

# Health Affairs

---

At the Intersection of Health, Health Care and Policy

Cite this article as:

Niteesh K. Choudhry, Michael A. Fischer, Benjamin F. Smith, Gregory Brill,  
Charmaine Girdish, Olga S. Matlin, Troyen A. Brennan, Jerry Avorn and William H.  
Shrank

Five Features Of Value-Based Insurance Design Plans Were Associated With Higher  
Rates Of Medication Adherence

*Health Affairs*, , no. (2014):

doi: 10.1377/hlthaff.2013.0060

The online version of this article, along with updated information and services, is  
available at:

<http://content.healthaffairs.org/content/early/2014/02/07/hlthaff.2013.0060.full.html>

**For Reprints, Links & Permissions:**

[http://healthaffairs.org/1340\\_reprints.php](http://healthaffairs.org/1340_reprints.php)

**E-mail Alerts :** <http://content.healthaffairs.org/subscriptions/etoc.dtl>

**To Subscribe:** <http://content.healthaffairs.org/subscriptions/online.shtml>

*Health Affairs* is published monthly by Project HOPE at 7500 Old Georgetown Road, Suite 600, Bethesda, MD 20814-6133. Copyright © 2014 by Project HOPE - The People-to-People Health Foundation. As provided by United States copyright law (Title 17, U.S. Code), no part of *Health Affairs* may be reproduced, displayed, or transmitted in any form or by any means, electronic or mechanical, including photocopying or by information storage or retrieval systems, without prior written permission from the Publisher. All rights reserved.

---

Advance online articles have been peer reviewed and accepted for publication but have not yet appeared in the paper journal (edited, typeset versions may be posted when available prior to final publication). Advance online articles are citable and establish publication priority; they are indexed by PubMed from initial publication. Citations to Advance online articles must include the digital object identifier (DOIs) and date of initial publication.

Not for commercial use or unauthorized distribution

By Niteesh K. Choudhry, Michael A. Fischer, Benjamin F. Smith, Gregory Brill, Charmaine Girdish, Olga S. Matlin, Troyen A. Brennan, Jerry Avorn, and William H. Shrank

DOI: 10.1377/hlthaff.2013.0060  
HEALTH AFFAIRS 33,  
NO. 3 (2014): -  
©2014 Project HOPE—  
The People-to-People Health  
Foundation, Inc.

# Five Features Of Value-Based Insurance Design Plans Were Associated With Higher Rates Of Medication Adherence

**ABSTRACT** Value-based insurance design (VBID) plans selectively lower cost sharing to increase medication adherence. Existing plans have been structured in a variety of ways, and these variations could influence the effectiveness of VBID plans. We evaluated seventy-six plans introduced by a large pharmacy benefit manager during 2007–10. We found that after we adjusted for the other features and baseline trends, VBID plans that were more generous, targeted high-risk patients, offered wellness programs, did not offer disease management programs, and made the benefit available only for medication ordered by mail had a significantly greater impact on adherence than plans without these features. The effects were as large as 4–5 percentage points. These findings can provide guidance for the structure of future VBID plans.

Copayments, coinsurance, deductibles, and other benefit structures are widely used to contain health care spending by encouraging patients to consider the costs of health services before deciding to purchase them. Cost sharing helps address the overconsumption that may result from generous insurance coverage (a type of “moral hazard,” in economic terms).<sup>1</sup> However, it may also lead patients to reduce their use of high-value services.<sup>2</sup> Value-based insurance design (VBID) plans seek to avoid this problem by setting cost-sharing amounts in inverse relationship to the clinical benefit that an intervention offers.<sup>3</sup>

The peer-reviewed literature supports the ability of copay reductions to increase the use of essential medication and improve clinical outcomes without increasing overall health spending.<sup>4–9</sup> As a result, VBID plans have been adopted by many employers and health plans throughout the United States.<sup>10</sup> In addition, the Affordable Care Act calls for the creation of guidelines to facilitate the broader use of VBID plans.

VBID plans all reduce cost sharing for medi-

cations used to treat chronic disease. However, the plans differ in a number of important ways. Some plans target members who meet specific clinical criteria; others reduce copays for all members. Some plans eliminate cost sharing; others only reduce it. Some plans concurrently offer disease management and wellness programs; others do not.

We sought to understand the influence of these and other plan characteristics on how VBID plans affect medication adherence. Based on our results, we identify best practices for the future implementation of VBID plans.

## Study Data And Methods

**SETTING AND PLAN CHARACTERISTICS** We identified VBID plans introduced by a large pharmacy benefit manager, CVS Caremark, on behalf of fifty-nine employer-based plan sponsors between 2007 and 2010. We classified plans according to whether or not they had the following six characteristics that we hypothesized would influence a VBID plan’s impact on medication adherence: targeting high-risk patients only, pro-

**Niteesh K. Choudhry** (nchoudhry@partners.org) is an associate professor at Harvard Medical School and an associate physician in the Division of Pharmacoeconomics, Brigham and Women’s Hospital, in Boston, Massachusetts.

**Michael A. Fisher** is an associate professor at Harvard Medical School and an associate physician in the Division of Pharmacoeconomics, Brigham and Women’s Hospital.

**Benjamin F. Smith** was a research assistant in the Division of Pharmacoeconomics, Brigham and Women’s Hospital at the time this work was done. He is now a technician at Bozeman Deaconess Hospital, in Bozeman, Montana.

**Gregory Brill** is a statistical programmer in the Division of Pharmacoepidemiology and Pharmacoeconomics, Brigham and Women’s Hospital.

**Charmaine Girdish** is director of prospective analytics, CVS Caremark, in Woonsocket, Rhode Island.

**Olga S. Matlin** is senior director of analytic development, CVS Caremark.

**Troyen A. Brennan** is executive vice president and chief medical officer at CVS Caremark.

**Jerry Avorn** is a professor of medicine at Harvard Medical School and in the Division of Pharmacoepidemiology and Pharmacoeconomics, Brigham and Women's Hospital.

**William H. Shrank** was an assistant professor at Harvard Medical School and an associate physician in the Division of Pharmacoepidemiology and Pharmacoeconomics, Brigham and Women's Hospital at the time this work was done. He is now chief scientific officer at CVS Caremark.

viding generous benefits (in the form of copay reductions), eliminating copay tiers, offering a disease management program, offering a wellness program, and making the benefit available for prescriptions filled by mail order only (see online Appendix Exhibit A for a classification of VBID plans).<sup>11</sup>

We categorized plans into three mutually exclusive groups according to how patients were targeted: plans that targeted high-risk patients (for example, high-risk patients with hypercholesterolemia were those who had experienced a cardiovascular event); those that required patients to engage in some behavior, such as completing a health risk assessment, to qualify for reduced copays; and those that lowered copays for all patients who were prescribed a drug, regardless of indication, risk level, or other behaviors. We hypothesized that plans targeting high-risk patients would be more effective than plans in the other two types, and therefore we grouped the other two types together.

We defined plans as having generous copay reductions if copays for generic drugs were \$0 and copays and coinsurance for brand-name drugs were no more than \$10 and 15 percent, respectively. Plans were considered to have no tiers if copays were identical for generic and brand-name medications.

We classified plans as having a disease management or wellness program if the program was available when the VBID plan was implemented. We included plans that introduced these programs concurrently with the start of their VBID plan because we hypothesized that the existence of these programs, not when they were introduced, was the most critical factor. We explored the implications of these decisions in our sensitivity analyses.

The presence or absence of some of these features (for example, whether the plan sponsor offered a wellness program) could not be determined using administrative data sources. Therefore, we surveyed plan sponsors and their CVS Caremark account team managers to obtain supplementary information. We achieved a 90 percent response rate from the sponsors (fifty-three of fifty-nine sponsors). Four plan sponsors had terminated coverage with CVS Caremark and could not be surveyed; the account teams for two plan sponsors had begun their employment after the VBID programs went into effect and thus did not have the information necessary to respond to our survey. For the thirty-three sponsors that we ultimately included in our analysis, the response rate was 100 percent.

**STUDY COHORT** We restricted our analysis to clinical conditions for which there was at least one plan with and one plan without each of the

six characteristics of interest described above. We excluded plans without at least twelve months of pre- and post-implementation data and plans whose average observed copays differed from those reported by the plans. The remaining seventy-six VBID plans provided by thirty-three plan sponsors formed our final study cohort.

**ANALYTICAL APPROACH** We used an interrupted time series design with a concurrent control group. This is the strongest quasi-experimental method for use in evaluating the longitudinal effects of time-delimited interventions.<sup>12</sup> We compared medication adherence after the implementation of VBID with a particular design characteristic (for example, maintaining copay tiers) with the level of adherence that would have been expected for these plans. We did this by extrapolating the pre-implementation trends in adherence into the future.

Our models also adjusted for trends among plans that did not have the particular design characteristic (for example, those that eliminated copay tiers). In other words, VBID plans without a characteristic served as concurrent controls for those with it.

To perform our analyses, we linked the survey responses described above with prescription claims data and client-specific lists of medications affected by the copay changes. All person-specific identifying factors were transformed into anonymous, coded study numbers to protect patients' privacy. The Institutional Review Board of Brigham and Women's Hospital approved the study.

**COHORT ELIGIBILITY** To conduct our analysis, we identified the date when each VBID program was implemented to establish a pre- and post-implementation period. We created separate cohorts for conditions (such as diabetes and hypertension) within each plan sponsor that we evaluated and applied the same criteria used by the actual plan. For example, we restricted copay reductions for diabetes medications to those patients with cardiovascular disease, if a plan required this restriction.

Patients entered each cohort on their "index" date—the day when they filled their first eligible prescription between eighteen months prior to and twelve months after the implementation of the VBID program. To mirror how the plans were actually implemented, patients could enter a cohort at any point before or after the VBID plan went into effect, were not required to maintain a minimum period of continuous enrollment, and left the cohort when they lost eligibility for the plan.

**MEDICATION ADHERENCE** We calculated the proportion of days in each month for which pa-

# The structure of VBID programs strongly influences their ability to increase medication adherence.

tients had medication available to them, starting with their index date. This gave us patients' monthly proportion of days covered. All drugs dispensed within a therapeutic class, such as sulfonyleureas, were considered to be interchangeable.

When a dispensing occurred before previously dispensed medication should have run out, we assumed that use of the new medication began the day after the previous supply ran out. If a patient had more than 180 days of medication on hand on any given day, we reduced the accumulated supply to 180 days. We did this so that our analysis was not biased by a small minority of patients who stockpiled large supplies of medications. The proportion of days covered was calculated by dividing the number of days of medication available to each patient in a given month by the number of calendar days in that month.

This method and all other claims-based techniques for calculating adherence creates an artifact: All patients appear to be 100 percent adherent in the first month after they enter a cohort, even if they had previously been less adherent. Therefore, we allowed patients to enter the study cohort up to eighteen months prior to the beginning of the VBID program, but we considered only twelve months of pre-implementation data in our models.

For conditions treated with more than one drug class, such as oral hypoglycemics for diabetes, adherence was calculated as the average of all classes whose use patients had initiated. Patients who qualified for more than one plan were considered separately in each plan.

**STATISTICAL ANALYSIS** To study the effect of the benefit design change on adherence, we plotted monthly adherence proportions for cohorts with and without each design feature, by disease, before and after copays were reduced. We then fit patient-level segmented linear regression models. Our models included a constant term, a linear time trend (which measured the pre-implementation trend), a binary indicator for exposure (such as having or not having a design

characteristic), and a binary indicator for the post-implementation period. Intervention effects were assessed with the interaction term between exposure and the post-implementation period parameter.

We controlled for correlated error terms with the use of generalized estimating equations and normally distributed errors. These models adjusted for repeated measures of adherence over time (up to twenty-four measures per patient) but not for the clustering of plans within sponsors.

We also adjusted for patients' age, sex, race, income, and comorbidities as of the date of their cohort entry. Data on socioeconomic status and race were obtained by linking patients' ZIP codes of residence with data from the US Census Bureau, which specified the median income and racial composition of the geographic population associated with each ZIP code. Income and race were dichotomized as being more or less than the median income or percentage of black residents, respectively, for the patients in our cohort. Comorbidities were assessed based upon fills for prescription medications in the six-month period prior to the index date.<sup>13</sup>

**SENSITIVITY ANALYSES** We conducted numerous analyses to assess the robustness of our findings. Instead of comparing plans that targeted only high-risk patients with plans that either reduced copayments for patients who engaged in a specific behavior or that lowered copayments for all patients who were prescribed a medication, we kept patient targeting in three groups and repeated our analysis.

Because we relied on copay amounts reported by the plans to categorize the generosity of VBID programs, we repeated our analyses using observed changes in cost sharing. To distinguish the effect of VBID from the effects of the few disease management and wellness programs that were introduced concurrently with VBID, we restricted our analysis to plans in which a disease management or wellness program was introduced prior to the start of the VBID program.

To confirm that the structure of our model did not influence our results, we repeated our analysis using a difference-in-differences design in which we eliminated the parameter for the linear time trend from our model. To capture relative—as opposed to absolute—changes in adherence, we repeated our analysis using a binary measure: the proportion of patients who were fully adherent to therapy. As an alternative method for modeling the marginal impact of given characteristics on the success of a VBID program, we compared plans that differed on only one characteristic.

Finally, to ensure that changes in the characteristics of patients enrolled in particular plans had not changed over time, we repeated our analyses considering only people who were continuously insured for the year prior to and the year after the start of the VBID program, even though this limited the external validity of our analyses to people who were stably insured for this entire time period. We also restricted our analyses to patients who had initiated therapy prior to the start of a VBID program, excluding those who did not initiate therapy in response to the lowered copays.

**LIMITATIONS** Our study has several potential methodological limitations. We used time-series analysis to conduct our evaluation, which is considered the strongest quasi-experimental design.<sup>12</sup> With this methodology, valid inferences about the importance of particular plan features can be made even if plans differ at baseline.<sup>14</sup> Nevertheless, three residual sources of bias remain with this approach.

First, our findings could have been influenced by changes in the characteristics of patients enrolled in particular plans over time (for example, because of adverse selection). The magnitude of the effects that we observed was generally smaller when we evaluated the subgroup of patients who were continuously insured for the year prior to and the year after the start of the VBID program. However, our results remained unchanged when we considered only people who had initiated therapy prior to the start of the program.

Second, it is possible that the improvements in medication adherence that we observed for some plans were the result of other simultaneous events, such as the introduction of other programs that might have influenced adherence or the introduction of more than one design change. A clear strength of our analysis is that we surveyed plan sponsors to capture information about common simultaneous interventions, and we attempted to disentangle their effects through the use of multivariable modeling.

Furthermore, when we restricted our analysis to plans in which disease management or wellness programs were introduced prior to the start of the VBID program, our findings were unchanged. This suggests that the presence or absence of such programs was more important than when they started. Nevertheless, other simultaneous events of which we are unaware—such as changes in copays for nondrug services, which might have influenced whether or not patients could afford their medications—could have influenced our results.

Third, we do not know the precise reasons why plans chose to introduce VBID with or without

other programs. It is possible that there were differences across plans that made beneficiaries in some plans more likely than those in other plans to respond to the new copay program. In that case, “confounding by indication” could have influenced our results. Similarly, because of the observational nature of our study, we might not have been able to fully disentangle the impact of any given plan characteristic from the impact of other characteristics. Thus, the estimates of effects in our regression models might be imprecise.

It is reassuring that our analysis evaluating the marginal impact of single program characteristics yielded results that were very similar to (although quantitatively larger than) those of our primary analysis. The inclusion of a control group of plans that had the design features we evaluated but that did not introduce a VBID program could have helped further minimize residual bias in our analysis. Of course, only a randomized trial could answer our question of interest with certainty.

Other limitations include our use of prescription refill claims to assess medication adherence. These data indicate what drugs patients purchased, but not necessarily what they consumed. However, validation studies have shown that the data are an accurate measure of actual medication-taking behavior.<sup>15</sup>

We evaluated adherence for patients taking multiple medications based on the average adherence with all classes of drugs whose use patients had initiated. This method might underestimate adherence for patients who appropriately discontinued therapy.<sup>16</sup>

Finally, all of the plans we studied were introduced by a single pharmacy benefit manager, which could influence the generalizability of our findings.

## Study Results

**PLAN AND PATIENT CHARACTERISTICS** Our sample consisted of 274,554 patients in seventy-six VBID plans provided by thirty-three unique plan sponsors (Appendix Exhibit B).<sup>11</sup> The characteristics of these plans and the patients enrolled in them are summarized in Exhibit 1 and in Appendix Exhibit C.<sup>11</sup> The majority of VBID plans did not have generous benefits, used copay tiers, and had a disease management program for the condition that the plan targeted.

In those plans with both disease management and wellness programs, the majority of the programs (88 percent and 85 percent, respectively) were introduced prior to the reduction in copays (data not shown). Few plans made the copay reduction available only if patients filled their

**EXHIBIT 1**
**Characteristics Of Plans And Patients In The Study Sample, By Condition**

	<b>Diabetes</b>	<b>High cholesterol</b>	<b>Hypertension</b>
Number of plans	32	23	21
Number of patients	78,264	143,925	203,895
<b>PATIENTS' DEMOGRAPHIC CHARACTERISTICS</b>			
Mean age (years)	54.8	58.8	57.3
Female (%)	48.4	45.0	50.8
Black (%)	1.7	1.6	1.7
Median income (\$)	45,075	47,461	46,211
Mean no. of Rx filled <sup>a</sup>	2.3	2.1	1.8
<b>PLAN CHARACTERISTICS (PERCENT OF PLANS)</b>			
Benefits targeted at high-risk patients			
Yes	13.9	12.5	7.0
No	86.2	87.5	93.0
Generous benefits <sup>b</sup>			
Yes	26.7	35.4	34.7
No	73.3	64.6	65.4
Copayment tiers			
Yes	75.9	73.3	71.1
No	24.1	26.7	28.8
Disease management program offered			
Yes	94.2	93.3	92.2
No	5.8	6.7	7.8
Wellness program offered			
Yes	77.7	78.7	76.0
No	22.3	21.3	24.0
Rx availability			
Mail only	7.5	4.0	7.7
Mail and retail	92.5	96.0	92.3
At least one of the above characteristics			
Yes	90.6	100.0	95.2
No	9.4	0.0	4.8

**SOURCE** Authors' analysis of prescription claims data from CVS Caremark. **NOTE** Percentages may not sum to 100 because of rounding. <sup>a</sup>Based on the six months prior to each patient's index date; see Study Data And Methods for more details. <sup>b</sup>No cost sharing for generic drugs and low monthly copays ( $\leq 10$  or less) or low coinsurance rates (15 percent or less) for brand-name medications.

prescriptions by mail (Exhibit 1). A minority of plans targeted high-risk patients. Twenty-five of the seventy-six plans (data not shown) required patients to enroll—and, in some cases, actively participate—in disease management to be eligible for reduced copays.

**ANALYSES EVALUATING DESIGN FEATURES INDEPENDENTLY** Monthly rates of medication adherence among plans with and without specific design features, before and after the VBID plans were introduced, are shown in Exhibits 2 and 3 and in Appendix Exhibit D.<sup>11</sup> Prior to the start of the VBID programs, plans that had a disease management or wellness program and that maintained copay tiers had higher levels of adherence than plans without these features. Medication adherence declined over time in all of the study cohorts. However, several plan characteristics were associated with a stabilization in the rate of decline after their implementation.

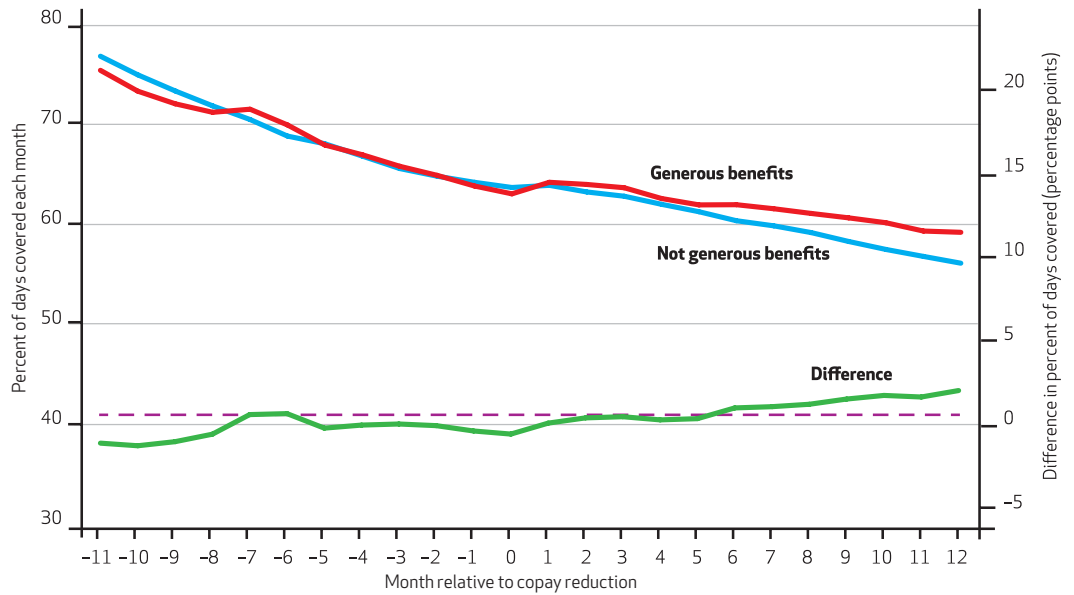
Exhibit 4 presents the results of time-series analyses (which adjust for baseline adherence

and trends in control plans) that evaluated each plan characteristic independently after patient characteristics were also adjusted for. Plans that provided more generous benefits, made the benefit available only for medication ordered by mail, retained copay tiers, had wellness programs, and did not have disease management programs had higher levels of adherence after their implementation than plans without these characteristics. For example, adherence was 3.3 percentage points (95% confidence interval: 2.9, 3.8) higher for plans targeting diabetes that retained tiers, compared to plans that eliminated tiers. In addition, plans that targeted high-risk patients had an increase in adherence after the VBID program was implemented, compared to plans that did not target such patients.

**ANALYSES EVALUATING DESIGN FEATURES SIMULTANEOUSLY** Analyses that simultaneously adjusted for multiple plan design features are also presented in Exhibit 4. In these analyses, the presence of copay tiers no longer consistent-

**EXHIBIT 2**

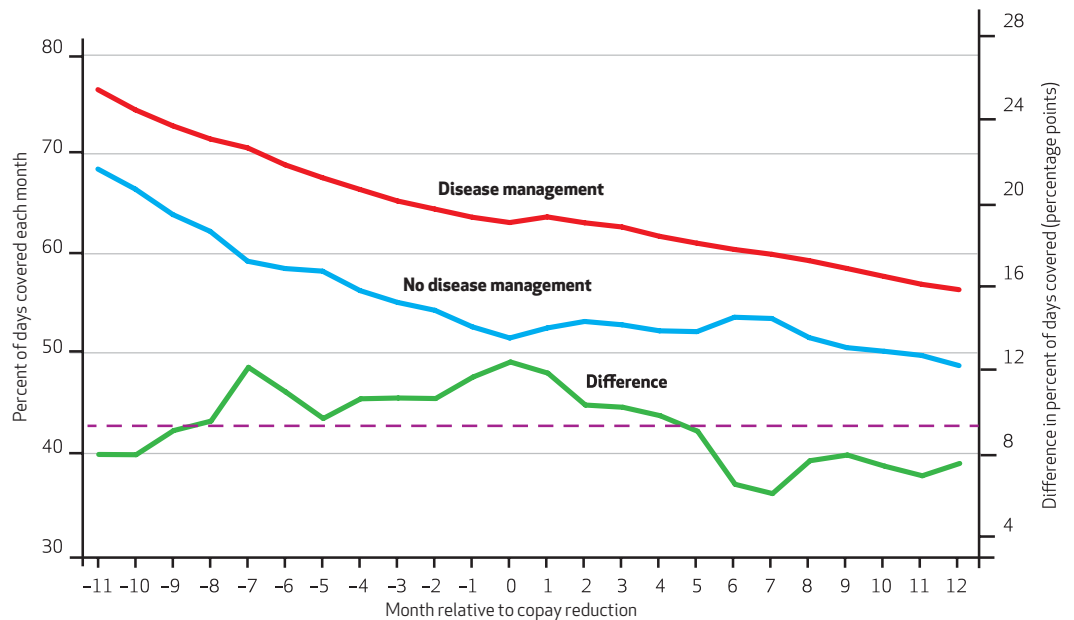
**Changes In Monthly Medication Adherence After The Implementation Of Value-Based Insurance Design (VBID), In Plans Targeting Diabetes, With And Without Generous Benefits**



**SOURCE** Authors' analysis of prescription claims data from CVS Caremark. **NOTES** Month 0 is when VBID was implemented. The red and blue lines represent monthly medication adherence for plans with and without generous benefits (see Exhibit 1), respectively, and relate to the left-hand y axis. The green line represents the differences in adherence between the two types of plans and relates to the right-hand y axis. The purple dashed line represents median difference in adherence (0.6 percentage point).

**EXHIBIT 3**

**Changes In Monthly Medication Adherence After The Implementation Of Value-Based Insurance Design (VBID) In Plans Targeting Diabetes, With And Without A Disease Management Program**



**SOURCE** Authors' analysis of prescription claims data from CVS Caremark. **NOTES** Month 0 is when VBID was implemented. The red and blue lines represent monthly medication adherence for plans with a disease management program targeted at diabetes ("disease management") and without such a program ("no disease management"), respectively, and relate to the left-hand y axis. The green line represents the differences in adherence between the two types of plans and relates to the right-hand y axis. The purple dashed line represents median difference in adherence (9.1 percentage points).

**EXHIBIT 4**

**Relationship Between Plan Characteristics And Change In Medication Adherence After The Implementation Of Value-Based Insurance Design (VBID)**

Plan characteristic	Diabetes		High cholesterol		Hypertension	
	Univariate	Multivariate	Univariate	Multivariate	Univariate	Multivariate
Generous benefits <sup>a</sup>	1.4****	3.6****	0.6****	1.6****	1.0****	2.4****
No copay tiers	-3.3****	-1.3****	-0.2	-0.6*	-3.0****	0.0
Targets high-risk patients	1.7****	2.2****	1.4****	1.3****	1.5****	1.4****
Wellness program offered	1.5****	4.4****	1.2****	3.3****	2.0****	5.4****
Disease management program offered	-1.7****	-6.7****	-1.6****	-4.9****	-1.2****	-5.1****
Benefits for mail-only Rx	1.4****	2.5****	1.5****	3.6****	1.0****	4.8****

**SOURCE** Authors' analysis of prescription claims data from CVS Caremark. **NOTES** The exhibit shows percentage-point changes in adherence after the implementation of VBID between plans with and without the given characteristic. "Univariate" means without adjusting for other plan characteristics. "Multivariate" means after controlling for all the other plan characteristics. All models controlled for differences in patients' demographic characteristics and comorbidities. <sup>a</sup>See Exhibit 1. \*p < 0.10 \*\*\*\*p < 0.001

ly influenced whether the VBID plans changed adherence. The impact of the other plan characteristics on adherence was consistent across the three conditions and had magnitudes that were larger than those observed in the models that considered only one feature at a time.

In particular, adherence in plans that offered a disease management program was significantly lower than in plans without such a program, with effects ranging from -4.9 percentage points (95% CI: -5.7, -4.1) for high cholesterol to -6.7 percentage points (95% CI: -8.0, -5.5) for diabetes. In contrast, plans that offered a wellness program had adherence levels that were 3.3-5.4 percentage points higher after their introduction than plans that did not offer this type of program.

**SENSITIVITY ANALYSES** Our sensitivity analyses generally yielded results similar to those of our primary analysis. Our results remained unchanged when we used three groups of patients, instead of two, based on the method in which plans targeted patients (Appendix Exhibit E).<sup>11</sup> The same was true when we relied on observed changes in cost sharing that resulted from the VBID implementation to classify VBID generosity, instead of changes reported by the plans (Appendix Exhibit F).<sup>11</sup> Restricting our analysis to plans in which disease management or wellness programs were introduced prior to the start of the VBID plan did not change our results, either (Appendix Exhibit G).<sup>11</sup> Alternative modeling approaches also produced results that were similar to those of our primary analyses (Appendix Exhibits H, I, and J).<sup>11</sup>

Restricting our analysis to patients who had initiated therapy prior to the start of the new VBID program (that is, to patients who did not initiate therapy in response to the lowered co-

pays) produced results very similar to those in our primary analyses (Appendix Exhibit K).<sup>11</sup> Analyzing the subset of individuals who were continuously insured for the year prior to and the year after the start of the VBID plan (n = 173,443; 63 percent of the study sample) yielded smaller, but directionally consistent, effects of plans' generosity, targeting of high-risk patients, and presence of a disease management program (Appendix Exhibit L).<sup>11</sup>

In this analysis, VBID plans that reduced copayments only for prescriptions filled by mail, offered a wellness program, or both were associated with higher levels of adherence than VBID plans without these characteristics for hypertension and high cholesterol medications. In contrast, these characteristics were not associated with the impact of copay reductions for plans that targeted diabetes.

**Discussion**

Our analysis of seventy-six different VBID plans introduced by a large pharmacy benefit manager demonstrates that the structure of these programs strongly influences their ability to increase medication adherence. After we adjusted for the other features, VBID plans that were more generous, targeted high-risk patients, had wellness programs, did not have disease management programs, and made the benefit available only for medication ordered by mail resulted in larger improvements in long-term adherence.

These results were consistent across the disease states we studied. Given the wide variation in how VBID plan designs have been implemented across the United States, these results may be used to influence how future plans are structured.



We hypothesized that plans with a disease management program would have larger effects on adherence than plans without such a program. This is because disease management programs produce greater patient engagement and understanding of the potential benefits of medication adherence. Consistent with this hypothesis, Teresa Gibson and coauthors found that beneficiaries of a single large employer who opted in to disease management and were offered copay reductions had larger improvements in adherence than beneficiaries who opted out of disease management and received copay reductions alone.<sup>5</sup>

However, when we analyzed many plans introduced by numerous plan sponsors and when we controlled for numerous other plan characteristics, we found large and consistently negative effects on adherence from the availability of disease management. It is possible that disease management blunts the effect of VBID, since both interventions attempt to achieve the same goal.

Alternatively, the beneficial effects of disease management might result primarily from the promotion of healthy behaviors other than medication adherence, and lifestyle modification might reduce the need for medications. That would make patients in our analysis appear to be nonadherent. Of course, we have no way of verifying whether individual patients actually participated in disease management activities. It is important to recognize that although these programs are very common, their nature varies widely across plans.

Plans with a disease management program started with a relatively high baseline level of adherence. Thus, our results may represent a “ceiling effect”: The addition of a financial incentive might have influenced only plans with lower baseline levels of adherence. A ceiling effect might also have contributed to the apparent benefit of plans offering wellness programs and a mail-only benefit. Conversely, the longer prescription lengths and the relative ease of access available through the use of mail-order prescriptions might have promoted adherence, as other researchers have observed.<sup>17,18</sup>

The positive association between wellness programs, patient targeting, and mail-order prescriptions is notable, considering that all of these interventions are very low cost and easily implemented. As a result, we can surmise that adding them to VBID programs would be a particularly efficient way to improve medication adherence. Of course, it is unclear whether the magnitudes of the differences in adherence that we observed between plans are meaningful. Al-

## Our analytic approach could help identify the best ways to structure other benefit designs and quality improvement programs.

though the existing evidence is limited, it suggests that a 3–6-percentage-point change in adherence is likely to be clinically significant for high-risk conditions.<sup>7,8</sup>

Furthermore, in interpreting our results, it is important to recognize that the typical increases in adherence from VBID implementations (3–5 percentage points) reported in the literature (4–6, 8, 19–22) are really a weighted average of individual plans with and without the characteristics that we studied. Thus, our results suggest that an optimally designed VBID plan might have an even larger impact on adherence than plans that leave copays unchanged.

Beyond their potential impact on future VBID plan design, we believe that our results have broader implications. We compared plans with a similar basic structure but with numerous potentially important cointerventions. Our analytic approach could help identify the best ways to structure other benefit designs and quality improvement programs. For example, reference pricing plans, tiered formularies, and disease management programs have many variations that could certainly have an impact on their effectiveness. These variations could be subjected to an analysis similar to the one we performed.

### Conclusion

Our study provides high-quality empirical data on the VBID plan features that appear to be most effective in stimulating greater medication adherence. These results can influence how future copay reduction plans are structured. In addition, we believe that the method employed in our analysis could be used to evaluate other benefit design and quality improvement activities that also have large variations in their design features. ■

These results were reported at the AcademyHealth Annual Research Meeting, Orlando, Florida, June 2012. Funding for this research was provided

by the Robert Wood Johnson Foundation Changes in Health Care Financing and Organization initiative. The authors acknowledge the very helpful comments

provided by Bruce Stuart on an earlier draft of the article. [Published online February 12, 2014.]

## NOTES

- 1 Siu AL, Sonnenberg FA, Manning WG, Goldberg GA, Bloomfield ES, Newhouse JP, et al. Inappropriate use of hospitals in a randomized trial of health insurance plans. *N Engl J Med*. 1986;315(20):1259–66.
- 2 Goldman DP, Joyce GF, Zheng Y. Prescription drug cost sharing: associations with medication and medical utilization and spending and health. *JAMA*. 2007;298(1):61–9.
- 3 Fendrick AM, Smith DG, Chernew ME, Shah SN. A benefit-based copay for prescription drugs: patient contribution based on total benefits, not drug acquisition cost. *Am J Manag Care*. 2001;7(9):861–7.
- 4 Chernew ME, Shah MR, Wegh A, Rosenberg SN, Juster IA, Rosen AB, et al. Impact of decreasing copayments on medication adherence within a disease management environment. *Health Aff (Millwood)*. 2008;27(1):103–12.
- 5 Gibson TB, Mahoney J, Ranghell K, Cherney BJ, McElwee N. Value-based insurance plus disease management increased medication use and produced savings. *Health Aff (Millwood)*. 2011;30(1):100–8.
- 6 Gibson TB, Wang S, Kelly E, Brown C, Turner C, Frech-Tamas F, et al. A value-based insurance design program at a large company boosted medication adherence for employees with chronic illnesses. *Health Aff (Millwood)*. 2011;30(1):109–17.
- 7 Choudhry NK, Fischer MA, Avorn JL, Lee JL, Schneeweiss S, Solomon DH, et al. The impact of reducing cardiovascular medication copayments on health spending and resource utilization. *J Am Coll Cardiol*. 2012;60(18):1817–24.
- 8 Choudhry NK, Avorn J, Glynn RJ, Antman EM, Schneeweiss S, Toscano M, et al. Full coverage for preventive medications after myocardial infarction. *N Engl J Med*. 2011;365(22):2088–97.
- 9 Lee JL, Maciejewski ML, Raju SS, Shrank WH, Choudhry NK. Value-based insurance design: quality improvement but no cost savings. *Health Aff (Millwood)*. 2013;32(7):1251–7.
- 10 Choudhry NK, Rosenthal MB, Milstein A. Assessing the evidence for value-based insurance design. *Health Aff (Millwood)*. 2010;29(11):1988–94.
- 11 To access the Appendix, click on the Appendix link in the box to the right of the article online.
- 12 Wagner AK, Soumerai SB, Zhang F, Ross-Degnan D. Segmented regression analysis of interrupted time series studies in medication use research. *J Clin Pharm Ther*. 2002;27(4):299–309.
- 13 Schneeweiss S, Seeger JD, Maclure M, Wang PS, Avorn J, Glynn RJ. Performance of comorbidity scores to control for confounding in epidemiologic studies using claims data. *Am J Epidemiol*. 2001;154(9):854–64.
- 14 Schneeweiss S, Maclure M, Soumerai SB, Walker AM, Glynn RJ. Quasi-experimental longitudinal designs to evaluate drug benefit policy changes with low policy compliance. *J Clin Epidemiol*. 2002;55(8):833–41.
- 15 Steiner JF, Prochazka AV. The assessment of refill compliance using pharmacy records: methods, validity, and applications. *J Clin Epidemiol*. 1997;50(1):105–16.
- 16 Choudhry NK, Shrank WH, Levin RL, Lee JL, Jan SA, Brookhart MA, et al. Measuring concurrent adherence to multiple related medications. *Am J Manag Care*. 2009;15(7):457–64.
- 17 Duru OK, Schmittiel JA, Dyer WT, Parker MM, Uratsu CS, Chan J, et al. Mail-order pharmacy use and adherence to diabetes-related medications. *Am J Manag Care*. 2010;16(1):33–40.
- 18 Adams AS, Uratsu C, Dyer W, Magid D, O'Connor P, Beck A, et al. Health system factors and antihypertensive adherence in a racially and ethnically diverse cohort of new users. *JAMA Intern Med*. 2013;173(1):54–61.
- 19 Chernew ME, Juster IA, Shah M, Wegh A, Rosenberg S, Rosen AB, et al. Evidence that value-based insurance can be effective. *Health Aff (Millwood)*. 2010;29(3):530–6.
- 20 Farley JF, Wansink D, Lindquist JH, Parker JC, Maciejewski ML. Medication adherence changes following value-based insurance design. *Am J Manag Care*. 2012;18(5):265–74.
- 21 Maciejewski ML, Farley JF, Parker J, Wansink D. Copayment reductions generate greater medication adherence in targeted patients. *Health Aff (Millwood)*. 2010;29(11):2002–8.
- 22 Zeng F, An JJ, Scully R, Barrington C, Patel BV, Nichol MB. The impact of value-based benefit design on adherence to diabetes medications: a propensity score-weighted difference in difference evaluation. *Value Health*. 2010;13(6):846–52.