BENEFIT PLAN DESIGN AND PRESCRIPTION DRUG UTILIZATION AMONG ASTHMATICS: DO PATIENT COPAYMENTS MATTER?*

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BENEFIT PLAN DESIGN, PRESCRIPTION DRUG AND OTHER HEALTHCARE UTILIZATION AMONG ASTHMATICS: DO PATIENT COPAYMENTS MATTER?*

ABSTRACT

Objective: The ratio of controller to reliever medication use has been proposed as a measure of treatment quality for asthma patients. In this study we examine the effects of plan level mean out-of-pocket asthma medication patient copayments and other features of benefit plan design on the use of controller medications alone, controller and reliever medications (combination therapy), and reliever medications alone, relative to no drug treatment.

Methods: 1995-2000 MarketScan™ claims data were used to construct plan-level out-of-pocket copayment and provider prescriber pattern variables for asthma medications. Separate multinomial logit models were estimated for patients in fee-for-service (FFS) and non-FFS plans relating benefit plan design features, provider prescribing patterns, patient demographics, patient comorbidities and county-level race and income variables to patient-level asthma treatment patterns.

Results: We find that the controller reliever ratio rose steadily over 1995-2000, along with out-of-pocket payments for asthma medications. However, after controlling for other variables, plan level mean out-of-pocket copayments were not found to have a statistically significant influence upon patient-level asthma treatment patterns. On the other hand, provider prescribing patterns did influence patient level treatment patterns; these effects differ somewhat between FFS and non-FFS plans.

Conclusions: There is no strong statistical evidence that higher levels of out-of-pocket copayments for prescription drugs influences asthma treatment patterns. Physician prescribing patterns do influence patient treatment, however, and this influence differs between FFS and non-FFS plans.

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I. INTRODUCTION

It has long been known that tradeoffs exist between the gains from pooling across individuals to insure against catastrophic medical expenditures, and efficiency losses from the moral hazard effects that arise due to the implicit marginal subsidies to health services utilization that occur under conventional medical insurance plans.[1] The existence of this tradeoff suggests that, given preferences and costs, there may be an optimal amount of coinsurance. Using data from the RAND Health Insurance Experiment in the 1980s, Manning and Marquis [1996] have estimated that with an $8000 cap on total expenditures, the optimal coinsurance rate would have been about 50%.[2]

Although coinsurance rates for office visits, emergency room, inpatient hospitalization and prescription drug services were set to be equal in the design of the RAND Health Insurance Experiment, in practice currently in the U.S. coinsurance and, more commonly, patient copayment amounts differ considerably among the different categories of health care services.[3]

Within the last decade considerable controversy has arisen involving the design of prescription drug benefits in health insurance plans. This controversy reflects in part the fact that prescription drugs have become an increasingly important component of health care costs, rising sharply from 5.6% in 1980 to 9.7% in 2000.[4] Continuing a recent pattern, in 2001 total prescription drug expenditures in the U.S. increased by about 17%.[5] In levels, the $172.8 billion implied an average of about $600 per capita, although the underlying distribution is highly skewed.

Managed care organizations have attempted to control rising prescription drug costs by changing cost sharing provisions, seeking to steer use to preferred drugs on the insurer's list of

approved medications ("formularies").[6] Already in the early and mid-1990s, plans began experimenting with two-tier copayment schemes, in which a low patient copay (say, $5) was assessed for a generic (first tier) drug, and a somewhat higher but still modest copay (say, $10) was assessed for (second tier) branded drugs; in some rare cases, physicians needed prior authorization from the payer before being granted permission to prescribe particularly costly medications.

After seeing continued increases in their prescription drug costs, in the mid and late 1990s some plans began implementing less generous three-tier copay schemes. A typical three-tier plan design of several years ago consisted of a $5 copay for a first tier generic drug, a $10 copay for a "preferred" branded drug within a given therapeutic class (the second tier); and a heftier $25 copay for the "non-preferred" branded drugs within the therapeutic class. Many plans also had a second, more favorable three-tier system for mail order pharmacy prescriptions.

Use of the three-tier copayment designs created incentives not only for insurees to shift toward increased use of the less costly medications, but it also gave insurance plans and payers increased bargaining power with pharmaceutical companies by allowing them to threaten to banish their branded products to the third tier, unless drug manufacturers offered the payer substantial discounts or rebates.[7] Frustrated again by continued increases in prescription drug spending, more recently many plans have increased the levels of prescription drug copayments at all three tiers, with the third tier copayment as high as $40 or $50 per prescription, while other plans have turned to coinsurance rather than copayment designs. According to one source, in 2000 the average patient retail copayment for a generic first tier drug was $7.17, that for preferred brands in the second tier was $14.14, while that for all other nonpreferred brands on the third tier was $27.35.[8]

The increased use of multi-tier copayment design mechanisms for prescription drugs raises at least two sets of important issues: (i) do variations in copay structures alter the level and composition of prescription drug utilization? Are they effective instruments in controlling prescription drug costs?[9] and (ii) to the extent three-tier copays affect the level and composition

of drug utilization, what are the associated health outcomes? Can copayment design mechanisms be used not only to control costs, but also to steer utilization to more medically appropriate uses of prescription drugs?[10] In this paper, we examine the first question in detail but leave the second question for future research. We also examine variation over time and among plans involving copayments for other medical services, such as physician office visits, emergency room treatments, and inpatient hospitalizations.

We address these issues using the therapeutic class of asthma medications as a case study. As described in further detail below, asthma drugs can be envisaged as being primarily "reliever" medications (used to relieve symptoms in an acute asthmatic exacerbation -- an asthma "attack"), or as being primarily "controller" medications (used to control pulmonary inflammation and prevent an "attack"). Health care officials have argued that the appropriate use of controller medications can result in reduced outpatient office visits, emergency room treatments and inpatient hospitalizations. While the optimal ratio of asthma controller to reliever drug utilization is difficult to quantify precisely (and likely is patient idiosyncratic), it is widely believed that in most cases increases in the controller/reliever ratio are beneficial, both in terms of economic and medical considerations (Gottlieb, Belser, and O'Connor [1995]; Frischer, et al. [1999]; Shelley, et al. [2000]). Interestingly, a recent historical overview of trends in asthma pharmacotherapy between 1978 and 2002 by Stafford et al. [2002] suggests that particularly in the last decade, the controller/reliever ratio has increased while the number of asthma-related office visits has stabilized or declined.

Before proceeding with a discussion of hypotheses to be tested, underlying data and econometric methods, we first digress and provide some medical background on asthma and its treatment.

II. BACKGROUND ON ASTHMA AND ITS TREATMENT

Asthma is a chronic disease characterized by inflammation of the airways and constricted bronchial tubes. Asthma affects about six percent of the population and is the third most common chronic condition among children. Although death from asthma is fairly unusual, morbidity from the condition is common. Since 1991, when consensus guidelines on the treatment of asthma were first released by the National Asthma Education Program [1991], clinicians have encouraged the use of maintenance therapy, typically using inhaled corticosteriods to "control" inflammation and to reverse chronic airway obstruction and hyper-reactivity. Other medications, particularly the short-acting beta-two agonists class of bronchodilators, are recommended to be reserved for "relief" of acute episodes of bronchospasm (Jain and Golish [1996]; Majeed, Ferguson, and Field [1999]; Nestor, et al. [1998]; Suissa, et al. [1994]).

A number of published articles have examined the benefits that have accrued as the preference of "controller" to "reliever" medications as maintenance therapy for asthma has gained acceptance (Majeed, Ferguson, and Field [1999]; Nestor, et al. [1998]; Suissa, et al. [1994]; Laumann and Bjornson [1998]; Donahue, et al. [1997]). Some of these articles have attempted to correlate a particular metric, commonly called the "C/B ratio" (ratio of inhaled corticosteroids to bronchodilators) with population-wide changes in survival and medical services utilization (Frischer, et al. [1999]; Shelley, et al. [2000]). Greater use of inhaled corticosteriods relative to bronchodilators has been reported to be associated with lower mortality rates and less frequent use of emergency room, inpatient and outpatient services in the care of patients with asthma (Gottlieb, Belser, and O'Connor [1995]).

III. HYPOTHESIS TO BE TESTED/ASSESSED EMPIRICALLY

We empirically assess the effects of several benefit plan design features on asthma treatment patterns. In particular, we test the hypothesis that higher controller/reliever copay ratios will be associated with reduced use of controller medications, other things being equal. We also test whether higher levels of asthma copayments for asthma drugs are associated with reduced use of asthma medications and, if so, whether these effects differ by plan type (FFS versus non-FFS plans). Finally, we examine whether provider prescribing patterns influence patient-level asthma treatment patterns and, if so, whether these effects differ between FFS and non-FFS plans.

IV. DATA SOURCES AND CONSTRUCTION OF VARIABLES

The MarketScan™ private insurance database for 1995–2000 was used in this study. MarketScan™ is the largest database of its kind, containing detailed descriptions of inpatient, outpatient medical, and outpatient prescription drug services for approximately three million persons in 2000 who were covered by corporate-sponsored healthcare plans. These individuals' healthcare was provided under a variety of fee-for-service (FFS), fully capitated, and partially capitated health plans, including exclusive provider organizations, preferred provider organizations, point of service plans, indemnity plans, and health maintenance organizations.

Race, ethnicity, and income information were extracted from the Bureau of Health Professions Area Resource File (ARF), a compendium of county-level information produced annually, and merged with the MEDSTAT analytic file by county.

Identification of asthma patients

Patients with evidence of asthma were selected from the intersection of the claims, encounter, enrollment, and pharmaceutical data files. Evidence of asthma was provided by searching the claims data during 1995–2000 for individuals meeting any of the following criteria:

- At least two outpatient claims with primary or secondary diagnoses of asthma; or
- At least one emergency room claim with primary diagnosis of asthma, and a drug transaction for an asthma drug 90 days prior or 7 days following emergency room claim; or at least one inpatient claim with a primary diagnosis of asthma; or
- A secondary diagnosis of asthma and a primary diagnosis of respiratory infection in an outpatient or inpatient claim; or at least one drug transaction for a(n): anti-inflammatory agent; oral anti-leukotrienes; long-acting bronchodilators; inhaled or oral short-acting beta-agonists;

Patients with a diagnosis of chronic obstructive pulmonary disease (COPD), who had one or more diagnosis or procedure codes indicating pregnancy or delivery, or who were not continuously enrolled for 24 months were excluded from our study group.

Measures

Socio-demographic characteristics. The sociodemographic characteristics included the: age of the head of the household; percent female; geographic region (Northeast, North Central, South, West, and unknown); member type, and year of entry into the study. In addition, several socio-demographic variables defined at the county level were merged onto the patient-level data. These variables included racial composition (%White, %Black, %Other), and income strata.

Plan Type. Fee-for service plans were defined as plans that did not have an incentive for patients to use a particular list of providers, including basic, major medical, and comprehensive health insurance coverage. The remaining plans, called non-FFS, were defined as plans that either required patients to choose from a list of providers or provided financial incentives to use a specific list of providers. Non-FFS plans included: exclusive provider organizations, health maintenance organizations, non-capitated point-of-service plans, preferred provider organizations, or capitated or partially-capitated point-of-service plans.

Copayments. Copayments for outpatient pharmaceuticals were calculated by first stratifying all prescription drug claims by year, then by plan within year. Next, we calculated the average out-of-pocket patient copayments for asthma drugs by therapeutic class for each plan, as well as the ratio of controller copayments to reliever copayments. These plan level ratios were then attached to each patient's record within a given plan.

We also constructed variables for the average out of pocket copayments paid for outpatient physician visits, emergency room visits, and hospital stays. The average copayment captured the actual dollar amount that the patients paid out of pocket. Note that we use the term "copayment" to refer to any out-of-pocket payment by individuals for health care. This includes both traditional copayments (e.g., $5 per office visit) as well as coinsurance (e.g., patient pays 20% of the bill).

Co-morbidities. A number of asthma-related co-morbidities were examined. These included allergic rhinitis, anxiety, depression, gastroesophageal reflux disease (GERD), and migraine. The number of unique ICD-9 codes (International Classification of Diseases, Ninth Revision) was used as a proxy for extent of overall medical and mental health comorbidities.

Charlson Index scores were generated to capture the level and burden of comorbidity. This index draws upon diagnostic information from ICD-9 codes and procedure codes, resulting in nineteen conditions that are weighted based on the adjusted risk of one-year mortality. The index score is the sum of the weights for all of a patient's conditions and ranges from one to six, with higher numbers indicating increased levels of comorbidity (Charlson et al. [1987]). The Index has been highly effective in predicting clinical outcomes and costs (Charlson et al. [1987]; Beddhu et al. [2000]). Of particular importance for our research, a recent study found that high levels of co-morbidity, as measured by the Charlson Index, were strongly associated with the underuse of inhaled steroid therapy in elderly patients with asthma (Sin and Tu [2001]).

Utilization. Utilization of healthcare services or prescription drugs was captured through claims and encounters over the study period. For individuals, we examined the mean number of emergency room visits, hospitalizations, hospital days, outpatient visits, and allergy/asthma specialist visits. Prescription drugs for treatment of persons with asthma were categorized as either "controller" or "reliever" medications. Controllers included: inhaled anti-inflammatory agents, oral corticosteroids, oral anti-leukotrienes, and long-acting bronchodilators; relievers were defined as drugs categorized as anticholinergics or inhaled short-acting beta-agonists. Based on this dichotomy a ratio of controller to relievers was examined as a measure of adequate management of asthma.

Costs. The analytic file contains patients with fee-for-service health plans and those with partially- or fully-capitated plans. However data on costs were not available for the capitated plans. Therefore the value of patients' service utilization under the capitated plan was priced and imputed using average payments from the MarketScan™ FFS inpatient and outpatient services by region, year, and procedure.

V. ECONOMETRIC METHODS

To reduce the potential for endogeneity between plan level copayment variables and plan level controller/reliever ratios in the multivariate analyses, we examined a discrete counterpart to the plan-level controller/reliever ratio examined in the descriptive analyses. In particular, we constructed a patient-level dependent variable with four mutually exclusive categories: controller drug alone, combination of a controller drug and a reliever drug, reliever drug alone, and no drug treatment. A likelihood ratio test was carried out to examine whether separate models were required for the FFS and non-FFS samples. Based upon the results of this test, we estimated separate multinomial logit models for the FFS and non-FFS subsamples. County-level race and income variables were appended to patient records to augment the medical claims. Robust standard errors were used to adjust for potential intra-county covariance among patients living in the same counties that may have been introduced by these variables.

In this paper, we do not examine the implications of treatment patterns on subsequent health care utilization. However, we do explore whether plan-level copayments and provider prescribing patterns might serve as identifying variables in future studies using instrumental

variables or parametric selection bias models to control for unobserved factors correlated with treatment that may also be correlated with patient outcomes.

VI. DESCRIPTIVE RESULTS

Using our asthma episode definitions, the sample included 44,926 patients in FFS plans and 18, 305 in non-FFS plans (63,231 patients in total).

Controller/Reliever Ratio. As shown in Figure 1, the controller/reliever ratio has been rising over time. Between 1995 and 1999, it increased by approximately 45%—appearing to increase more rapidly in recent years. The ratio is consistently higher for FFS plans than for non-FFS plans and, since 1997, the rate of increase appears to be higher for the FFS plans than for non-FFS plans. However, irrespective of plan type, almost all plans had average controller/reliever ratios greater than one (data not shown).

Patient Demographics. Table 1 reports the demographic characteristics of the sample, stratified by FFS and non-FFS plans. Patients in FFS plans had a mean age of 34 years compared to 27 years for non-FFS plans ($p<.001$) and were more likely to be female (57% versus 52%, $p<.001$). Patients in FFS plans were also more likely than patients in non-FFS plans to be located in the North Central region (67% versus 9%, $p<.001$), as well as more likely to receive their health care coverage as the employee rather than as the spouse or dependent (41% versus 37%, $p<.001$).

County Race and Income. Substantial differences in racial distribution and mean income between FFS and non-FFS plans were evident from county-level Census data linked to the claims data. The mean household county income of patients covered by FFS plans ($27,001)

was significantly lower than that for patients covered by non-FFS plans ($31,223) (p<.001). Interestingly, the racial distribution of counties for patients covered by FFS plans was less likely to be white than that of non-FFS plans.

Health Status. Patients in FFS plans appear to be sicker than those in non-FFS plans. As reported in Table 2, patients in FFS plans have higher numbers of major diagnostic categories, higher Charlson comorbidity scores and higher rates of comorbidities of allergic rhinitis, depression, gastrointestinal disorders, and migraine (p<.001 for all comparisons). The rate of comorbid anxiety was not statistically different between FFS and non-FFS plans (p=0.78). Similar patterns were evident both for patients ages 4-11 and those ages 12-64.

Copayments. Table 3 indicates that prescription drug copayments are significantly higher in non-FFS plans than in FFS plans for both asthma medications and nonasthma medications. Across all drugs and all years (1995-2000) the average out of pocket copayment made by patients in non-FFS plans was $8.64 compared to $5.20 in FFS plans (p<.001). However, as shown in Figure 2, average controller/reliever copayment ratios were higher in FFS plans than in non-FFS plans—consistent with the higher controller/reliever medication ratios of FFS plans. In both types of plans the controller/reliever ratio has been rising over time in conjunction with the increased use of controller medications.

The mean copayments reported in Table 3 mask considerable variation in copayments over time and across plans. Figure 3 illustrates that out-of-pocket copayments for asthma medications have been consistently higher for patients in non-FFS plans compared to patients in FFS plans. Although both patients in both types of plans experienced significant jumps in out-of-pocket copayments beginning in 1998, the gap between FFS and non-FFS plans appears to have narrowed. In addition, to trends over time, there is high variation in copayment levels for

specific drugs within year. For example, in 1999, copayments for fluticasone, an inhaled corticosteroid (a controller medication), varied from $2 in one plan to $28 in another plan. Similarly, 1999 copayments for albuterol, a short-acting beta agonist (a reliever medication), ranged from $2 to $12 across plans.

Figure 4 reports the trend in the ratio of total payments for controller versus reliever prescription drug claims, alongside the trend in the ratio of patient out-of-pocket copayments for these medications. Both ratios show an upward trend--largely reflecting the increased use of controller medications. However, it is clear that the total payment ratio is rising at a steeper rate than the copayment ratio. This suggests that, although large employers and health plans are using copayments to help manage rising prescription drug costs, they appear to be absorbing more of the cost than they are passing on to beneficiaries in the form of higher copayments.

Average copayments for outpatient visits, emergency room visits, and inpatient visits also differed between non-FFS and FFS plans (Table 3). Although statistically significant, copayments for outpatient visits and emergency room visits were fairly similar across non-FFS and FFS plans. In contrast, copayments for inpatient stays were significantly and materially higher among patients covered by FFS plans than those covered by non-FFS plans ($16.12 versus $2.78, respectively, $p<.001$).

Medication Use. Table 4 summarizes the medication use of asthma patients covered by non-FFS and FFS health plans. Patients covered by FFS plans have a higher ratio of controller to reliever medications than patients in non-FFS plans (1.49 versus 1.17, $p<.001$), as well as a higher number of asthma prescriptions (4.89 versus 4.17, $p<.001$). With the exception of leukotriene modifiers, patients in FFS plans have more days of therapy and higher units dispensed for each therapeutic class of asthma medication than patients in non-FFS plans

(p<.001 for all comparisons). For leukotriene modifiers, days of therapy and units dispensed were higher for asthma patients covered by non-FFS plans (p<.001).

The most commonly prescribed asthma medications were the short acting beta agonists (SABAs). Patients in non-FFS plans were somewhat more likely than patients in FFS plans to be prescribed SABAs, oral steroids, and leukotriene modifiers; they were less likely to be prescribed bronchodilators, inhaled steroids, and anticholinergics (p<.001 for all comparisons).

Health Care Utilization. Table 5 reports the health care utilization of patients in non-FFS and FFS plans. For each measure—emergency room visits, hospitalizations, hospital days, and outpatient visits—utilization was higher in FFS plans than in non-FFS plans (p=0.09 for all comparisons). Thus, despite higher controller/reliever medication ratios, health care utilization was higher in FFS plans than in non-FFS plans. However, this association is likely confounded by the greater average age and level of disease severity of patients covered by FFS plans (Table 2).

VII. ECONOMETRIC FINDINGS

FFS Model. Table 6 reports the results of a multinomial logit model of the log odds of a patient receiving controller medication alone, a controller and a reliever (combination therapy), or a reliever medication alone relative to no medication. Separate models were estimated for FFS and non-FFS plans after the results of a likelihood test ($\chi^2=$) indicated that separate analyses were warranted. No statistically significant effects of region or gender were found. Adults were more likely to receive a controller alone and less likely to receive a reliever alone relative to no drug treatment. However, adult status was not a statistically significant predictor of combination therapy relative to no drug treatment.

We also included county-level variables from the Census as proxies for the income and race of patients--variables not available directly from the claims. None of these variables was statistically significant.

The presence of allergic rhinitis reduced the odds of getting a controller alone or a reliever alone relative to no drug therapy; it was not a statistically significant predictor of combination therapy. The presence of sinusitis was associated with increased odds of getting all three treatment options relative to no drug therapy. Interestingly, the number of unique 3-digit ICD-9 codes was positively associated with the log odds of getting a controller alone, or a controller plus reliever, but negatively associated with the log odds of getting a reliever alone. None of the other comorbidity variables (migraine, depression, GI disorders, or anxiety disorders) were statistically significant.

None of the variables measuring out-of-pocket copays for controller medications, the ratio of controller to reliever copays, mean copays for all asthma medications, nor the interactions of these variables with year dummies was found to be statistically significant determinants of the controller/reliever ratio. On the other hand, the medication ratios measuring provider prescribing preferences were highly significant determinants for all three medication patterns, relative to no drug treatment.

Non-FFS Model. Table 7 reports the results of the corresponding multinomial logit model for patients in non-FFS plans. Living in the Northeast or the West reduced the odds of receiving all of the pharmaceutical treatment options relative to no drug treatment. No statistically significant effects of gender were found. Adults were more likely to receive a controller alone and less likely to receive either combination therapy or a reliever alone relative

to no drug treatment. As in the FFS model, none of the county-level income or race variables from the Census was statistically significant.

The presence of allergic rhinitis reduced the odds of getting combination therapy or a reliever alone relative to no drug therapy; it was not statistically significant for controller therapy alone. The presence of sinusitis was associated with increased odds of getting combination therapy relative to no drug therapy but was not a significant predictor of controller or reliever therapy alone. Higher numbers of unique 3-digit ICD-9 codes reduced the odds of getting a reliever alone relative to no drug therapy but was not associated with the odds of getting a controller alone or a controller plus reliever. None of the other comorbidity variables (migraine, depression, GI disorders, or anxiety disorders) was statistically significant.

As with the FFS model, none of the variables measuring out-of-pocket copays for controller medications, the ratio of controller to reliever copays, mean copays for all asthma medications, nor the interactions of these variables with year dummies were found to be statistically significant determinants of the controller/reliever ratio. On the other hand, the medication ratios measuring provider prescribing preferences were highly significant determinants for all three medication patterns, relative to no drug treatment. Higher levels of the plan controller percentage and the combination percentage were associated with an increased odds of receiving a controller relative to no drug therapy. Higher levels of the combination percentage were associated with higher odds of receiving combination therapy. Finally, higher levels of the reliever percentage and the combination percentage were associated with a higher odds of getting a reliever medication.

VIII. DISCUSSION AND LIMITATIONS

This study describes the patterns of medication use among patients with asthma, and examines the relationship of these patterns with other forms of health care utilization, using a dataset encompassing more than two million covered lives. The average controller/reliever ratios were found to be greater than one, both for members of non-FFS (1.17) and FFS (1.49) plans. Moreover, the controller/reliever medication ratio has been consistently rising over time, suggesting that the clinical practices they embody reflect a considerable degree of acceptance of the consensus guidelines, and the supporting research literature.

Theoretically, we would expect higher relative prices for controller to reliever medicines to be associated with a lower controller/reliever ratio, other things equal. However, teasing this out statistically is more complex. Shifts in the composition of drugs in the controller and reliever classes, and changes in plan design, could cause the ratio of controller to reliever copays to either rise or fall over time. As shown in Figure 1, the controller/reliever medication ratio has been trending upward over time, although after controlling for other variables we did not find a statistically significant relationship between out-of-pocket copayments and asthma treatment patterns. Figure 4 indicates that total payments have been rising more rapidly than copayments—suggesting that health plans and large employers are reluctant to increase copayments for covered beneficiaries at the same rate that total payments have increased.

The observation that the prescribing of all classes of asthma medications (except leukotriene modifiers) was greater among members of FFS plans is generally consistent with the findings that these patients are “sicker” than their counterparts in non-FFS plans, as measured by the number of co-morbid conditions and higher levels of health care utilization. Asthma patients

covered by FFS health plans made more extensive use of all other types of health services we examined, including inpatient hospitalizations, use of emergency services and ambulatory visits.

The principal objective of this study has been to examine whether and how the characteristics of health plan coverage as part of the employee benefits affects the therapy selection decision among patients with asthma. The preponderance of clinical literature now suggests that patients with asthma experience more favorable clinical courses when they make regular use, often several times daily of inhaled corticosteriods, leukotriene modifiers, or other medications that "control" inflammation and reversible airway disease. In the descriptive analysis, we found that the controller/reliever ratio continued to rise (and its increase even accelerated in recent years) despite rising medication copays. However, this apparent association between mean copayments at the plan level and plan-level controller/reliever ratios is potentially endogenous. For example, if mean copayments are higher for controller medications than reliever medications, growing use of controllers would result in a rising mean copayment ratio for controller-to-reliever medications. That is, at the plan level, the direction of influence between the controller-to-reliever copayments and the controller/reliever ratio could go both ways. To reduce the endogeneity problem, we examined the effect of plan-level copayment variables on individual treatment choices. When we did so, no statistically significant association was found. It is possible that this lack of association resulted from an understatement of the size of out-of-pocket copayments. This understatement is due to the averaging of patient copays across asthma drugs and years at the plan level in an effort to reduce the number of degrees of freedom consumed by plan-, drug-, and year-specific copayments. Most of the large copayment increases have occurred since 1999. Plans that instituted very large copayment increases for certain asthma drugs may, indeed, have shifted asthma treatment patterns.

However, in our analysis these more recent changes were aggregated with earlier experience of patients where copayment changes were not as common, nor as large. Thus, we expect that there is a downward bias in our estimate of the copayment effect that deserves further scrutiny.

On the other hand, we found that provider prescribing patterns were strongly associated with patient treatment patterns and that the nature of this association differed somewhat for patients in FFS and non-FFS plans.

In addition to the specific statistical issues already discussed, the conclusions from our analysis should be viewed in light of the limitations common to most retrospective studies. In particular, although we have attempted to correct for selection bias associated with patients having higher versus lower controller to reliever ratios, other sources of selection bias may remain. For example, the MarketScan claims data used in the analysis lack clinical measures of symptom severity (e.g., FEV-1 values). In addition, missing data on regional location could have introduced bias due to geographical variations in asthma treatment practice patterns.

Although future work is unlikely to be able to control for all sources of selection bias in retrospective database studies of the type reported here, the provider prescribing pattern variables appear to offer promise as identifying variables. For example, future work could use instrumental variables or parametric selection models to control for unobserved factors associated with both treatment selection and outcomes when examining the effects of asthma treatments on health care utilization. This general approach is likely to have broad applicability to other medical conditions and treatments as well.

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FOOTNOTES

[1]See Zeckhauser [1970] for a seminal discussion. For more recent analyses, see the exchanges among Nyman [1999], Blomqvist [2001], and Manning and Marquis [1996,2001].

[2]For evidence from the RAND Health Insurance Experiment, see Newhouse [1993], Manning et al. [1986], Leibowitz, Manning and Newhouse [1985], and Marquis [1985]. More recent evidence for a more aged population is given in Feenberg and Skinnner [1994].

[3] The term *copayment* typically refers to fixed payments by the individual for service received (e.g., five dollars for each generic prescription); *coinsurance* typically refers to a fixed percentage payment by the individual (e.g., 20% of the retail price of the drug). In this paper, we use the term copayment to refer to any out of pocket payments by consumers for drugs or other services.

[4]Berndt [2002]; also see Berndt [2001].

[5]IMS Health [2002].

[6]For policies and impacts of changing prescription drug cost-sharing provisions in Canada, see Alan et al. [2002], Grootendorst [2002], Poirier et al. [1998] and Tamblyn et al. [2001].

[7]For further discussion, see Berndt [2002] and the references cited therein.

[8]See Pharmacy Benefit Management Institute [2001].

[9]For related empirical evidence (much of it quite dated), see Harris et al. [1990], Johnson et al. [1997], Leibowitz, Manning and Newhouse [1985], Marquis [1985] and Smith [1993].

[10]For related empirical analyses, see Keeler et al. [1985], Leibowitz et al. [1985], and Newhouse [1993].