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## Patient, Physician, and Payment Predictors of Statin Adherence

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| Citation          | Chan, David C., William H. Shrank, David Cutler, Saira Jan, Michael A. Fischer, Jun Liu, Jerry Avorn, Daniel Solomon, M. Alan Brookhart, and Niteesh K. Choudhry. 2010. Patient, physician, and payment predictors of statin adherence. <i>Medical Care</i> 48(3): 196-202.  |
| Published Version | <a href="https://doi.org/10.1097/MLR.0b013e3181c132ad">doi:10.1097/MLR.0b013e3181c132ad</a>  |
| Accessed          | February 19, 2015 9:06:13 AM EST   |
| Citable Link      | <a href="http://nrs.harvard.edu/urn-3:HUL.InstRepos:5343023">http://nrs.harvard.edu/urn-3:HUL.InstRepos:5343023</a>  |
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Manuscript Number: MDC-D-09-00118R2

Title: PATIENT, PHYSICIAN, AND PAYMENT PREDICTORS OF STATIN ADHERENCE

Article Type: Original Article

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Abstract: BACKGROUND: Although many patient, physician, and payment predictors of adherence have been described, knowledge of their relative strength and overall ability to explain adherence is limited.

OBJECTIVES: To measure the contributions of patient, physician, and payment predictors in explaining adherence to statins

RESEARCH DESIGN: Retrospective cohort study using administrative data

SUBJECTS: 14,257 patients insured by Horizon Blue Cross Blue Shield of New Jersey (BCBSNJ) who were newly prescribed a statin cholesterol-lowering medication

MEASURES: Adherence to statin medication was measured during the year after the initial prescription, based on proportion of days covered (PDC). The impact of patient, physician, and payment predictors of adherence were evaluated using multivariate logistic regression. The explanatory power of these models was evaluated with C statistics, a measure of the goodness of fit.

RESULTS: Overall, 36.4% of patients were fully adherent. Older patient age, male gender, lower neighborhood percent black composition, higher median income, and fewer number of emergency department (ED) visits were significant patient predictors of adherence. Having a statin prescribed by a cardiologist, a patient's primary care physician, or a US medical graduate were significant physician predictors of adherence. Lower copayments also predicted adherence. All of our models had low explanatory power. Multivariate models including patient covariates only had greater explanatory power ( $C = 0.613$ ) than models with physician variables only ( $C = 0.566$ ) or copayments only ( $C = 0.543$ ). A fully specified model had only slightly more explanatory power ( $C = 0.633$ ) than the model with patient characteristics alone.

CONCLUSIONS: Despite relatively comprehensive claims data on patients, physicians, and out-of-pocket costs, our overall ability to explain adherence remains poor. Administrative data likely do not capture many complex mechanisms underlying adherence.

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Administrative data likely do not capture many complex mechanisms underlying adherence.

**KEY WORDS:** ADHERENCE, RELATIVE IMPORTANCE, EXPLANATORY MODEL, PATIENT, PHYSICIAN, **PAYMENT**

## INTRODUCTION

Despite advances in medical therapy, adherence to medications, or the extent to which patients take medications as prescribed by their health care providers, remains suboptimal (1, 2). In particular, although statins have been shown to yield significant reductions in cardiovascular mortality and morbidity (3-7), they remain significantly underused in patients who are prescribed them (8-14), with yearly adherence rates from 25% to 40% (10, 15).

Current interventions to encourage adherence are at best blunt (16). The only programs shown to be successful are multifaceted combinations of patient education, simplified dosing schedules, patient-physician communication, increased follow-up and monitoring, and clinic schedules that improve medication access, but these programs remain costly and likely impractical when applied to all patients (1, 16). At the same time, although less frequently, innovations that reduce the patient's share of drug costs have been proposed to increase adherence (17-19). A better understanding of the relative contributions of patient, physician, and payment-related predictors in adherence may be useful in understanding non-adherence and designing more practical interventions.

The barriers to adherence are complex and arise from interactions among the patient, the physician, and the health care system (1, 20). For example, patients may fail to be adherent due to reasons as varied as attitudes toward their medications, out-of-pocket costs, side effects, the complexity of their regimens, and poor communication with their

physicians. Although these reasons have been incorporated into overarching theories of adherence and patient behavior (21-23), studies have mostly documented groups of predictors separately, including demographic, clinical, socioeconomic, payment, and provider-related factors (1, 24). To our knowledge, no study has examined the relative importance of patient, physician, and payment factors in explaining adherence or the cumulative explanatory power of readily observable predictors.

We examined the adherence of patients insured by Horizon Blue Cross Blue Shield of New Jersey (BCBSNJ) who were prescribed statins. Using a combination of health care utilization, socioeconomic, and provider data, we measured the contributions of patient, physician, and payment factors in adherence.

## **METHODS**

### *Study Sample*

We conducted a retrospective study in the setting of a large private health insurance provider, Horizon BCBSNJ, which is the largest health insurer in New Jersey. Enrollees of the program were eligible for inclusion in the study if they filled a prescription in either 2004 or 2005 for a statin (atorvastatin, rosuvastatin, fluvastatin, lovastatin, pravastatin, or simvastatin). Because adherence is time-dependent (10), we restricted our cohort to patients who had not filled a statin prescription in the year prior to their first prescription in 2004 or 2005. All patients included were required to be continuously

enrolled in Horizon BCBSNJ for one year before and one year after their index date. The index date was defined as the first date that the patient filled a prescription for a statin.

### *Data Sources*

We compiled filled-prescription information from Horizon BCBSNJ pharmacy claims data. Prescription information in the claims data included drug name, dosage, date dispensed, quantity dispensed, and days supplied. The claims data also identified the prescribing physician with a unique Drug Enforcement Agency (DEA) number and indicated whether he or she was also listed as the patient's primary care physician (PCP). Prescription information also included the copayment, or the cost of each prescription that the patient was required to share.

Horizon BCBSNJ claims data also included patient characteristics and health care utilization information. Patient characteristics included age, gender, zip code of residence, and medical conditions as coded by the International Classification of Diseases, 9<sup>th</sup> Revision (ICD-9). Health care utilization information for each enrollee included dates of physician visits, emergency department (ED) visits, and hospitalizations.

Data on aggregate patient socioeconomic status as a proxy for individual socioeconomic status was obtained by linking patient zip code of residence with the United States Census, which specified the median income and racial composition of the geographic

population associated with the zip code of residence for each patient. Physician specialty and years in practice were obtained by linking the DEA number of the physician who prescribed the patient's index statin with data from the AMA Physician Database obtained through a private intermediary (PracticeMatch, Saint Louis, Missouri).

The study was approved by the Institutional Review Board of Brigham and Women's Hospital. Permission was obtained from Horizon BCBSNJ to use their claims data. All unique patient identifiers were removed from the data prior to analysis.

### *Measure of Adherence*

We constructed a continuous measure of statin adherence (25), the proportion of days covered (PDC), which we defined as the number of days that the statin was in the patient's possession (based on filled prescriptions), from the index date to one year after the index date, divided by the number of outpatient days in the interval. We then defined a patient to be "fully adherent" if the patient had a PDC of at least 80% (8, 10).

### *Potential Predictors of Adherence*

We categorized potential predictors of adherence into groups related to the patient, the prescribing physician, and the out-of-pocket cost of the prescription. Patient-related factors were evaluated during the 12 months prior to the index date and included patient age in decades, gender, neighborhood median income in quartiles, neighborhood percent



black or African American composition, number of other prescriptions written, number of outpatient physician visits, number of ED visits, and number of hospitalizations.

We determined whether patients had evidence of an acute coronary syndrome hospitalization within 30 days prior to their index date or whether they had any other less-acute evidence of coronary artery disease (i.e., prior angina, coronary angiography, coronary artery bypass graft, stent, percutaneous transluminal coronary angioplasty, or coronary artery disease not otherwise specified). For each patient, we determined the number of medical comorbidities, specified as hypertension, diabetes, heart failure, stroke, peripheral vascular disease, chronic obstructive pulmonary disease, chronic kidney disease, or malignancy, and the existence of any psychiatric comorbidities, defined as dementia, depression, psychosis, or schizophrenia. Medical and psychiatric comorbidities were identified using ICD-9 diagnosis and procedure codes (available from the authors upon request).

For the prescribing physicians, we considered the number of decades in practice from residency training, whether the physician was a cardiologist, whether the physician was also the patient's PCP, whether the physician and the patient had the same sex, and whether the physician was a US medical graduate. Forty-five percent of the sample did not have a record of their PCP, which reflects the fact that many patients were in plan types that did not require a record of a PCP in the administrative data, despite the fact that a PCP may exist. Of seven plan types, three had missing PCP rates less than 10%: health maintenance organization (HMO), point of service (POS), and Medicare. The remaining

four were all more expensive plans and had missing PCP rates greater than 70%: preferred provider organization (PPO), traditional indemnity, “Horizon Direct Access,” and “Exclusive Provider Organization” (EPO). To account for this, we allowed for three comprehensive and mutually exclusive categories of the PCP variable, “PCP unknown,” “PCP was index prescriber,” and “PCP was not index prescriber,” in order to use the full sample and adjust for possible bias by only considering patients with a known PCP.

For prescription cost-sharing, we considered the total costs shared by the patient divided by the number of days supplied, in order to account for the fact that patients who filled more statin prescriptions would naturally have higher total cost-sharing. Our measure of cost-sharing therefore reflected the out-of-pocket cost per day of prescribed statin.

### *Statistical Analysis*

To study the contribution of each category of predictors, we constructed 7 sets of multivariate logistic regression models: only patient variables; only physician variables; only daily averaged cost-sharing; patient and physician variables; patient and payment variables; physician and payment variables; patient, physician, and payment variables (Table 2). We clustered the data by the index prescriber whenever applicable (e.g. when both patient- and physician-level data were included in the model) using generalized estimating equations with an independent covariance matrix (26). The primary purpose of separate sets of regression models was to evaluate increases in explanatory power when adding categories of predictors.

For each model, we estimated the effect of each of their respective variables by an odds ratio, along with an associated 95% confidence interval. We also calculated the *C* statistic in order to measure the model's ability to discriminate whether patients with certain characteristics will be fully adherent or not. The *C* statistic represents the area under the receiver operating characteristic curve (27). A *C* statistic value of 0.5 indicates that a model does not have any increased discriminatory power over a random coin toss to classify whether a patient will be fully adherent or not, whereas a *C* statistic value of 1.0 represents perfect discriminatory power. For example, the Framingham Coronary Heart Disease Prediction Score has been found to have a *C* statistic between 0.63 and 0.83 when validated in different cohorts (28). While the *C* statistic is a useful summary measure of discriminatory power, we also report rates of full adherence for the highest and lowest deciles as ranked by each model in order to reflect model performance across the distribution of patients, specifically at the high and low ends of the spectrum. Finally, we calculated Hosmer-Lemeshow statistics, which test the null hypothesis of proper calibration across all deciles, for each model (29).

We used the Wald statistical test to estimate *p* values for maximum likelihood estimates, considering *p* values less than 0.05 to indicate statistical significance. We also used the Wald statistical test to estimate the 95% confidence intervals around odds ratio estimates. All analyses were conducted using SAS (Version 9.1, Cary, North Carolina).

## RESULTS

The overall study sample included 14,257 patients. Patients of this cohort had a mean age of 51.6 years, were 45.2% female. Median neighborhood percent black composition was 4.4%, and median neighborhood median income was \$57,900 (the respective means for these measures were 12% and \$59,800). Of these patients, 8.77% of them had a history coronary heart disease; 1.26% had a history of acute coronary syndrome; the average number of comorbidities was 0.65; and 3.63% had a psychiatric comorbidity. Averaged over the cohort of patients, the number of ER visits was 0.15 per patient; the number of hospitalizations was 0.11 per patient; the number of physician visits was 4.16 per patient; and the number of concomitant medications was 5.33 per patient. The average copayment for the prescribed statin was \$0.37 per day. The index prescriber was their primary care provider for 31.8% of the patients overall, or 56.7% of patients with a known primary care provider; the index prescriber was a cardiologist for 13.2% of the patients. The average index prescriber had been in practice for 23.8 years. Table 1 compares baseline characteristics for patients who were fully adherent and those who were not.

Of the patients in our cohort, 36.4% were fully adherent. Figure 1, a plot of PDC values across the entire distribution of patients, shows considerable variation in adherence measured as PDC but also confirms an expected coarseness in the measure as most prescriptions are prescribed in at least monthly intervals. Our binary definition of full adherence is indicated by the vertical line in Figure 1. Patient, prescription, cost-sharing, and index-prescriber characteristics are presented separately for adherent and non-adherent patients in Table 1.

### *Predictors of adherence*

Table 2 summarizes the odds ratios for predictors of adherence in the range of models that we considered. Older patient age (OR 1.34 per decade, 95% CI 1.28-1.40) and higher neighborhood median income (OR 1.13 per quartile, 95% CI 1.09-1.17) both were statistically significant predictors of full adherence. Female gender (OR 0.89, 95% CI 0.81-0.97), higher neighborhood percent black composition (OR 0.88 per quartile, 95% CI 0.85-0.91) were statistically significant predictors of non-adherence. In addition, an index prescription close to an episode of acute coronary syndrome was associated with significantly higher rates of adherence (OR 1.68, 95% CI 1.18-2.38), while higher additional ED visits were associated with lower rates of adherence (OR 0.87 for each visit, 95% CI 0.80-0.94).

Certain types of physician prescribers were noted to be associated with greater rates of adherence among their patients. For patients with a known PCP, those who had their index prescription written by their PCP were significantly more likely to be fully adherent than patients whose known PCP did not write their index prescription (OR 1.12, 95% CI 1.02-1.25). Patients without a known PCP, who were mostly in more expensive plans, were also more likely to be fully adherent than patients with a known PCP who did not write the index prescription (OR 1.21, 95% CI 1.10-1.33). Controlling for PCP status, having a cardiologist as the index prescriber was independently associated with significantly higher adherence (OR 1.26, 95% CI 1.12-1.40). US medical graduates were

significantly associated with higher rates of adherence (OR 1.32, 95% CI 1.22-1.42).

Finally, although patient-physician sex concordance missed statistical significance at the 95% confidence level in the full model, sex concordance was associated with higher rates of adherence that were statistically significant in models that did not include other patient characteristics.

Higher average copayment per day of prescribed statin, the only **payment**-related **predictor**, was associated with lower rates of adherence (OR 0.54 per copay daily dollar, 95% CI 0.47-0.60).

Although not shown in our Table 2, we also ran the full model with an additional 8 interaction terms: between copayment and 4 patient characteristics (**neighborhood** percent black **composition**, psychiatric comorbidity, coronary heart disease **older** than 30 days, and acute coronary syndrome **within** 30 days), and between PCP status and these same 4 patient characteristics. All of the odds ratios for these interaction terms were insignificant except for copayment and percent black, which was 0.83 and significant (95% CI 0.75-0.91).

### *Explaining adherence*

Table 2 also reports measures of the explanatory power of each multivariate regression model. Multivariate models including only patient covariates had greater explanatory power ( $C = 0.613$ ) than models with only physician variables ( $C = 0.566$ ) or only

copayments ( $C = 0.543$ ). Adding physician or payment variables to the model had little impact on the models' predictive ability. The full model, which included patient, physician, and cost-sharing variables (but not interaction terms), yielded a  $C$  statistic of 0.631. When ranked by propensity to be fully adherent according to this model, 50.8% of patients in the highest decile were fully adherent, compared to the 16.8% of patients in the lowest decile who were fully adherent. Hosmer-Lemeshow statistics generally confirmed poor calibration in addition to poor predictive ability of the models; the null hypothesis of proper calibration was rejected in all models except the patient-only and physician-only models.

Although not shown in Table 2, the full model with the additional interaction terms had essentially the same explanatory power, with a  $C$  statistic of 0.632.

## DISCUSSION

We examined adherence among privately insured patients with patient, physician, and cost-sharing data. Consistent with the literature, which reports yearly statin adherence rates from 25% to 40% (10, 15), we confirm that statin adherence is low (36.4%) even among privately insured patients who have been continuously enrolled for at least one year. Despite considerable variation in adherence among patients (Figure 1), our findings suggest that the ability to predict adherence using conventional measures is poor. In our fully specified model, only about half of the patients ranked in the highest decile of

predicted adherence actually exhibit full adherence, reflecting low population adherence and poor model prediction.

When aggregating covariates into patient-related, physician-related, and payment-related predictors, we find that patient-related predictors account for the largest incremental explanatory power in predicting adherence. For example, older patients who live in neighborhoods with higher median incomes are more likely to be adherent. Patients generally in more expensive plans (those with missing PCPs) also had higher levels of adherence, possibly reflecting better health care delivery or greater preference for adherence. Some of these covariates are indeed clinically significant: patients with a recent acute coronary syndrome had odds of full adherence that were 70% greater than other patients.

The physician-related predictors that we considered have incrementally less power in explaining adherence. However, we found relationships that, to our knowledge, have not been highlighted to the same degree as patient-related predictors in the literature. For example, among patients with a known PCP (those generally in HMO and POS plans), having the PCP write the index statin prescription is associated with higher adherence. In addition, an index prescription written by a cardiologist is independently associated with higher adherence than in patients whose index prescription was written by a non-cardiologist, which is an effect that persists even when accounting for patient comorbidities and cardiovascular disease. Interestingly, measures that may reflect the social or cultural interaction between physician and patient, such as sex concordance and



the country of the physician's medical education, are also positively correlated with patient adherence.

Finally, we confirm previous literature that copayments are negatively correlated with adherence. The negative effect of copayments is quite significant, with each daily copayment dollar associated with a diminished odds ratio of full adherence of about 0.55. However, although **payment-related predictors** of adherence have been documented convincingly in the literature (12, 17, 18, 24, 30), we show that the explanatory power of copayments is actually lower than the other two categories – patient-related and physician-related **predictors** – that we consider. This low explanatory power may be due to the fact that the variation of copayments is appropriately low among the privately insured patients that we studied.

There are some limitations to our paper. First, we restricted our attention to patients in the private insurance setting of Horizon BCBSNJ, a population that was primarily employed, non-elderly, and with good drug insurance. In addition, we did not broaden our inclusion criteria to allow for patients who have been enrolled for intervals of less than one year. Similarly, as in other studies of adherence, we restrict attention to adherence after the initiation of treatment (8, 9, 12, 14), while it has been shown that adherence can fluctuate over the longer-term, with some patients becoming more adherent after initial non-adherence (31). The prevalence and determinants of adherence likely differ among patient populations and health care arrangements, and findings may need to be confirmed in separate or more comprehensive populations. For example, although we found no

relationship between psychiatric comorbidity and adherence among our patients, psychiatric conditions such as depression have been found in other studies to be correlated with poor adherence (32, 33). Similarly, payment-related reasons may feature more prominently among patients in plans with higher variation in copayments, or among patients who are poorer, less educated, or lack drug insurance.

Second, there is likely to be measurement error in identifying non-adherence. Using claims based data, we chose the proportion of days covered (PDC) as our primary metric and arbitrarily defined adherence as binary measure by setting a PDC cutoff of 80% (Figure 1). This definition has been used elsewhere (8, 10), and our findings do not change much when using different percentage cutoffs in PDC to define full adherence. However, there are a multitude of other instruments, some with finer resolution, some more direct than others, but none of which is a gold standard (1). Of course, it would ultimately be very difficult to ascertain with full certainty whether a patient is actually taking or “adhering to” a medication, and any measurement error would bias the significance levels of the odds ratios and the explanatory power of the models to the null hypothesis. Alternatively, we may view adherence as a sequence of behaviors, of which refilling prescriptions is a part. In the context of refilling medications, the PDC is a much more accurate measure.

Lastly, although our data were fairly comprehensive in the limited sense of administrative data, there undoubtedly remain numerous variables unobservable to us and omitted in our analysis. As described above, we were unable to identify the PCP for a significant

proportion of patients, although our results did not change when excluding these patients. We could not account for practice characteristics, such as support staff or electronic medical record systems that might encourage adherence. We could not identify physician race, individual patient race, or patient language and therefore could not estimate the effect of racial or cultural interactions. We could not approximate the quality of the physician-patient relationship with variables such as the number of missed appointments or the length of time the patient has known the prescriber (31). Indeed, perhaps the most important correlates to adherence, such as physician-patient communication, understanding, social support, satisfaction and trust (22, 23, 34-36), may not be obtainable from administrative databases.

These findings and limitations suggest that better data need to be collected to identify and understand non-adherence. Readily observable correlates may be inadequate in describing and predicting adherence, and a better explanatory model of adherence may have to account for factors that are more difficult to measure, such as patient understanding and the physician-patient relationship. Of course, the finding of low explanatory power in a study must distinguish between what is unobservable to the statistician and what is unobservable to the physician, since the information available to the clinician is naturally richer. However, the fact that even physicians perform poorly at predicting the adherence of their patients implies that much of non-adherence is difficult to observe at the individual level (1). From a clinical perspective, our immediate findings imply that administrative data would be insufficient to identify and describe non-adherence, and that the most cost-effective way to identify non-adherence may still be for

clinicians to ask their patients about adherence on a routine basis. As we have done here with administrative data, simple clinical tools to identify adherence should be tested for predictive power.

Systematic and in-depth evaluation of the predictors of non-adherence may ultimately reveal a heterogeneous phenomenon that cannot be completely explained or predicted by any single model. Unobservable determinants and heterogeneity make our models particularly unsuited to identifying highly adherent patients. However, it is important to note that the presence of multiple risk factors can still imply high risk for non-adherence. Even with our relatively crude model, we are able to identify patients who are very unlikely to be adherent; in our fully specified model, patients ranked in the lowest decile have only a 16.8% likelihood of full adherence. The practical implication is that even with models of poor predictive ability, most if not all patients should be screened for non-adherence. In addition, although much of adherence is still unexplained, we have identified several correlates that deserve further investigation. For example, the positive effect of PCP prescribing on adherence may be explained by a good physician-patient relationship or by better practice-wide coordination. Similarly, the positive effect of a cardiologist prescribing the index statin may reflect the importance of expertise for patient understanding or trust, or it may be related to greater familiarity and support systems for patients with cardiovascular conditions.

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**FIGURE LEGEND**

FIGURE 1: The distribution of the proportion of days covered (PDC) for statin prescriptions across the sample of patients is illustrated in this figure. The cumulative percentage of patients with a PDC up to any given level is shown, starting from a PDC of 0% and increasing to a PDC of 100%. A line at the 80% PDC indicates our definition of full adherence.

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and Pharmacoeconomics*



August 4, 2009

Monika M. Safford, M.D.  
Deputy Editor  
*Medical Care*

Dear Dr. Safford:

Thank you for your response to our manuscript, MDC-S-09-00139, "PATIENT, PHYSICIAN, AND PAYMENT DETERMINANTS OF STATIN ADHERENCE."

We are pleased to hear that our manuscript has been found acceptable for publication, and we have followed your recommendations for revision. Changes in the revised manuscript have been highlighted. A summary of our changes is as follows:

- We have revised Table 1 so that the numbers in parentheses are sample standard deviations and have clearly indicated each row where this applies. In addition, as suggested, we have changed the rows corresponding to the neighborhood percent black and neighborhood median income to describe quartile values. Finally, we have added a third column describing each variable for the overall sample.
- We have revised Table 2 so that it is clear which variables are considered as continuous and which are considered as categorical. For categorical variables, we indicate the referent category, and for continuously linear variables, we indicate the incremental unit (e.g. "per additional decade" for age, which has no referent category). We have revised the title as you have requested. Information on neighborhood quartiles is now in Table 1.
- We have made minor changes in wording throughout the manuscript to improve clarity. Most of these highlighted changes are self-explanatory. Most significantly, we have decided to replace most uses of the word "determinant" with "predictor," including in the title, since we have not addressed causality.

I remain the corresponding author for this manuscript. Thank you again for your consideration, and we look forward to hearing from you.

With best regards,

Niteesh K. Choudhry, M.D., Ph.D.  
Assistant Professor, Harvard Medical School



**TITLE PAGE**

**PATIENT, PHYSICIAN, AND PAYMENT DETERMINANTS OF STATIN  
ADHERENCE<sup>1</sup>**

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<sup>1</sup> Brief title for running head: DETERMINANTS OF ADHERENCE. None of the authors received financial support for this work. Word count: 3,789. Text pages: 16. Figure(s): 1. Tables: 2.

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FIGURE 1: DISTRIBUTION OF PROPORTION OF DAYS COVERED (PDC) FOR STATIN PRESCRIPTION

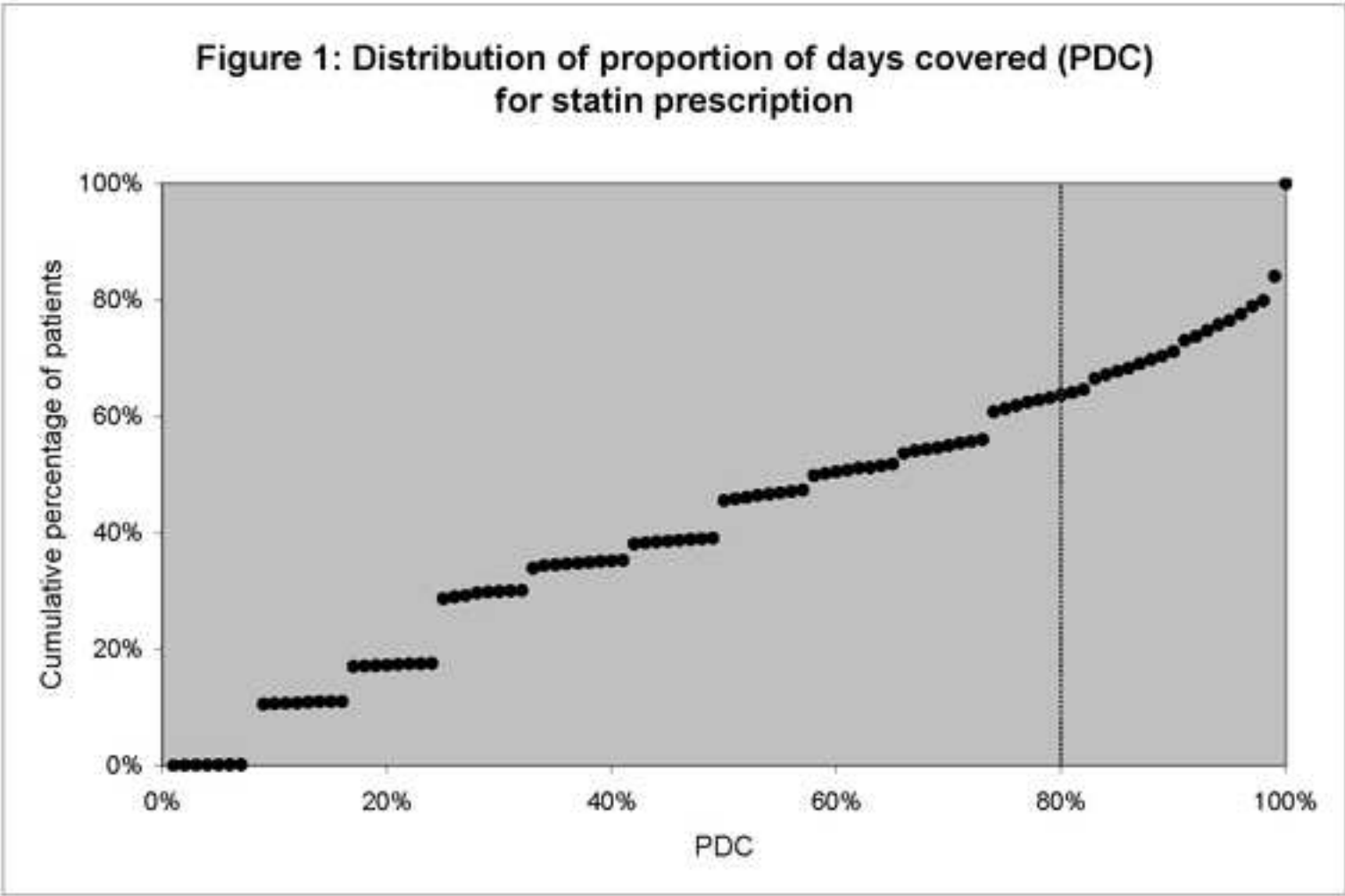


TABLE 1: BASELINE CHARACTERISTICS

|  | Not Fully Adherent            | Fully Adherent                | All                           |
|--|-------------------------------|-------------------------------|-------------------------------|
|  | N = 9,062                     | N = 5,195                     | N =14,257                     |
| <i>Patient Variables</i>   |                               |                               |                               |
| Mean age in years (SD)*  | 50.7 (8.66)                   | 53.1 (7.48)                   | 51.6 (8.33)                   |
| % female gender*   | 46.5%                         | 43.0%                         | 45.2%                         |
| Median neighborhood % black or African American (interquartile range)* | 5.2%<br>(1.8-16%)             | 3.7%<br>(1.3-10%)             | 4.4%<br>(1.6-14%)             |
| Median neighborhood median income (interquartile range)*               | \$56,300<br>(\$44,300-69,000) | \$60,600<br>(\$49,400-73,500) | \$57,900<br>(\$45,600-70,600) |
| % with CHD > 30 days   | 8.46%                         | 9.32%                         | 8.77%                         |
| % with ACS < 30 days*  | 1.03%                         | 1.67%                         | 1.26%                         |

\* Variable shows statistically significant difference ( $p$ -value < 0.05) between patients who are fully adherent and those who are not fully adherent.

|   |                 |                 |                 |
|---|-----------------|-----------------|-----------------|
| Mean number of comorbidities (SD)                     | 0.65 (0.86)     | 0.66 (0.89)     | 0.65 (0.87)     |
| % with Psychiatric comorbidity                        | 3.62%           | 3.64%           | 3.63%           |
| Mean number of emergency department (ED) visits (SD)* | 0.17 (0.55)     | 0.12 (0.55)     | 0.15 (0.55)     |
| Mean number of physician visits (SD)                  | 4.19 (5.70)     | 4.09 (6.27)     | 4.16 (5.92)     |
| Mean number of other medications (SD)*                | 5.43 (5.54)     | 5.15 (5.51)     | 5.33 (5.53)     |
| Mean number of hospitalizations (SD)                  | 0.11 (0.45)     | 0.11 (0.43)     | 0.11 (0.45)     |
| <i>Payment Variable</i>                               |                 |                 |                 |
| Mean copay per day (SD)*                              | \$0.40 (\$0.34) | \$0.34 (\$0.28) | \$0.37 (\$0.32) |
| <i>Physician Variables</i>                            |                 |                 |                 |
| Mean years of practice of index prescriber (SD)       | 23.8 (9.67)     | 23.8 (9.47)     | 23.8 (9.59)     |

|   |       |       |       |
|---|-------|-------|-------|
| % with index prescriber as cardiologist *                               | 11.9% | 15.6% | 13.2% |
| % with index prescriber as PCP (not including those with unknown PCP) * | 56.2% | 57.2% | 56.7% |
| % with index prescriber as PCP* (including those with unknown PCP)      | 32.6% | 30.5% | 31.8% |
| % with same sex as index prescriber *                                   | 58.0% | 61.1% | 59.1% |
| % with index prescriber as US medical graduate *                        | 56.1% | 64.2% | 59.1% |

**TABLE 2: ADJUSTED ODDS RATIOS (WITH 95% CONFIDENCE INTERVALS) AND EXPLANATORY POWER BY MODEL \***

|  | Patient Model        | Payment Model | Physician Model | Patient, Payment Model | Patient, Physician Model | Payment, Physician Model | Full Model           |
|--|----------------------|---------------|-----------------|------------------------|--------------------------|--------------------------|----------------------|
| <i>Patient Variables</i>   |                      |               |                 |                        |                          |                          |                      |
| Age (per additional decade)  | 1.36<br>(1.30, 1.41) |               |                 | 1.35<br>(1.29, 1.41)   | 1.35<br>(1.29, 1.40)     |                          | 1.34<br>(1.28, 1.39) |
| Female gender <sup>†</sup>   | 0.85<br>(0.79, 0.92) |               |                 | 0.86<br>(0.79, 0.92)   | 0.88<br>(0.80, 0.97)     |                          | 0.88<br>(0.80, 0.97) |
| Neighborhood percent black or African American (per quartile increase) | 0.86<br>(0.83, 0.89) |               |                 | 0.86<br>(0.83, 0.89)   | 0.88<br>(0.85, 0.91)     |                          | 0.88<br>(0.85, 0.91) |
| Neighborhood median income (per quartile increase)                     | 1.13<br>(1.09, 1.17) |               |                 | 1.14<br>(1.10, 1.18)   | 1.12<br>(1.08, 1.16)     |                          | 1.13<br>(1.08, 1.17) |
| Coronary artery disease > 30 days <sup>†</sup>                         | 0.98<br>(0.85, 1.13) |               |                 | 0.98<br>(0.85, 1.13)   | 0.92<br>(0.79, 1.07)     |                          | 0.92<br>(0.79, 1.07) |
| Acute coronary syndrome < 30 days <sup>†</sup>                         | 1.70<br>(1.19, 2.41) |               |                 | 1.70<br>(1.20, 2.42)   | 1.67<br>(1.17, 2.38)     |                          | 1.68<br>(1.18, 2.40) |
| Number of comorbidities (per additional comorbidity)                   | 1.02<br>(0.97, 1.07) |               |                 | 1.02<br>(0.97, 1.07)   | 1.03<br>(0.97, 1.08)     |                          | 1.02<br>(0.97, 1.07) |
| Psychiatric comorbidity <sup>†</sup>                                   | 1.05<br>(0.86, 1.27) |               |                 | 1.06<br>(0.87, 1.29)   | 1.02<br>(0.83, 1.25)     |                          | 1.04<br>(0.85, 1.27) |

\* Unless otherwise indicated, variables were included as continuous linear predictors. Where useful, we indicate the unit of linear increases in parentheses.

<sup>†</sup> Referent for these variables is the lack of the specified condition.



|   | Patient Model        | Payment Model        | Physician Model      | Patient, Payment Model | Patient, Physician Model | Payment, Physician Model | Full Model           |
|---|----------------------|----------------------|----------------------|------------------------|--------------------------|--------------------------|----------------------|
| Number of emergency department (ED) visits (per additional visit) | 0.86<br>(0.78, 0.96) |                      |                      | 0.86<br>(0.78, 0.96)   | 0.86<br>(0.78, 0.96)     |                          | 0.87<br>(0.78, 0.96) |
| Number of physician visits (per additional visit)                 | 1.00<br>(0.99, 1.01) |                      |                      | 1.00<br>(0.99, 1.01)   | 1.00<br>(0.99, 1.01)     |                          | 1.00<br>(0.99, 1.01) |
| Number of other medications (per additional medication)           | 1.00<br>(0.99, 1.01) |                      |                      | 0.99<br>(0.99, 1.00)   | 1.00<br>(0.99, 1.01)     |                          | 0.99<br>(0.99, 1.00) |
| Number of hospitalizations (per hospitalization)                  | 1.00<br>(0.91, 1.10) |                      |                      | 1.01<br>(0.91, 1.11)   | 1.00<br>(0.91, 1.11)     |                          | 1.01<br>(0.91, 1.12) |
| <i>Payment Variable</i>   |                      |                      |                      |                        |                          |                          |                      |
| Copay (per additional dollar per day)                             |                      | 0.56<br>(0.50, 0.62) |                      | 0.55<br>(0.49, 0.61)   |                          | 0.53<br>(0.48, 0.60)     | 0.54<br>(0.48, 0.60) |
| <i>Physician Variables</i>  |                      |                      |                      |                        |                          |                          |                      |
| Years of practice (per additional decade)                         |                      |                      | 1.00<br>(0.96, 1.04) |                        | 0.99<br>(0.95, 1.03)     | 1.00<br>(0.96, 1.04)     | 0.99<br>(0.95, 1.03) |
| Index prescriber is cardiologist <sup>‡</sup>                     |                      |                      | 1.40<br>(1.26, 1.55) |                        | 1.26<br>(1.13, 1.40)     | 1.39<br>(1.26, 1.55)     | 1.25<br>(1.12, 1.40) |
| PCP is unknown <sup>‡</sup>                                       |                      |                      | 1.29<br>(1.18, 1.42) |                        | 1.17<br>(1.07, 1.29)     | 1.34<br>(1.23, 1.47)     | 1.21<br>(1.10, 1.33) |
| Index prescriber is PCP <sup>**</sup>                             |                      |                      | 1.13<br>(1.02, 1.26) |                        | 1.13<br>(1.01, 1.25)     | 1.13<br>(1.02, 1.26)     | 1.12<br>(1.01, 1.25) |
| Index prescriber is same sex as patient <sup>†</sup>              |                      |                      | 1.12<br>(1.05, 1.21) |                        | 1.04<br>(0.95, 1.14)     | 1.13<br>(1.05, 1.21)     | 1.04<br>(0.95, 1.14) |

<sup>‡</sup> The referent is that the PCP is known and is not the index prescriber.

|  | Patient Model | Payment Model | Physician Model      | Patient, Payment Model | Patient, Physician Model | Payment, Physician Model | Full Model           |
|--|---------------|---------------|----------------------|------------------------|--------------------------|--------------------------|----------------------|
| Index prescriber is US medical graduate <sup>†</sup> |               |               | 1.42<br>(1.31, 1.54) |                        | 1.32<br>(1.22, 1.43)     | 1.42<br>(1.31, 1.54)     | 1.32<br>(1.22, 1.43) |
| <i>Explanatory Power</i>                             |               |               |                      |                        |                          |                          |                      |
| C Statistic  | 0.613         | 0.543         | 0.566                | 0.624                  | 0.620                    | 0.585                    | 0.631                |
| Full adherence in lowest-ranked decile               | 19.7%         | 26.9%         | 36.6%                | 18.6%                  | 19.0%                    | 24.8%                    | 16.8%                |
| Full adherence in highest-ranked decile              | 49.6%         | 37.8%         | 44.4%                | 49.9%                  | 50.8%                    | 46.6%                    | 50.8%                |