, I14, I18)

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ON MY HONOR, I HAVE NEITHER GIVEN NOR RECEIVED
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Signature

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Introduction

The United States spends more on healthcare than any other country in the world (Kane 2012). In 2016, the U.S. spent $3.35 trillion USD on healthcare, or $10,345 a person annually, roughly 17% of our GDP (Alonso-Zaldivar 2016). To put that in perspective, if the U.S. healthcare sector were its own economy, it would be the fifth largest in the world. However, this spending on healthcare has not improved the quality of care nor patient outcomes. In 2015, the United States ranked 43rd in average life expectancy with the average length of life being 79.68 years (World Statistics 2015). Switzerland is the next highest country in terms of healthcare spending, with a health spending per capita of $6,786.57 and an average life expectancy of 82.85 years. Other high-income countries such as Germany, Sweden, France, and Canada are spending less than $6,000 a person while seeing average life expectancies of 81 years or more (Roser 2016). Americans should not be happy with these numbers, and this is exactly why healthcare reform has been on the forefront of politics for the last decade. As it stands, Americans are paying excessively for healthcare that has not led to healthier patients. To improve patient outcomes, 3rd party payers recognize that they must create a payment structure that aims to get the best Return on Investment (ROI) by improving quality, improving patient outcomes, and realigning physician incentives with those of their patients.

Literature Review

Quality

In healthcare, "quality" has been used as a buzz word by administrators as a measurement to link to physician pay; however, when asked what quality is in healthcare, often administrators

will struggle to come up with a definition. This lack of a definition for quality often leads to spotty information transfer between administration and physicians in regards to what is expected of them. Both parties will usually agree that measurements such as mortality rates, readmission rates, and Hospital Acquired Conditions (HAC's) can be great units of measurement for quality in healthcare. These measures however, are by no means perfect, and often have limitations. For example, a physician can do everything right when treating a patient with some sort of chronic illness, such as diabetes, but because diabetes is a chronic illness, chances are they will likely be readmitted to the hospital later on. Does this mean that the physician provided poor quality care to this patient? No it does not. But that is exactly why quality of care can be so complicated to define in healthcare. Besides the consensus that mortality is important when discussing quality of care, quality is inconsistently defined in healthcare literature today. Quality of care can be defined as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (Lohr and Schroeder 1990). While Lohr and Schroeder's definition is great for acknowledging the impact of health on individuals and populations, it does a poor job of addressing the impact of healthcare services on subpopulations. Dudley et al argues that, "the perfect measurement of quality would not just include the overall impact of a service on patient outcome, but also whether the benefits of the outcome were distributed equally across racial, ethnic, age, gender, education, income, and socioeconomic groups" (1998). While this is a type of measurement of quality in healthcare that we aspire to achieve one day, we are still years away from establishing an algorithm that can take all those measurements into account when analyzing quality in healthcare.

Since quality is so complex in healthcare, most hospitals categorize quality metrics in four categories: volume, structure, outcomes, and process also known as VSOP (Lazar et al., 2013). Volume is traditionally expressed as procedures per year. A common assumption is that the more volume a physician has, the better quality care their patients are receiving. One study found that while high-volume surgeons did have a lower surgical mortality, very-high-volume surgeons were not significantly better than low-volume surgeons (Billingsly et al., 2007). While high volumes correlating with better outcomes is attractive to administration, the data to support this theory has been mixed. The reality is that volume metrics are typically used in healthcare for quality assessment because of the relative ease of data collection (Lazar et al., 2013). The next type of metric used to study quality is structure. Examples of structure include elements such as physician board certification, electronic health records, and program certification. These factors are generally easy to collect which is why they tend to be so appealing to administrators when assessing quality. Outcomes are the next metric to measure quality and usually are the most important metric to outside parties when assessing quality. Outcome quality measures quality by the influence it has on the patient (Ogrod 1997). Outcomes include measurements such as mortality rates, readmission rates and quality of life. While outcome measures are the perfect quality measure in healthcare, they are often tough to interpret and collect due to the complex nature of the circumstances surrounding outcomes with patients. The final measure that most hospitals use as a quality metric is process. Process measures are much like outcomes; however, the main difference is they do not directly gauge the clinical condition of the patient, but rather use evidence-based elements of an episode of care (Lazar et al., 2013).

A more recent trend in healthcare to measure the quality of care provided is to analyze patient satisfaction (Dudley et al., 1998). This has become important to providers because they

know that word of mouth and patient satisfaction has great power in affecting the hospital's bottom line. The aim of the public availability of patient satisfaction scores is to encourage hospitals to compete for patients based on quality. Public reporting of quality measures has also helped drive improvement in all aspects of quality in hospitals (Lazar et al., 2013). The United Kingdom requires their hospitals to collect Patient Reported Outcome Measures (PROM's). PROM's reflect the patient views on health and health improvement. Since the release of PROM data, there has been a strong correlation between patient volume and high satisfaction scores, meaning that providers can attract more patients by increasing quality of care (Gutacker et al., 2016). The United States health system has followed in England's footsteps in creating a way to measure patient satisfaction with surveys following procedures or visits. The Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) is a standardized survey of hospital patients that captures patients' perspectives on their care. HCAHPS has become so important in American healthcare, that Health Maintenance Organizations (HMO's) such as Kaiser Permanente, have even begun to tie financial bonuses to high HCAHPS scores (Dudley et al., 1998). Because of the financial incentives tied to HCAHPS within organizations, physicians have changed their behavior to align with incentives. Patient-centered care is a term in healthcare that is becoming ever more important. Patient-centered care has improved patient satisfaction scores because it allows the patient to perceive their visit as one in which they had a say and could find common ground with the physician. Patient-centered practice has improved health status and increased efficiency of care by reducing diagnostic tests and referrals by taking the patient's wants into account (Stewart et al., 2000). Due to the ever-growing importance of quality, administration and insurance companies have tried different payment schemes for physicians that try to incentivize doctors to provide the best quality of care, however, all have

had their strengths and limitations. Most compensation systems pay physicians for their output, not the patient education or time spent preventing future episodes of care. One of the concerns that physicians have is that a line will be crossed and quality will be forgotten because patients will not have access to needed services. Physicians want a compensation system that clearly outlines the behavior that is expected, and bases the reward on precise information reflecting that behavior (Ogrod 1997).

Payments Schemes

There is no doubt that the method in which a physician is compensated will affect how they practice medicine (Collier 2012). Insurance companies have begun to recognize that "physicians seek to maximize their patients' health, subject to the constraint of earning at least a competitive return on their human capital and financial investment in their practice or organization" (Conrad & Perry 2009). To maximize patient health outcomes and quality of care provided, administration and insurance companies have developed different compensation plans in an attempt to incentivize physicians to provide the best possible care.

Most hospitals in the United States today use what is called Fee For Service (FFS) to pay their physicians. Under this system, the physician is paid for each service they provide to the patient. A fee is set in advance and measured by Relative Value Units (RVU's). RVU's assign a number based on the difficulty of the procedure, weighted for regional costs of living and service provision. Under FFS a physician is incentivized to increase their volume. The more patients they see and the more procedures that they perform on their patients results in higher physician reimbursement, regardless of whether they provided quality care or improved that patient's

health. Payers developed FFS because "generally there is no restriction on patient services provided, outside of the patient's ability to pay. This system motivates physicians to provide care, rather than to minimize it" (Ogrod 1997). Many studies have found that physicians in a FFS plan deliver drastically more medical services than other payment plans, and will provide significantly more medical services than optimal (Hennig-Schmidt et al., 2011). FFS creates the financial incentive to provide additional care, not always optimal care. This results in costing insurance companies more money for healthcare that is not improving health outcomes.

Capitation is another accepted compensation system for physicians in the United States. Capitation is a budget-based system aimed at creating a financial incentive for physicians to provide lower-cost care. Under capitation, a set dollar amount is allotted for each patient regardless of how much care they receive, and a physician must work within that budget. If the physician has money remaining after treating a patient, the physician keeps it. If they go over budget, the physician must pay out of their own pocket. While capitation was originally designed to encourage cost-conscious medical practice (Kao et al., 1998), adversely it has created incentives to limit the amount of care given and even possibly avoid serving patients with complex medical conditions. Physicians in capitation plans will underserve patients in bad and intermediate states of health (Hennig-Schmidt et al., 2011) and are much more likely to refer patients with difficult treatment plans to other physicians (Allard et al., 2011). Capitation also incentivizes physicians to spend less time with their patients. Since capitation has marginal revenue equal to zero for services that have positive marginal costs, physicians who are able to reduce their services provided to capitated patients by even one test are able to increase their profits substantially (Melichar 2009). Capitation incentivizes physicians to reduce the number of services they provide which will usually affect the quality of care they are providing. One study

found that when asked about the quality of care they provided, Physicians believed that the quality of care that they provided under capitation was inferior to that of the quality of care that they provided under different payment plans (Kerr et al., 1997). Capitation may be best for cutting costs, but it is not ideal for providing the optimal amount of care to a patient.

Another way that physicians can be paid is with a straight salary. The aim of giving physicians a straight salary is to eliminate incentives for them to either over provide or under provide care. Instead a straight salary simply allows physicians to focus on providing what is best for the patient regardless of what it costs or how it can affect their paycheck. While salary may be good for trying to align patient and physician goals, salary usually leads to much lower production from physicians since they no longer have the incentive to see more patients or perform more tests (Ogrod 1997). When physicians had their salaried compensation replaced with a lower salary plus bonuses for encounters, physicians increased their encounters by 11-61% by increasing how many people they saw per day and how many days they worked per year (Helmchen & Lo Sasso 2009).

An alternative method to pay physicians that has gained popularity in recent years is through Pay For Performance (P4P). Pay for performance usually acts as a blended payment model. Typically, it uses the base salary as either FFS or capitation and then adds in bonuses for performing well with certain quality measurements. By blending different models, you can eliminate the flaws within the other payment schemes. Capitation usually leads to underutilization and FFS usually leads to overutilization. With P4P, the schemes are usually tied and then have bonuses added for better patient health outcomes. By changing a physician's focus from patient traffic to providing better patient outcomes, the financial incentive now shifts from providing more care to providing better care (Collier 2012). While P4P has become

popular with administration, often it is impossible to implement. Tying money to quality is ideal in any market, but in healthcare, quality is less transparent than it may be in other markets. P4P therefore must be carefully designed to ensure that physicians act in accordance to the incentives without unintended consequences. When studying the effects of P4P on patient outcomes, one study found that when incentivized to improve certain quality metrics for certain chronic illnesses (asthma, diabetes and heart disease), the payment on improving outcomes within these chronic illnesses accelerated improvements in quality for two out of three of the conditions. They also found that the quality of care for conditions not linked to incentives had declined (Campbell et al., 2009). This suggests that P4P helps accelerate improvement in the short run, meaning that physicians were quick to realign their goals with the new incentives, but once they reached their targets, growth slowed back to normal. Another study looked at how P4P affected hospitals paid through Medicare and Medicaid services. The study found that more than half of the P4P hospitals relative to the control group had higher performance scores, however, in the long run the two groups were identical, suggesting that P4P once again had no effect on quality in the long run (Werner et al., 2011). Another study analyzed one specific quality metric (30-day mortality rate) in P4P hospitals and found that there was no evidence that suggested that the P4P program led to a decrease in 30-day mortality (Jha et al., 2012).

In an ideal world, all physicians would be perfectly self-sacrificing, and payment schemes would have no effect on physician practice (Collier 2012). However, the harsh reality is that financial incentives will always play a role in the ways in which physicians will practice medicine. There is nothing in medicine that influences a physician's behavior like hard cash (Jauhar 2014). Incentives for physicians in modern medicine today are mismanaged. Until incentives are realigned to serve the broader social goal of better patient outcomes, Americans

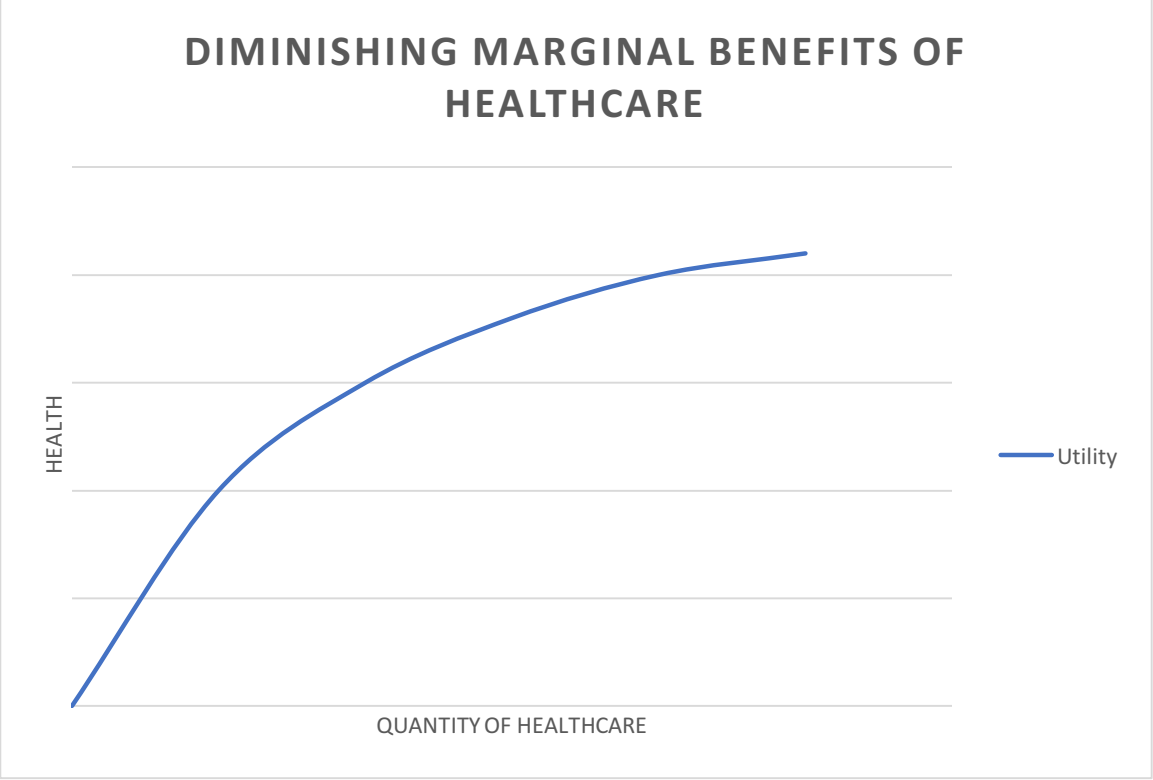
will continue to pay large amounts of money on healthcare that does not improve health. It is now the responsibility of administrators and insurance companies to determine the best compensation method for physicians to realign patient and physician goals, which ultimately results in better patient outcomes. Incentivizing strategies linked to patient outcomes will continue to be dominant in healthcare studies for many years to come. It is the goal of this study to unravel which physician compensation plan incentivizes physicians to produce the best quality of care, by analyzing the patient outcomes and linking them to physician behavior and patient experience. These relationships will help to enlighten the debate over the best type of physician payment plan for optimal patient health.

Theory

To better understand healthcare, it is important to first understand what health is. The World Health Organization defines it as "a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity" (WHO). When talking about health in economic terms, however, it is important to understand that health is a durable good, meaning that it is not always for immediate consumption and can be used over a long period. Several factors influence an individual's health such as healthcare, initial health, exercise, eating habits, and everything in between. Since an individual has the power to influence and change their health, we assume that health is something that can be produced. According to Machado the health production function in its most simple form is $H=F(HC, \text{other inputs}; I_0)$ where H is health, HC is healthcare, and I_0 is the initial conditions of the individual (2011). Other inputs include factors such as lifestyle choices, environmental factors, genetics, occupation, education, etc. He

also argues that when health is made a function of healthcare, it will produce diminishing marginal benefits. This means that the total utility will increase at a decreasing rate with regards to how much medical care is being consumed. The curve will be an arc shape because each additional unit of healthcare that is being consumed, will result in a smaller increase in their health than the previous unit produced. The reason for this is because when a person is sick, an extra unit of healthcare will have greater utility, but as they continue to add additional units of healthcare, the benefits will start to marginally decrease, as seen in Figure 1. Due to the law of diminishing marginal utility there is such a thing as too much healthcare.

FIGURE 1



As with any consumable good in economics, consumers will purchase goods and services to gain utility. This utility gained from a good or service creates a demand. According to Michael Grossman, consumers will have a demand for health for two reasons. The first is because health is a consumption commodity meaning it will make the patient/consumer feel better. The second reason is because health is an investment commodity, meaning that a state of health will affect the amount of time that is available to the consumer for production. According to Grossman's model, medical care demand that is derived from the demand for health implies that an increase in age leads to an increase at which a person's health will depreciate, and that people will attempt to offset their increasing rate of depreciation in their state of health, by increasing how much they spend on health as they age. While no two people will have the exact same demand for health, it can be assumed that the quantity of health that an individual will demand will always be affected by factors such as quality, income, insurance, state of health, and their taste preferences.

Now that we better understand what health is and how the demand for health is influenced, we can properly describe how physicians and hospitals can influence a patient's health. In health economics, the principle agent theory is often what is used to describe the patient-physician relationship. The principle agent model emphasizes the information asymmetry between the physician and patient, and how that creates an environment in which the physician will act on the patient's behalf to maximize the patient's utility as if it were his own (Stavropoulou 2012). This information asymmetry between the two parties allows the physician to influence the quantity of medical care supplied and demanded. When patients view their physician as someone who is superior to them, physicians gain the power to be able to persuade patients to demand and consume more or less care than may be optimal if they had perfect

information about their treatment (Mcguire 2000). This is what is known as physician induced demand. Another theory on which physicians have the power to control patient demand is through the quality of care they provide. Under this theory there is less information asymmetry because the patient can at least understand on some level about the care that is being provided to them.

A physician will act as an agent in both the hospital's and patient's utility function since they are trying to maximize patient health outcomes while also trying to maximize profits for the hospital (and themselves). While administrators desire a perfect altruistic approach within a physician's utility function, the constraints that these administrators place on the physicians make it difficult for them to be perfectly altruistic. "These economic models allow doctors' behavior to be driven by not only altruistic elements, but also other aspects such as workload, income, payment schemes, reputation, time pressures, organizational constraints" (Stavropoulou 2012). This complexity of physician behavior makes it increasingly difficult to create one single common utility function for a physician. However, Scott argues that the vast majority will include the patient's utility, along with the income-leisure framework as a budget constraint in the model (2000). Doctors seek to improve their socioeconomic status, and improve the health of their patient. However, just like in any other profession, they also desire the ability to have respectful working relationships with their colleagues, and the ability to make clinical decisions without interference from administration, while also being able to have a life outside of the office (Stavropoulou 2012).

Each payment system changes a physician's utility function but to keep it simple we will just discuss the basic cost and utility function of a physician. In healthcare, the physician's economic costs to operate include both fixed and variable costs. These include factors such as

rent, medical training, time, etc. Wedig describes these costs that a physician faces using a simple costs function.

$$C=F+C(q^s,q^t,\ldots),C_q>0,C_{q,q}=0$$

Here q^s is the physician's production of service s and F is the fixed cost. It is also important to note that because of the labor-leisure decisions that a physician faces, variable costs are assumed to be constant, however it is important to note that this is a loose assumption and is only made so that it can be solved (Wedig 1993). Wedig also creates a utility function for physicians that has become widely accepted in literature.

$$U(q^s,q^t,\ldots)=U(\sum P^s q^s-C,\ B(q^s,q^t..)-(1-\alpha)\sum P^s q^s),$$

Using this equation Wedig argues that physicians maximize their utility in two ways, their net income and patient benefits from out of pocket expenses which is represented by $(1-\alpha)$. P^s is the maximum price that physicians can charge, B are the benefits the physician's patient receives from treatment, and α represents the constant fraction that consumers are insured. Using the theory discussed above we now have a better understanding for the model that we will use in this study.

Methodology

Model Specifications

To calculate overall hospital quality, the Center for Medicare and Medicaid services (CMS) has determined that 7 different outcome measures are significant in determining the quality of a hospital. These measures include mortality, safety of care, readmissions, patient experience, effectiveness of care, timeliness of care, and efficient use of medical imaging (Tinker 2016). In our model, we are trying to determine how physician behavior impacts patient

outcomes, and ultimately if physician payment schemes effect the patient outcome. To do that we are going to estimate a health production function. In this production function our independent variable (Y variable) is going to represent different health outcomes. These Y variables will include outcomes that CMS identified as important such as mortality rates, readmission rates, and hospital complications. These outcomes will then be a function of demographics, which we use to help control for factors such as poor populations having a worse initial state of health, and for populations that smoke, we would also expect them to have more negative health outcomes. The other x variables that will affect the outcomes are the patient experience which we measure using HCAHPS scores. While we do not have the individual level payment scheme data, we will be able to use this model to see how patient behavior affects the outcomes, and then we can look at what other studies found with physician behavior changing under different payment schemes. We will then be able to link the two to gain a better perspective on if physician payment models influence the outcomes of the patients. The model that we use in this study can be seen below.

$$Outcome=\beta_0+\beta_1 popdens+\beta_2 PCFminpov+\beta_3 unemprate+\beta_4 medage+\beta_5 Lnmedinc_{+}\beta 6 Lnalcohol+\beta 7 Lntobacco+\beta_8 Pcthighed+\beta_9 Pctwhite+\beta_{10} uninsured+\beta_{11} commnurse+\beta_{12} commdocs+\beta_{13} respstaff+\beta_{14} pain+\beta_{15} commmeds+\beta_{16} cleanquiet+\beta_{17} discharge, robust$$

Where:

Popdens= Population Density

PCFminpov= Percent of Families Below the Minimum Poverty Rate

Unemprate= Unemployment Rate

Medage=Median Age

Lnmedinc= Natural Log of Median Income

Lnalcolohol= Natural Log of Average Alcohol Expenditure per Household

Lntobacco= Natural Log of Average Tobacco Expenditure per Household

Pcthighed= Percent of population who have received higher education

Pctwhite+ percent of population who is Caucasian

Uninsured= Uninsured Rate of Population

Commnurse= Communication with Nurses

Commdocs= Commincation with Physicians

Respstaff= Responsiveness of Hospital Staff

Pain= Pain Management

Commmeds= Communication about Medication

Cleanquiet= Cleanliness and Quietness of Hospital

Discharge= Discharge Information

Data

We use data from the 2016 hospital compare database which is provided by the Centers for Medicare and Medicaid Services (CMS). This database became popular during the affordable care act because it acts as a way for patients to hold the healthcare system more accountable while also being able to recieve more affordable care. Hospital compare was created with the intent to help improve the quality of care hospitals provide by publishing objective, easy to understand information on hospital's quality information and performance from the prospective of the consumer/patient. Hospital compare provides data on over 4,000

Medicaid certified hospitals which include: acute care hospitals, critical access hospitals, children's hospitals, and outpatient departments. The data sets are split into 10 different categories that measure quality of care, these indicators include: general information, linking quality to payment, payment and value of care, number of Medicare patients, patient survey results, readmissions and deaths, complications, timely and effective care, use of medical imaging, and veterans administration. In our model, we pulled variables from all of these categories except for the veterans administration. It is important to note that data collection from each category is collected in different timeframes and uses various quality measurement contractors.

As a way to control for socioeconomic demographics of populations that live near any given hospital, we used data from the Geolytic Annual Files. The data within this comes from the 2010 U.S. Census. The data we decided to include in this were population density, percent of families below poverty level, unemployment rate, median age, median income, average alcohol expenditure per household, average tobacco expenditure per household, percent high education, percent white, and uninsured rates. The tobacco and alcohol expenditure data that we included in our data set comes from the consumer expenditure survey that is merged with the U.S. Census data. To link the patient population demographics to the hospital location we used the zip code of the hospital and linked all the demographics collected using the U.S. census of that zip code to that demographic, since we assume that the populations using the hospital will mostly come from the same zip code. These demographics help us to control for less healthy patient populations so that a physician's performance is not affected by a naturally unhealthy patient population.

The HCAHPS that are being measured following the demographics in the model are derived from the Hospital Value Based Purchasing Total Performance Score section of the

hospital compare data. The patient value of care (measured by HCAHPS), composes 7 of the most important questions from the HCAHPS survey and gives them the average score that the hospital received in that category between 1 and 10. These questions that were determined to have the greatest impact on patient's experience at a hospital include: communication with nurses, communication with physicians, responsiveness of hospital staff, pain management, communication about medications, cleanliness and quietness, and discharge information. These measures will not only influence the patient's experience, but will also affect the outcome of the patient. The table below represents the summary statistics for the X variables that are included in my model. This table lists the number of observations, means, standard deviations, minimums, and maximums for each variable.

Table 1

X Variable Summary Statistics

Variable	Observations	Mean	Std Dev	Min	Max
Population Density	11,246	6193.106	58524.97	0.19	2996458
% Families Minimum Poverty	11,246	12.792	6.182	1.598	57.471
Unemployment Rate	11,246	7.26	5.228	0	58.466
Median Age	11,246	42.856	3.685	20.5	61.34
lnMedian income	11,246	10.88	0.27	9.99	11.751
lnAlcohol	11,246	5.859	0.172	5.169	6.454
lnTobacco	11,246	5.896	0.044	5.428	6.186
% High Education	11,246	19.437	7.19	4.428	50.455
% White	11,246	77.177	18.057	0.782	100
Uninsured Rate	11,246	17.755	5.182	4	39
Communication with Nurses	8,445	2.444	2.91	0	10
Communication with physician	8,445	2.049	2.814	0	10
Responsiveness of Hospital Staff	8,445	2.069	2.784	0	10
Pain Management	8,445	2.033	2.786	0	10
Communication about Medication	8,445	2.378	2.852	0	10
Cleanliness and Quietness	8,445	2.131	2.746	0	10
Discharge Information	8,445	3.833	3.451	0	10

The final part of our model that we still need to explain is the outcome measures that we plan on utilizing as our Y variables. As stated earlier CMS identified 7 important outcome measures to measure the quality of any given hospital. These include mortality, safety, readmission, patient experience, effectiveness of care, timeliness of care, and use of medical imaging. For patient experience, we used HCAHPS as a proxy and put it on the right side of our model since we did not believe that it could be measured as a specific outcome. Aside from patient experience, we put the rest of the outcome measures on the left side of our model as our physical health outcomes that we have data on. Effectiveness and timeliness of care are generally combined to create what is called process of care. To measure process of care we are using IMM3 as a proxy which is a measure of how many healthcare workers were given the influenza vaccination. To measure safety of care we use PSI13 as our proxy variable. This stands for postoperative sepsis rate. For use of medical imagining we use OP11 as our proxy which is a measure of outpatient CT scans of the chest that were "combination" scans, meaning they could have been scanned more than the optimal amount. For mortality, we use PSI4 which measures the amount of mortalities a hospital faces for patients who experience serious treatable conditions following a surgery. The last outcome variable that we wanted to include as one of our Y variables was Readmission which measured the overall unplanned readmission rate for a hospital.

The table below includes the summary statistics for all the different Y variables that we use in our models. Once again these statistics include the number of observations, means, standard deviations, minimums, and maximums for each Y variable.

Table 2					
Y Variable Summary Statistics					
Variable	**Observations**	**Mean**	**Std Dev**	**Min**	**Max**
IMM3	3583	82.323	15.64	11	100
PSI4	5236	136.703	18.432	70.79	212.16
PSI13	6611	10.256	2.2	4.5	27.96
OP11	8562	3.099	5.649	0	63.3
READMHOSP	10117	15.603	0.888	10.8	19.9

Results

In this chapter, I will discuss my findings from each regression that I computed. I will discuss how the HCAHPS influenced and correlate with patient outcomes, which specific HCAHPS scores are directly influenced by physician behavior, and the demographics and how they influence a patient's health and ultimately their outcome. After I discuss the significance that my independent variables had in determining outcome, I will discuss the tests that I conducted to verify the validity of my model. After testing the validity of my model and the significance of my statistics, we can then use my model to show how physician payment schemes have a direct impact on physician behavior, which then ultimately affect a patient's outcome.

Table 3, listed below, shows the 3 HACAHPS scores that we are most interested in for our model. We are most interested in these 3 because these are the HCAHPS measures that are a result of physician behavior during the patient's stay.

Table 3					
Physician Controlled Variable Regression Results					
HCAHPS Measure	**VACINATION**	**MORTALITY**	**SEPSIS**	**IMAGING**	**READMISSION**
Communication with physician	-0.613***	0.591***	-0.114***	0.166***	-0.0170***
	(-3.70)	(-3.37)	(-6.43)	(-3.92)	(-3.51)
Communication about medication	-0.470**	0.482**	0.0166	-0.126**	0.00184
	(-2.82)	(-2.99)	(-1)	(-3.14)	(-0.33)
Discharge information	0.709***	-0.576***	0.0393***	-0.0445*	-0.0510***
	(-6.96)	(-5.70)	(-3.62)	(-1.99)	(-14.67)
Note: t-statistics in parentheses; p-values: *p<0.05, **p<0.01, ***p<0.001					

These HCAHPS measures include communication with the physician, communication about any medication that was administered to them, and discharge information that was given to the patient from the physician as they were leaving the hospital. These behaviors that the physicians were being scored on in these HCAHPS, have the potential to directly impact the outcome of a patient. The outcome variables that we chose in our models can be seen along the top of Table 3 and include: vaccination of healthcare staff, preventable mortalities that were a cause of post-operative complications, sepsis rate, medical imaging, and unplanned readmission to the hospital. As expected, almost every single physician behavior HCAHPS rating was statistically significant in determining the patient outcomes. When looking at the HCAHPS that physicians control, only on two occasions were there not statistically significant variables in affecting the outcome on the patient. These instances include communication about medication with sepsis as an outcome, and communication about medication with unplanned readmission to the hospital as on outcome. Communication about medication was not significant to the sepsis outcome since sepsis usually is a result of physicians and staff being careless with their sterile technique during surgery and recovery. Sepsis occurs when a wound gets infected and bacteria gets into your bloodstream which then causes your body's immune system to attack its own organs and tissues.

While communication about medication is important to recovering from sepsis, the sepsis outcome itself is not caused from communication about medication but rather a result of taking the necessary steps to avoid infection with open wounds. Communication about medication also was not significant in affecting the unplanned readmission to the hospital outcome. The reason for that is because communication about medication is only measuring the communication about medications that you are taking while in the hospital. Since this is only a measure of communicating about the medications you are being given during your stay and not once you get out of the hospital, we would expect that this variable would not be significant. We would however, expect that patient adherence to instructions regarding medication after your stay to be significant in affecting the unplanned readmission rate. If we look at the T-statistic of discharge information under readmission to a hospital, we see a T-statistic of -14.67 meaning that we can say with .999 confidence that the discharge information given to the patient prior to leaving the hospital (including medication instructions) influences the unplanned readmission rates back to the hospitals.

It is also important for us to look at the coefficient sign for these variables. The coefficients tell us how much the dependent variable is expected to increase (if the coefficient is positive) or decrease (if the coefficient is negative) when the independent variable, in this case our outcome variables, increase by one unit. Since the HCAHPS are measured using a 1 to 10 scale, we would expect most of the coefficients on these variables to be negative since a higher HCAHPS score is better. However, for almost half of our variables in this case, we end up with positive coefficients. The reason I believe this is happening is because rather than the outcome being affected by the independent variables, we are seeing the outcomes affecting the ratings that are being given to physicians when they fill out their HCAHPS survey following their stay. One

example of this could be a patient becoming upset about not being given pain medication. While it could be argued that the physician was certainly acting in the best interest of the patient, the physician's HCAHPS score is now being affected because the patient gave them a lower score because they were not given the pain medication that they wanted. An example of this can be seen where the coefficients for communication about medication were significant and positive under the mortality outcome. Another example of why the independent variables would be affected by the outcome is because the patient may reacquire a disease or illness after they are discharged. While most of the time, the discharge information given to a patient will affect their outcome, there are instances where patients may not adhere to the instructions being given to them, which will cause them to have an unfavorable outcome even though they were given the proper instructions. This would cause them to be upset and therefore give the physician a bad rating for discharge information even though the doctor was doing exactly what he was supposed to be doing. The last place that we see positive coefficients that are statistically significant are with communication with a physician. The reason that these coefficients could be positive and still mean that the physician is doing a good job would be when a patient is experiencing an unfavorable outcome, the physician is increasing their communication with that patient to keep them informed and let them know of all the treatment options going forward. While we would come to expect all the coefficients to be negative, when we dig deeper, we find that a positive coefficient on a statistically significant variable that involves physician behavior, is not always due to poor physician practice.

The Other HCAHPS that we included in our model were not specific to physician behavior, but were included because of the impact they can have on patient outcomes. These

other HCAHPS, seen below in Table 4, include communication with nurses, responsiveness of hospital staff, pain management, and cleanliness and quietness of the hospital.

Table 4

Other HCAHPS Regression Results

HCAHPS Measure	VACINATION	MORTALITY	SEPSIS	IMAGING	READMISSION
Communication with Nurses	0.844***	-0.810***	-0.000687	-0.0999*	0.0149*
	(-4.08)	(-4.09)	(-0.03)	(-2.21)	(-2.27)
Responsiveness of Hospital Staff	-0.414*	-0.709***	-0.0181	0.0489	-0.0280***
	(-2.49)	(-3.37)	(-1.00)	(-1.11)	(-4.78)
Pain Management	0.482**	-0.510**	-0.0378*	0.0629	-0.0147**
	(-2.77)	(-2.77)	(-2.20)	(-1.49)	(-2.63)
Cleanliness and Quietness	-0.418**	0.397*	0.0143	0.131***	-0.0103
	(-2.61)	(-2.48)	(-0.8)	(-3.37)	(-1.93)

Note: t-statistics in parentheses; p-values: *p<0.05, **p<0.01, ***p<0.001

While there are still statistically significant variables within this table, there are far more variables in this table that do not affect the outcome of a patient than in the previous table. This does not come as a surprise. The physician is the one performing the surgery, prescribing the medicine, and implementing the treatment plan that the patient is supposed to follow. We would expect any interaction that they have with the patient to influence the outcome. The other employees of a hospital such as nurses and administration certainly are important to the efficiency of the hospital, but we would expect them to have less of an impact on patient outcomes. Pain management however, did prove to be significant across 4 of the 5 outcome variables. It is also important to note with pain management, that 3 of the 4 that are significant, have negative coefficients which is also what we would expect and want with HCAHPS scores. We would expect the negative sign because when there is a higher HCAHPS score the outcomes should be better, meaning that there are less of them, hence the negative coefficient. We would also expect pain management to be significant because the outcomes that we chose, tend to have

significant amounts of pain associated with them. If the hospital does well preventing unfavorable outcomes, most likely these patients will not be experiencing pain. But if the patient does experience one of these outcomes, they will most definitely feel pain during their stay in the hospital. Therefore, it should come as no surprise that how a hospital handles pain management will influence the outcomes of its patients. Communication with nurses is another variable that we would come to expect would have an impact on patient outcomes. In healthcare, the nurse's role is to provide around the clock observation and care to the patient and to implement the physician's orders. If there is anyone besides the physician who we would expect to impact the outcome of the patient, we would expect it to be the nurse, which in this instance includes Physician's Assistant, Registered Nurse, Nurse Practitioner, and Medical Assistant. The one place where communication with nurses was not statistically significant however, was with the Sepsis rate. In fact, this outcome did not prove to be statistically significant anywhere in Table 4 apart from pain management. Sepsis is a result of how careful the physician is while performing the procedure and how well they dress the wound following the procedure, which is why this variable was so significant in Table 3. Responsiveness of hospital staff measures how quickly staff is to respond when you either hit your call light requesting help or you need medical assistance immediately. It should come as no surprise that how quickly the hospital staff responds to a medical emergency is statistically significant with mortalities among patients with serious treatable conditions following surgery. This measures "preventable" mortalities meaning that the responsiveness of staff should without a doubt impact the outcome. The last variable that I am going to discuss from Table 4 is cleanliness and quietness of a hospital. This variable came as a bit of a surprise to me. I would have expected this to be significant across all levels, however, it only proved to be significant with immunization, postop preventable mortalities, and

MRI's of the chest. We would expect that the immunization is negative and statistically significant because if a hospital appears to be clean and organized and quiet, they would also be taking precautions against immunizing their staff so that not only are they protected from viruses and diseases but they also are not helping to spread them throughout the hospital. The biggest surprise however, is that it did not prove to be significant with sepsis, or unplanned readmission. This leads us to believe that while cleanliness should be important to a hospital for obvious reasons, the most important influences on a patient's outcomes include their current state of health, and how the physician interacts with the patient.

The last set of variables that we included in our health production function model were the demographics of patients that were meant to control for the initial conditions of the patient population prior to receiving healthcare. The demographic variables that we decided were important to our model include: population density, percent of families below the minimum poverty level, unemployment rate, median age, median income, average alcohol and tobacco expenditure per household, percent who have gone to college or received higher education, percent of the population that is white, and the uninsured rate. This table also includes the R-squared value, number of observations, and root MSE for each model. The results can be seen below in Table 5.

Table 5					
Demographic Regression Results					
Demographics	**VACINATION**	**MORTALITY**	**SEPSIS**	**IMAGING**	**READMISSION**
Population Density	-0.0000973	-0.0000477*	-0.000000212*	-0.000000129	0.000000247
	(-1.68)	(-2.34)	(-2.23)	(-0.83)	(-1.92)
% Families Minimum Poverty	0.397***	-0.256**	-0.0133	0.0561*	0.0378***
	(-3.81)	(-2.60)	(-1.32)	(-2.12)	(-10.76)
Unemployment Rate	0.104	0.353***	-0.00694	-0.0163	0.00486*
	(-1.87)	(-5.73)	(-1.19)	(-1.25)	(-2.28)
Median Age	-0.839***	-0.713***	-0.0479***	-0.0593**	0.0330***
	(-8.80)	(-7.23)	(-4.68)	(-2.61)	(-9.29)
lnMedian Income	-14.89*	-6.746	1.583*	-9.517***	0.108
	(-2.05)	(-0.82)	(-2.09)	(-4.19)	(-0.43)
lnAlcohol	8.155	-14.05	-2.744*	20.08***	0.49
	(-0.66)	(-1.05)	(-2.16)	(-5.56)	(-1.21)
lnTobacco	-4.211	-11.5	-3.402**	-27.61***	-2.233***
	(-0.36)	(-0.91)	(-2.85)	(-8.85)	(-5.90)
% High Education	0.309***	0.138*	-0.0048	-0.123***	-0.0175***
	(-5.11)	(-2.3)	(-0.74)	(-9.22)	(-7.40)
% White	0.106***	-0.0824***	-0.00327	0.0299***	-0.00502***
	(-4.35)	(-3.70)	(-1.51)	(-5.67)	(-5.65)
Uninsured Rate	-1.166***	-0.318**	0.014	0.224***	-0.0245***
	(-11.29)	(-3.00)	(-1.32)	(-10.32)	(-6.18)
_cons	259.3***	405.2***	31.68***	149.8***	24.26***
	(-3.52)	(-4.78)	(-4.1)	(-6.77)	(-9.76)
N	3121	5149	6482	7709	8326
R-squared	0.188	0.073	0.024	0.123	0.156
Root MSE	13.44	17.77	2.182	5.024	0.863
Note: t-statistics in parentheses; p-values: *p<0.05, **p<0.01, ***p<0.001					

There is a significant amount of data here, so I am just going to discuss the 4 measures that are most important in deciding a patient's health outcome and most important in influencing a physician's behavior towards a patient. The first variable that is necessary to analyze is median age. As Michael Grossman stated, "an increase in age will also increase the rate at which a person's health will depreciate" therefore it is not surprising that age is statistically significant in

affecting all the outcomes in our model. However, it did come as a surprise that all the coefficients on this variable were negative. With a higher age, we would also expect the percentages and numbers of patients to increase due to Grossman's rules. This means that as a patient gets older they are experiencing worse outcomes. Since they are all negative we assume that median age is somehow correlating with another variable in the dataset giving it the negative coefficients. The next important variable to review is percentage of the population receiving higher education. This is statistically significant because the smarter a population is, the better decisions they are making about their health, and the more they are doing to prevent bad health outcomes from happening. This has a positive coefficient under the immunization outcome because the more educated a population is, the more weight they will put on preventive care of sickness which in this case includes getting immunizations. The other positive coefficient we see from this variable is under mortalities for patients with serious treatable conditions. The reason this has a positive coefficient is because the higher education populations tend to have more money, therefore they are the ones who can afford more expensive surgeries. Since this is a measure of post-operation mortalities for patients with serious treatable conditions, meaning that they should not have died in the first place, I believe we see a positive coefficient because these are the more educated and healthier populations who are dying in this outcome. For the rest of the outcomes under percent who have received high education, we get negative coefficients which is what we come to expect. The higher the education, the healthier they should be, therefore the populations with higher educated people, should have less unfavorable outcomes. The next variable that is important to analyze in this table is percent of families below the minimum poverty rate. This is statistically significant across most outcomes because poorer populations can be assumed to have worse initial health conditions. It can also be assumed that

poorer populations will just go to the hospital or ER when they are sick rather than see a general practice doctor because the hospital and ER are required to serve them even in the case where they cannot afford care. Therefore, we see a positive and statistically significant variable on the unplanned readmission. Even though their readmission might not have been necessary, poorer populations come straight to the hospital to be served, because they know they cannot afford to be seen by a general practice doctor or a specialist. The last variable that I think is important to examine is the uninsured rate. This was proven to be significant across almost all outcomes, meaning that whether you had insurance or not, it strongly affected the type of health outcome you received. This is in line with Dudley when he found that the uninsured received worse quality of care than those who had insurance (1998). Since we see that the uninsured rate was significant with affecting most of the outcomes, we can agree with Dudley that whether you are insured or not, determines the type of quality and time that the physician is willing to provide while treating you. This alone proves that the way in which a physician is paid, affects the type of quality of care that they are willing to provide, which then affects the outcomes that patients are receiving.

Other important values to view in Table 5 include the R-Squared value, the number of observations, and the Root MSE. The R-Squared value measures the amount of variance in Y that can be explained by our X's. Health is extremely complicated and is a result of many different factors. It should come as no surprise that our R-squared values are not excessively high due to the type of modeling that we are running.

For our models, we wanted to make sure that our Y variables had at least 1,000 observations. You will see that the lowest number of observations that we decided to include as a measure of outcomes was our vaccination outcome, which still had 3,121 observations.

Root MSE is the root mean squared error. Essentially it is the standard deviation of the regression. This means that the closer to zero it is, the better our regression is. None of our values are high enough to cause worry so we can assume that because of our Root MSE, our regressions are good.

However, we wanted to do even more tests to ensure that our models were infallible. The tests we ran include the VIF test which tests for multicollinearity, the White test that tests for normality, and the reset tests which tests the AV plots.

A Variance Inflation Factors (VIF) test measures how much the variance of the estimated regression coefficients are inflated as compared to when the predictor variables are not linearly related. We use this to describe how much correlation exists between the predictor variables (multicollinearity). Multicollinearity is bad for models because it means you have two variables that essentially measure the same thing which then results in the data being skewed. When we ran a VIF test on our model that uses readmission as the Y variable we get the results that can be seen in Figure 2.

FIGURE 2

```
. vif
```

Variable	VIF	1/VIF
lnAlcohol	54.98	0.018190
lnHMEDINC	53.74	0.018608
Communica~ev	4.61	0.217036
PCFMINPOV	4.47	0.223804
Unins13	3.69	0.270807
Responsive~f	3.54	0.282326
P~Achievem~n	3.16	0.316031
Communicat~c	3.11	0.321446
PctHighEd	2.88	0.347032
Cleanlines~s	2.64	0.378407
Communicat~e	2.59	0.385482
lnTobacco	2.15	0.464499
PctWhite	2.01	0.497302
Disch~evemen	1.71	0.583731
MEDAGE	1.54	0.651351
UNEMPRATE	1.16	0.858389
POPDENS	1.02	0.978507
Mean VIF	8.77	

The first time we ran this test we got extremely high numbers for alcohol, median income, and tobacco. We realized that these were all variables that used dollars as inputs. To fix this we created a natural log version of each of those variables. While these variables still have high numbers in the VIF test, making a natural log of those brought the mean VIF below 10 meaning that multicollinearity did not exist in our model. When the VIF test was run on the other 4 models, we saw similar results.

The next test that we ran was the white test which tests for heteroscedasticity. Heteroscedasticity refers to the condition in which the inconsistency of a variable is unequal across the scope of values of a second variable that predicts it. Heteroscedasticity has a negative impact on a model because it can lead to biased and misleading parameter statistics. The White test that we ran on our readmission model can be seen in Figure 3 below.

FIGURE 3

```
. imtest, white

White's test for Ho: homoskedasticity
         against Ha: unrestricted heteroskedasticity

         chi2(170)     =   1552.22
         Prob > chi2   =    0.0000

Cameron & Trivedi's decomposition of IM-test
```

Source	chi2	df	p
Heteroskedasticity	1552.22	170	0.0000
Skewness	148.91	17	0.0000
Kurtosis	29.46	1	0.0000
Total	1730.58	188	0.0000

As you can see from the figure above, based on our P values which are all 0.000 we must fail to reject the null hypothesis that there is no heteroscedasticity in our model. This can be expected with the kind of data that we are using in our model. Similar results were seen when we applied the White test to the rest of our models. However, we can fix this in our models by using the robust command following each regression in Stata.

The last test that we decided to run on our model was the Ramsey Regression Equation Specification Error Test also known as the RESET test. This is used to measure whether the non-linear combinations of the fitted variables help explain our outcome variables. The results of the RESET test on our readmission model can be seen below in Figure 4.

FIGURE 4

```
. estat ovtest

Ramsey RESET test using powers of the fitted values of READMHOSP
       Ho:  model has no omitted variables
                 F(3, 8305) =     16.59
                   Prob > F =     0.0000
```

The results of the RESET test on our other models once again looked extremely similar to that of our RESET test on readmission. We must fail to reject the hypothesis for this test meaning that in our model we are omitting some variables. However, this is not concerning due to the complexity of different influences on a patient's health and outcome. Our model while not perfect did a great job predicting what we set out to predict. With our model, we simply wanted to see how a physician's behavior impacted the health outcome that a patient faces.

DISCUSSION/CONCLUSION

In this paper, we estimate the influence that physician behavior has on patient outcomes. Using a modified version of the health production function, along with data from the 2010 U.S. Census and 2016 Hospital Compare Database, we can see that physician behavior highly correlates and impacts the outcomes that patients will experience during their time in the hospital. Ultimately the goal of this study was to see how physician payment schemes affected different patient outcomes, but because the Hospital Compare Database does not differentiate outcomes under different payment schemes, we must infer and derive conclusions based on our prior knowledge. We can now analyze how our results can be transformed into seeing how

different payment schemes affect physician behavior, which consequently will have an impact on the quality of care provided and ultimately the patient health outcome.

Our results clearly depict that the physician behavior (Table 3) impacted patient outcomes. Almost every HCAHPS variable that measured physician behavior was statistically significant on impacting the patient outcomes. Communication with a physician and discharge information were both significant across all outcomes. These two variables also had predominantly negative coefficients, which is what we would come to expect since a higher HCAHPS score is expected to lead to less undesirable outcomes. The coefficients that do not follow the expected behavior and are positive, are a result of our outcome variable affecting our independent variable rather than the other way around. An example of this would be when a patient experiences a disadvantageous outcome. This unfavorable outcome causes the patient to be upset with the physician, which results in them giving the physician a bad HCAHPS score, regardless of physician behavior during their encounter. Hence the positive coefficient. We expect negative coefficients on all the variables measuring physician behavior because we desire to examine how physician behavior, which we measure using specific HCAHPS scores, will impact the patient outcome. Communication about medication was significant across all outcomes apart from sepsis rate. We would not expect sepsis to be significant in this instance however, due to sepsis being a result of a physician's attention to detail with sterilization, and not how a patient communicates with their physician about their medication.

Since we have proven that physician behavior affects patient outcomes, the next step is examining how physician payment plans have affected physician behavior in other studies and link that to our model. Under FFS, one study found that patients were more likely to trust their physician (Kao et al., 1998). When examining the physician behaviors that we included in our

model, increased communication can be inferred to increase the amount of trust a patient has in their physician. In fact, one study even found that under FFS patients felt they not only had greater communication with their physician, but also greater access to care (Dudley et al., 1998). When one study looked at Capitation, they found that capitated patients would be readmitted to the hospital less than under other payment schemes (Nuscheler 2003). Under straight salary, one study found that physicians had no incentive to see extra patients and do extra work (Gosden et al., 1999). Lastly P4P affected physician behavior by realigning their goals to only focus on reimbursement rewarded outcomes and focus less on other outcomes with other patients (Werner et al., 2011).

The way in which a physician is paid will always affect the way in which a physician practices medicine. Within our study, we can review the uninsured rate and how that affects outcomes to determine that if a physician believes they will not get paid, or even believe they will not get paid as much as they deserve, they will put less effort or work into improving patient outcomes. Our model shows that physician behavior influences outcomes, and other studies have concluded that physician payment schemes affect physician behavior. Therefore, we can conclude that physician payment schemes ultimately influence patient outcomes.

The goal of this study was to determine how physician behavior affects patient outcomes. We were able to accomplish that goal by using our model. However, future studies should analyze how these same outcomes will differ across different payment schemes. Unfortunately for us, the data that we used in hospital compare did not provide a distinction of different payment schemes and the outcomes associated with those payment schemes. The next steps of this study would then be able to look at the different outcomes across different payment schemes

and see if those outcomes were affected in a positive or negative fashion by each payment structure.

The United States health system is broken. We know that physician behavior is driven by physician payment schemes, and we know that physician behavior impacts patient outcomes. To improve the sub-par outcomes that the United States healthcare system is providing, we must ultimately change the system. To improve patient outcomes, we must first realign patient goals with that of the physician. Through different payment schemes, the United States health system has less focus on putting the patient first, and rather started to focus on how it can either spend less money, or make more money. This has not led to better outcomes and is not the best method to improve the quality of care that the physicians are providing. You improve the health of a nation by providing and emphasizing patient-centered care and by implementing a system that allows doctors to act in the patient's best interest without having to worry about how that decision will affect their paycheck. Until we find a payment scheme that allows our doctors to align their goals with that of their patients, the United States will not only pay too much for healthcare but also will continue to see mediocre outcomes relative to that of other First World countries.

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