Medication Adherence Changes Following Value-Based Insurance Design

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Objectives: To determine whether participation in a value-based insurance design (VBID) program was associated with improved medication adherence in 8 drug classes 2 years after implementation and to examine whether adherence changes varied by baseline adherence.

Study Design: We used a pre-post quasi-experimental study design with a retrospective cohort of 74,748 enrollees using 8 different therapeutic classes of medications to treat diabetes, hypertension, hyperlipidemia, or congestive heart failure.

Methods: Brand-name medication copayments were lowered (from tier 3 to tier 2) for all enrollees, while generic copayments were waived only for employers who opted into the VBID program. Medication adherence of VBID program participants and nonparticipants 12 months before and 12 and 24 months after program implementation were estimated on 8 propensity-matched cohorts using generalized estimating equations, as well as on subgroups stratified by baseline adherence. Adherence was measured using the medication possession ratio (MPR) from medication refill records.

Results: VBID was associated with improved medication adherence ranging from 1.4% to 3.2% at 1 year, which increased to 2.1% to 5.2% 2 years following VBID adoption. Adherence changes were most notable among patients who were nonadherent (MPR <.50) before VBID implementation.

Conclusions: Population-based implementation of VBID can improve adherence to medications to treat cardiometabolic conditions, particularly for previously nonadherent patients. VBID guidelines being developed in response to healthcare reform should account for the heterogeneity in patient response to VBID programs.

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For author information and disclosures, see end of text.

Adherence to essential medications is suboptimal for many patients with chronic medical conditions,[1,2] resulting in significant morbidity and mortality.[3,4] Cost-related nonadherence (CRN) has been well documented as a significant problem in uninsured patients.[5-7] Cost-related nonadherence leads patients to forgo medication, skip doses, ration medication by splitting tablets, or forgo other necessities. Insured patients also face CRN due to ever-increasing medication copayments and coinsurance.[8,9]

One policy innovation that targets CRN in the context of health insurance is value-based insurance design (VBID). Value-based insurance design posits that cost-sharing should be set according to a medication's clinical value instead of its acquisition cost.[10] Following principles of VBID, policy makers may set copayments lower for medications that are more effective or more cost-effective than other medications in the same drug class. An alternative VBID approach would reduce cost sharing for certain populations of patients or subgroups who are most likely to benefit from improved access to treatment.[11] The removal of cost barriers for high-value medications under VBID should lead to better medication adherence, better disease management, and lower healthcare spending. Existing VBID evaluations suggest that eliminating copayments for high-value services may result in 1-year adherence improvements ranging from 1.5% to 3.8%, depending on the therapeutic category examined.[12,13] However, few studies have examined adherence changes beyond 1 year,[14,15] which would help insurers optimize patients' behavioral response to VBID.

The objective of this study is to determine whether participation in a population-based VBID program was associated with improved adherence in 8 drug classes 2 years after implementation. We also wanted to address the concerns of VBID critics who argue that statistically significant, yet modest, improvements in adherence may not be clinically meaningful by examining adherence changes among populations with varying levels of prepolicy adherence.[16,17] Previous research suggested a clinical threshold for adherence at 80%[18-20] so we examined whether adherence changes differed between patients who were fully adherent (≥80%), somewhat adherent (between 50% and 80%), or nonadherent (≤50%) in the year before VBID implementation. The potential heterogeneity in patient response may reflect subgroups of patients for whom CRN is the underlying reason for nonadherence,

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We showed significant clinical improvements in medication adherence among patients who experienced a reduction in copayments following the implementation of a value-based insurance design (VBID) copayment program by a larger private insurer.

- VBID adherence improvements were sustained and improved to a greater extent 2 years into policy adoption and were greatest among patients with poorer adherence prior to policy implementation.
- Further studies examining the economic effect of VBID medication copayment policies are needed to better understand the overall effect of these policies on managed care decision makers and patients.

and who might be exceptionally responsive to VBID. The results from this study extend a 1-year adherence analysis[13] and identify which patients would most benefit from VBID programs. This is particularly relevant as the Secretary of Health and Human Services develops guidelines for VBID implementation under healthcare reform as stipulated in section 2713 of the Patient Protection and Affordable Care Act.

METHODS

VBID Program

In January 2008, BlueCross BlueShield of North Carolina (BCBSNC) instituted a VBID program termed "Medication Dedication" for medications to treat diabetes, hypertension, hyperlipidemia, and congestive heart failure. Generic copayments for these medications were waived for all fully underwritten employers and for a subset of self-funded employers who opted in to this program. All employees and dependents at the employers who participated had the new benefit applied. In addition, brand-name copayments for 8 different therapeutic classes of medication (metformin, HMG-CoA reductase inhibitors [statins], thiazide diuretics, angiotensin-converting enzyme inhibitors [ACEIs], beta-blockers, calcium channel blockers [CCBs], angiotensin receptor blockers [ARBs], and cholesterol absorption inhibitors [CAIs]) were lowered from tier 3 to tier 2 for all enrollees. As a result of this policy, per prescription copayments for VBID participants compared with non-VBID participants declined on average from $15.57 to $2.42 versus $16.23 to $12.91, respectively, for ACEI users; from $15.05 to $2.07 versus $15.63 to $12.74, respectively, for beta-blocker users; from $13.13 to $5.17 versus $14.19 to $14.16, respectively, for metformin users; from $21.93 to $6.14 versus $23.95 to $16.28, respectively, for CCB users; from $24.89 to $19.46 versus $27.15 to $25.66, respectively, for statin users; from $16.91 to $9.14 versus $17.63 to $16.00, respectively, for thiazide users; from $36.31 to $32.28 versus $38.42 versus $32.65, respectively, for ARB users; and from $37.09 to $32.90 versus $40.41 to $33.90, respectively, for CAI users. This policy was population based because it was made available to all employers offering health benefits through BCBSNC in 2008. This study was approved by institutional review boards at both Duke University and the University of North Carolina at Chapel Hill.

Study Design and Sample

This VBID evaluation used a retrospective pre-post quasi-experimental study design with a nonequivalent control group. The 12 months prior to program implementation (January-December 2007) was the pre-period. Administrative claims data were used by BCBSNC to create annual observations for each of the variables described below between 2007 and 2009. Data for the post-period were drawn from the subsequent 24 months (2008 and 2009) to examine adherence changes 1 and 2 years after program implementation. The unit of analysis was the person-year with 3 observations per person.

VBID participants and nonparticipants were included if they were continuously enrolled from January 2007 through December 2009, did not have a change in their VBID enrollment status from 2008 to 2009, were 18 years or older in 2007, and were taking at least 1 of the 8 classes of drugs previously indicated in 2007. The comparison group of nonparticipants was selected from BCBSNC members enrolled in Administrative Services Only benefits. These patients also experienced a reduction in copayments for prescriptions in the 8 therapeutic categories examined from tier 3 to tier 2. However, copayments for generic medications were not eliminated. The same enrollee could be included in analyses for more than 1 class of drugs if using medications from 2 or more of the 8 classes. Given that these medications are all used for chronic health conditions, we used an intention to treat approach whereby patients in the analytical cohort were followed until the end of the study (2009).

After applying these criteria, we identified 5020 participants and 2883 nonparticipants taking metformin; 16,771 participants and 10,204 nonparticipants taking diuretics; 14,978 participants and 8234 nonparticipants taking ACEIs; 12,164 participants and 7298 nonparticipants taking beta-blockers; 21,635 participants and 12,804 nonparticipants taking statins; 8045 participants and 4834 nonparticipants taking CCBs; 3301 participants and 2073 nonparticipants taking CAIs; and 8688 participants and 5705 nonparticipants taking ARBs.

Of the 8 classes, 2 (CAIs and ARBs) did not have any generic options during the period of observation, so VBID participants and nonparticipants both experienced the same copayment reduction from tier 3 to tier 2. We expected similar changes in CAI and ARB adherence between VBID participants and nonparticipants because the copayments were

similar for both groups, so CAIs and ARBs were added as nonequivalent dependent variables to strengthen the design of the study.

Medication Adherence Outcome

Medication adherence was assessed using the continuous medication possession ratio (MPR), calculated as days of supply for a specific therapeutic class during each of the 3 annual observation periods. The MPR was calculated as the number of days of supply dispensed per year over the number of days observed in the year (365) and was capped at 1 for patients filling more days of supply than days observed. Adjustments to the days of supply in the MPR were made to account for carryover from previous medication fills, including carryover for medication fills that preceded each observation period including the pre-period (2007). If there were no fills for the drug during the 90 days before the start of the period, then the start date was the date of the member's first fill for the drug during the period. The MPR accounted for medication switching between different drug therapeutic classes (eg, from a CCB to an ACEI) to avoid undercounting the supply of the drug (eg, a CCB) that members were no longer taking.

Explanatory Variables

There were 3 explanatory variables of interest: (1) an indicator of VBID participation, (2) a time indicator to reflect the pre-period or post-period(s) around VBID implementation, and (3) an interaction of the VBID participation and pre-post indicators. This interaction term indicates whether the pre-post adherence trends differed significantly between program participants and nonparticipants (eg, a difference-in-difference analysis). Separate comparisons were made between 2007 and 2008 as well as 2007 and 2009 to understand the potential for VBID to result in both near-term and sustained adherence benefits.

Covariates

Consistent with past research, each of the models included age in years, male sex, and comorbidity burden (measured as Episode Risk Groups) as covariates. In addition, we controlled for several covariates not accounted for in prior VBID analyses that reduced the extent of unobserved confounding by controlling for the count of unique medications filled, the average generic copayment per 30-day supply, the average brand-name copayment per 30-day supply, whether a patient filled at least 1 prescription with a 90-day supply, and the generic dispensing rate. In addition, patient use of case management or disease management during baseline was included to control for the influence of additional program participation on medication adherence.

Statistical Model Specification

To account for nonnormality in the adherence outcome, we used generalized estimating equations (GEEs) with a gamma distribution, inverse square root function link, robust standard errors to account for repeated measures, and identical covariate specifications for each of the 8 medication classes. Based on GEE results, the impact of the VBID program on adherence was assessed by comparing the difference in program participants' predicted adherence and their predicted adherence had they not participated in the VBID program. The difference in these 2 predictions (done only for program participants) represents the "treatment effect for the treated."

To reduce the nonequivalence of the control groups from the imbalance in observed covariates, one-to-one propensity score matching was conducted by iteratively matching program participants to nonparticipants from the eighth to the second digit of the propensity score in the mean adherence models. In the propensity score analysis, we included the covariates described above and 4 interaction terms (case management and disease management, male and case management, male and disease management, and total number of unique medications used and disease management). We present propensity-matched results, because our prior work found concordance between the unmatched adjusted results and matched results.[13]

Subgroup Analysis

In addition to the primary 2-year adherence analysis, we examined adherence changes following VBID among patients with varying baseline adherence in 2007. Patients were stratified into 1 of 3 adherence categories based on 2007 adherence levels (nonadherent (MPR $\leq$0.50), somewhat adherent (0.5 <MPR <0.80), or fully adherent (MPR $\geq$0.80). A GEE with the same specifications as the 2-year adherence analysis was used within each stratum.

RESULTS

Descriptive Results

Prior to propensity score matching, there appeared to be significant differences between treatment and comparator groups on several variables (**Table**). For example, VBID participants taking ACEIs were slightly younger (51.7 vs 52.6 years) and more frequently male (64.6% vs 55.6%); had a higher comorbidity burden (47.8 vs 49.7); used more disease management (20.4% vs 16.9%); and had lower rates of 90-day fills (11.6% vs 21.3%), lower baseline copayment amounts ($10.65 vs $11.30), and lower overall health expenditures at baseline ($7086 vs $7460) than non-VBID participants taking ACEIs. Following propensity score matching, statis-

Table. Prepolicy Descriptive Statistics of Program Participants and Nonparticipants

Therapy and Patient Characteristics	Nonparticipants, Mean (SD)	Participants, Mean (SD)	Unmatched Standardized Difference	PS-Matched Standardized Difference
Diuretics				
No.	10,204	16,771	—	9789
Age, y	52.2 (8.5)	51.6 (8.5)	0.07	0.01
% Male	36.1 (48.0)	45.7 (49.8)	−0.20	−0.03
Comorbidity burden	2.98 (2.78)	2.91 (2.67)	0.03	−0.02
Unique medications	3.64 (2.59)	3.70 (2.66)	−0.02	−0.03
90-Day fills, %	21.9 (41.4)	13.1 (33.7)	0.23	−0.01
Generic fills, %	69.8 (44.8)	71.9 (44.0)	−0.05	0.05
Generic copayment, $	9.73 (5.62)	9.89 (3.59)	−0.03	−0.01
Brand copayment, $	36.83 (11.54)	36.40 (8.95)	0.04	0.03
Case management, %	0.4 (6.4)	0.5 (6.8)	−0.01	−0.02
Disease management, %	14.2 (34.9)	16.5 (37.1)	−0.06	−0.04
Health expenditures, $	6594 (11,698)	6321 (10,713)	0.02	−0.01
ACEIs				
No.	8234	14,978	—	8044
Age, y	52.6 (8.7)	51.7 (8.5)	0.10	0.00
% Male	55.6 (49.7)	64.6 (47.8)	−0.19	0.00
Comorbidity burden	3.34 (3.22)	3.32 (3.24)	0.01	−0.01
Unique medications	4.36 (2.77)	4.44 (2.87)	−0.03	−0.01
90-Day fills, %	21.3 (40.9)	11.6 (32.0)	0.26	0.00
Generic fills, %	81.0 (35.7)	81.0 (36.0)	0.00	0.01
Generic copayment, $	11.30 (7.16)	10.65 (4.52)	0.11	0.01
Brand copayment, $	40.00 (10.88)	39.71 (9.73)	0.03	0.02
Case management, %	0.7 (8.1)	0.9 (9.3)	−0.02	−0.01
Disease management, %	16.9 (37.5)	20.4 (40.3)	−0.09	−0.03
Health expenditures, $	7460 (13,127)	7086 (13,368)	0.03	−0.01
Statins				
No.	12,804	21,635	—	12,129
Age, y	53.8 (8.0)	52.9 (7.9)	0.11	−0.01
% Male	55.3 (49.7)	64.2 (48.0)	−0.18	−0.01
Comorbidity burden	3.39 (3.28)	3.42 (3.28)	−0.01	0.00
Unique medications	3.95 (2.81)	4.02 (2.86)	−0.02	0.00
90-Day fills, %	23.99 (42.71)	11.53 (31.94)	0.33	0.01
Generic fills, %	35.84 (46.82)	36.83 (47.12)	−0.02	0.03
Generic copayment, $	12.09 (5.50)	11.28 (3.08)	0.18	0.01
Brand copayment, $	35.07 (15.06)	33.81 (13.49)	0.09	0.02
Case management, %	0.66 (8.07)	0.84 (9.13)	−0.02	0.00
Disease management, %	16.18 (36.83)	19.95 (40.00)	−0.10	−0.01
Health expenditures, $	8031 (14,413)	7792 (13,304)	0.02	−0.01
Beta blockers				
No.	7298	12,164	—	7080
Age, y	53.0 (8.9)	52.3 (8.8)	0.09	0.01
% Male	45.3 (49.8)	55.1 (49.7)	−0.20	0.00
Comorbidity burden	4.24 (4.05)	4.23 (3.92)	0.00	0.00
Unique medications	4.52 (2.94)	4.64 (3.04)	−0.04	−0.01
90-Day fills, %	21.36 (40.99)	11.52 (31.93)	0.27	0.00
Generic fills, %	77.17 (33.11)	77.37 (32.75)	−0.01	0.01
Generic copayment, $	10.97 (7.20)	10.42 (4.70)	0.09	0.00
Brand copayment, $	32.81 (10.55)	32.33 (8.94)	0.05	0.02
Case management, %	1.07 (10.28)	1.48 (12.08)	−0.04	0.00
Disease management, %	15.62 (36.31)	18.24 (38.62)	−0.07	−0.02
Health expenditures, $	10,305 (20,954)	9874 (18,583)	0.02	−0.02

(Continued)

Table. Prepolicy Descriptive Statistics of Program Participants and Nonparticipants *(Continued)*

Therapy and Patient Characteristics	Nonparticipants, Mean (SD)	Participants, Mean (SD)	Unmatched Standardized Difference	PS-Matched Standardized Difference
Calcium channel blockers				
No.	4834	8045	—	4402
Age, y	53.5 (8.6)	52.7 (8.3)	0.09	−0.04
% Male	51.2 (50.0)	61.9 (48.6)	−0.22	0.01
Comorbidity burden	3.60 (3.66)	3.45 (3.45)	0.04	−0.10
Unique medications	4.84 (2.92)	4.89 (3.04)	−0.02	−0.08
90-Day fills, %	19.90 (39.93)	9.72 (29.63)	0.29	−0.03
Generic fills, %	70.35 (35.58)	68.48 (36.55)	0.05	−0.02
Generic copayment, $	12.89 (7.56)	11.03 (4.48)	0.30	0.01
Brand copayment, $	49.10 (18.52)	47.06 (15.14)	0.12	−0.03
Case management, %	0.52 (7.17)	1.03 (10.11)	−0.06	−0.07
Disease management, %	15.89 (36.56)	17.73 (38.19)	−0.05	−0.08
Health expenditures, $	8992 (18,530)	8169 (15,837)	0.05	−0.07
Metformin				
No.	2883	5020	—	2709
Age, y	51.9 (9.1)	51.3 (9.0)	0.06	0.02
% Male	45.6 (49.8)	55.2 (49.7)	−0.19	−0.01
Comorbidity burden	3.39 (2.69)	3.38 (2.74)	0.00	0.03
Unique medications	5.51 (2.91)	5.59 (3.03)	−0.03	0.01
90-Day fills, %	19.11 (39.33)	8.55 (27.96)	0.31	−0.02
Generic fills, %	86.37 (32.36)	86.03 (32.92)	0.01	0.01
Generic copayment, $	10.93 (7.23)	10.01 (4.24)	0.16	−0.02
Brand copayment, $	34.00 (7.25)	33.92 (5.99)	0.01	0.01
Case management, %	0.49 (6.95)	0.68 (8.20)	−0.03	−0.02
Disease management, %	31.39 (46.41)	38.79 (48.73)	−0.16	−0.03
Health expenditures, $	7128 (10,669)	6842 (9527)	0.03	−0.01
Cholesterol absorption inhibitors				
No.	2073	3301	—	1950
Age, y	54.3 (7.9)	53.7 (7.6)	0.08	−0.02
% Male	57.3 (49.5)	66.0 (47.4)	−0.18	0.00
Comorbidity burden	3.84 (3.52)	3.97 (3.56)	−0.04	0.03
Unique medications	4.36 (3.03)	4.39 (2.99)	−0.01	0.01
90-Day fills, %	22.58 (41.82)	10.27 (30.36)	0.34	0.02
Generic fills, %	0 (0)	0 (0)	—	—
Generic copayment, $	0 (0)	0 (0)	—	—
Brand copayment, $	40.68 (22.81)	37.28 (18.98)	0.16	0.02
Case management, %	0.63 (7.90)	0.82 (9.01)	−0.02	0.03
Disease management, %	18.57 (38.90)	22.75 (41.93)	−0.10	0.01
Health expenditures, $	9057 (13,319)	9334 (13,378)	−0.02	0.04
Angiotensin receptor blockers				
No.	5705	8688	—	5313
Age, y	52.9 (8.4)	52.2 (8.2)	0.08	−0.01
% Male	45.5 (49.8)	57.3 (49.5)	−0.24	0.01
Comorbidity burden	3.30 (3.20)	3.23 (3.06)	0.02	−0.01
Unique medications	3.85 (2.85)	3.85 (2.87)	0.00	−0.03
90-Day fills, %	20.70 (40.52)	9.10 (28.77)	0.33	0.01
Generic fills, %	0 (0)	0 (0)	—	—
Generic copayment, $	0 (0)	0 (0)	—	—
Brand copayment, $	38.71 (21.38)	36.62 (17.34)	0.11	0.01
Case management, %	0.60 (7.58)	0.56 (7.49)	0.00	−0.01
Disease management, %	16.00 (36.65)	18.67 (39.00)	−0.07	−0.03
Health expenditures, $	8093 (14,800)	7645 (12,141)	0.03	−0.01

ACEI indicates angiotensin-converting enzyme inhibitor; PS, propensity score; SD, standard deviation.

tical differences between groups were eliminated, allowing for meaningful comparisons between groups on adherence differences resulting from the VBID Medication Dedication program.

Unadjusted Adherence Comparisons

Prior to implementation of Medication Dedication in 2007, adherence rates were similar between treatment and comparator patients across each of the 8 therapeutic categories (**Figure 1**). Average MPR rates in 2007 ranged from 75% for statin medications to 83% for ACEIs for both program participants and nonparticipants. Following VBID implementation, average adherence declined less for program participants than for nonparticipants in 2008 and 2009. Compared with nonparticipants, 2008 adherence was higher for patients taking ACEIs (0.84 vs 0.82), beta-blockers (0.82 vs 0.80), metformin (0.76 vs 0.73), CCBs (0.84 vs 0.82), thiazide diuretics (0.80 vs 0.78), and statins (0.74 vs 0.73). The adherence differences continued to grow in 2009 for ACEIs (0.83 vs 0.79), beta-blockers (0.81 vs 0.77), metformin (0.77 vs 0.71), CCBs (0.83 vs 0.80), thiazide diuretics (0.80 vs 0.75), and statins (0.76 vs 0.73). As expected, VBID participants and nonparticipants showed similar adherence changes for ARBs and CAIs.

Propensity Score–Matched Adherence Comparisons

In adjusted analyses (**Figure 2**), percentage point adherence from 2007 to 2008 improved 0.9% ($P = .02$) for VBID participants taking CCBs, 1.4% ($P < .001$) for statin medications, 2.2% ($P < .001$) for beta-blockers, 2.5% ($P < .001$) for ACEIs, 2.8% ($P < .001$) for thiazide diuretics, and 3.2% ($P < .001$) for metformin. Compared with VBID nonparticipants, adherence improvements were sustained into 2009. Percentage point improvements from 2007 to 2009 were higher for each class of medication over this 2 year period than the period from 2007 to 2008. Percentage point improvements from 2007 to 2009 improved 2.2% ($P < .001$) for CCBs, 2.3% ($P < .001$) for statin medications, 4.3% ($P < .001$) for beta-blockers, 4.8% ($P < .001$) for ACEIs, 4.5% ($P < .001$) for thiazide diurectics, and 5.0% ($P < .001$) for VBID participants taking metformin. There were no significant differences in adherence trends for VBID participants and nonparticipants using CAIs or ARBs in 2008 or 2009.

Adherence Changes Greatest Among Those Previously Nonadherent

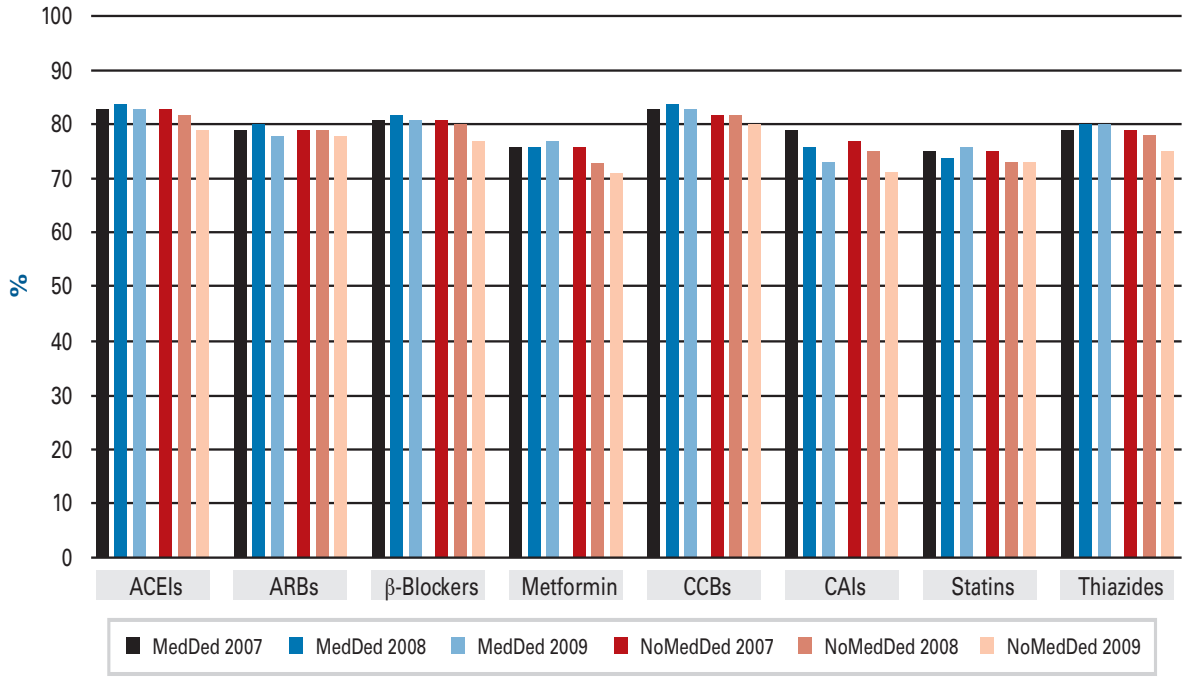
Consistent with our a priori hypothesis, the greatest adherence improvements were observed for patients with poorer baseline adherence (**Figure 3**). Compared with patients who were fully adherent at baseline, percentage point adherence improvements were greatest for previously nonadherent and somewhat adherent VBID participants taking ACEIs (9.7% [nonadherent], 5.4% [somewhat], and 4.4% [fully]); beta-blockers (6.1%, 5.5%, and 3.7%); metformin (6.6%, 8.8%, and 4.0%); CCBs (5.2%, 4.5%, and 1.9%); statins (3.0%, 3.4%, and 2.2%); and thiazide diuretics (7.3%, 5.2%, and 3.7%).

DISCUSSION

With the explicit authorization of VBID in section 2713 of the Patient Protection and Affordable Care Act, experimentation with medication cost sharing is likely to increase significantly. Given the escalating interest in cost-sharing reforms, it is essential that these imminent changes be informed with rigorous evidence. In this study, we evaluated the impact of the first population-based implementation of VBID that we know of on adherence to 8 distinct drug classes. Consistent with our earlier work,[13] we found that medication adherence improved 1% to 3% for VBID participants 1 year into implementation of the VBID program. We also showed that adherence improvements were sustained and became larger 2 years into the program, consistent with 1 prior study.[15] Adherence improvements 2 years into the program ranged from 2 percentage points for CCBs to 5 percentage points for metformin. VBID-related adherence changes may take time to realize, as patients and providers learn which medications are the best high-value treatments to address chronic health conditions.[15]

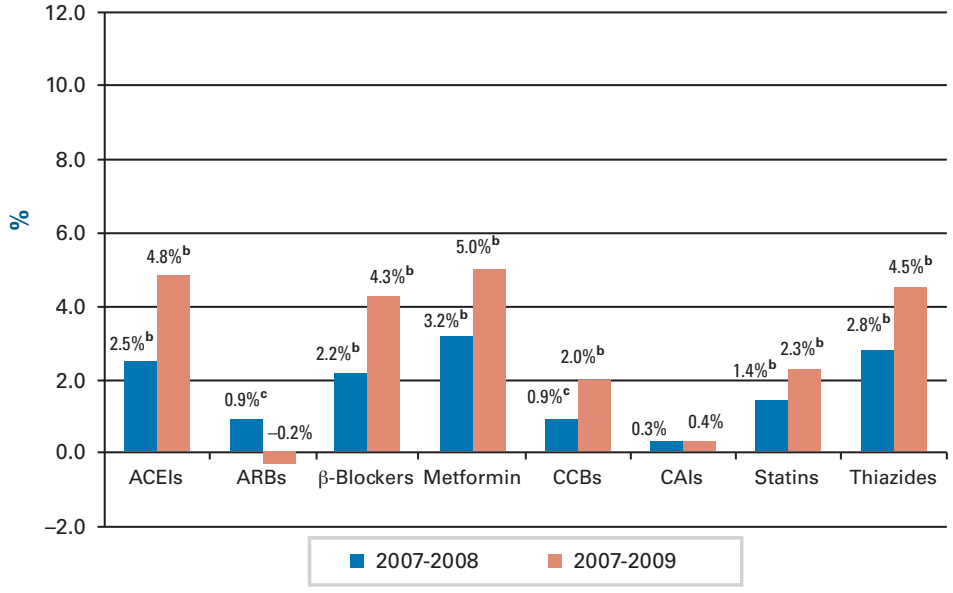
We also found that adherence changes varied according to VBID participants' baseline adherence. Prior adherence analyses of VBID programs have focused on the average patient, which lumps together patients who experience CRN and would be responsive to VBID programs with patients who are nonadherent for other reasons and would be less responsive. In this analysis, VBID participants with the lowest baseline medication adherence (MPR ≤50% in a year) experienced the greatest adherence increases, ranging from a 3 percentage point adherence increase between 2007 and 2009 for statins to a 9.7 percentage point adherence increase for ACEIs. Critics of VBID note that a 3% adherence improvement translates to a mere 10 to 12 days of additional medication treatment per year, which may not be clinically meaningful for individual patients.[17] Our results are suggestive of a more clinically meaningful improvement in adherence, particularly among certain subpopulations. For example, among patients who were previously nonadherent to metformin before policy implementation, there was an average adherence improvement of 8.8 percentage points, which equates to an additional 32-day supply of medication per year. Prior research has shown that for every decrease of 10 percentage points in adherence there is a 0.14% increase in glycated hemoglobin levels, which suggests a potentially meaningful improvement

Figure 1. Mean Unadjusted Medication Possession Ratio Between Unmatched Medication Dedication Participants and Nonparticipants



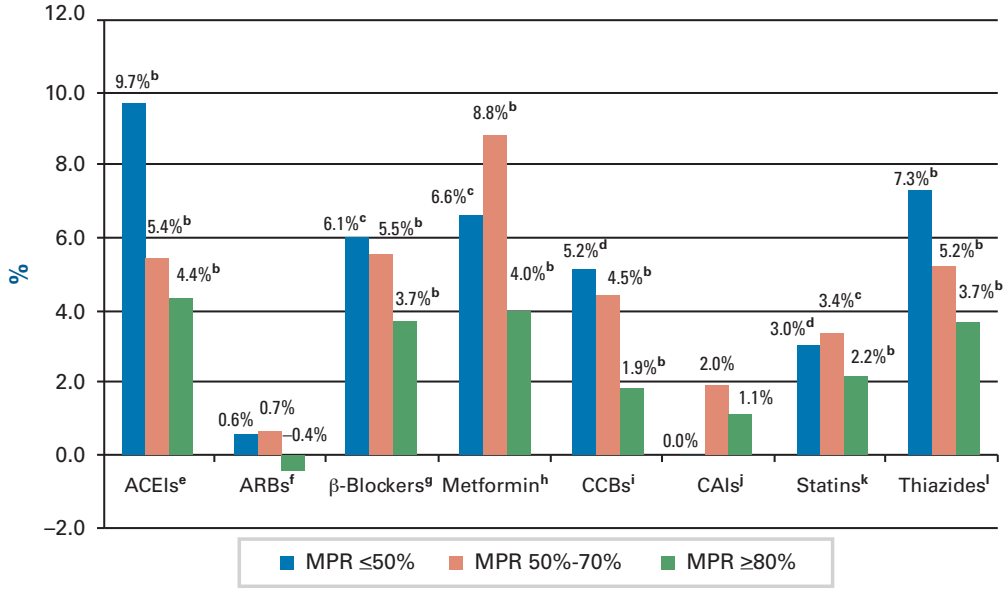
ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CAI, cholesterol absorption inhibitor; CCB, calcium channel blocker; MedDed, Medication Dedication; NoMedDed, No Medication Dedication.

Figure 2. Difference-in-Difference Adherence Results Between Propensity Score–Matched Medication Dedication Participants and Nonparticipants[a]



ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CAI, cholesterol absorption inhibitor; CCB, calcium channel blocker.
[a]Propensity score matched on age, sex, 90-day fills, average copayment, number of medications used, comorbidity burden, percentage of prescriptions filled generically, disease management participation, case management participation, and baseline 2007 healthcare expenditures.
[b]$P < .001$.
[c]$P < .05$.

Figure 3. Covariate-Adjusted 2009 Adherence Change Between Medication Dedication Participants and Nonparticipants Stratified by Baseline 2007 Adherence[a]



ACEI indicates angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; CAI, cholesterol absorption inhibitor; CCB, calcium channel blocker; VBID, value-based insurance design.

[a]Covariate adjusted for age, sex, 90-day fills, average copayment, number of medications used, comorbidity burden, percentage of prescriptions filled generically, disease management participation, case management participation, and baseline 2007 healthcare expenditures.

[b]Sample size for VBID participants and nonparticipants = 1648 and 906 (MPR ≤50%), 1548 and 1609 (MPR 50%-79%), and 5778 and 5651 (MPR ≥80%), respectively.

[c]Sample size for VBID participants and nonparticipants = 1246 and 787 (MPR ≤50%), 1255 and 1306 (MPR 50%-79%), and 3459 and 3394 (MPR ≥80%), respectively.

[d]β-blocker sample sizes for VBID participants and nonparticipants = 1733 and 979 (MPR ≤50%), 1516 and 1557 (MPR 50%-79%), and 4762 and 4705 (MPR ≥80%), respectively.

[e]Metformin sample sizes for VBID participants and nonparticipants = 919 and 536 (MPR ≤50%), 711 and 758 (MPR 50%-79%), and 1533 and 1587 (MPR ≥80%), respectively.

[f]Sample size for VBID participants and nonparticipants = 917 and 593 (MPR ≤50%), 887 and 938 (MPR 50%-79%), and 3333 and 3198 (MPR ≥80%), respectively.

[g]Sample size for VBID participants and nonparticipants = 452 and 321 (MPR ≤50%), 494 and 534 (MPR 50%-79%), and 1244 and 1155 (MPR ≥80%), respectively.

[h]Statin sample sizes for VBID participants and nonparticipants = 4223 and 2431 (MPR ≤50%), 3216 and 3234 (MPR 50%-79%), and 7004 and 6933 (MPR ≥80%), respectively.

[i]Thiazide diuretic sample sizes for VBID participants and nonparticipants = 2620 and 1490 (MPR ≤50%), 2262 and 2328 (MPR 50%-79%), and 2109 and 2187 (MPR ≥80%), respectively.

[j]$P < .05$.

[k]$P < .01$.

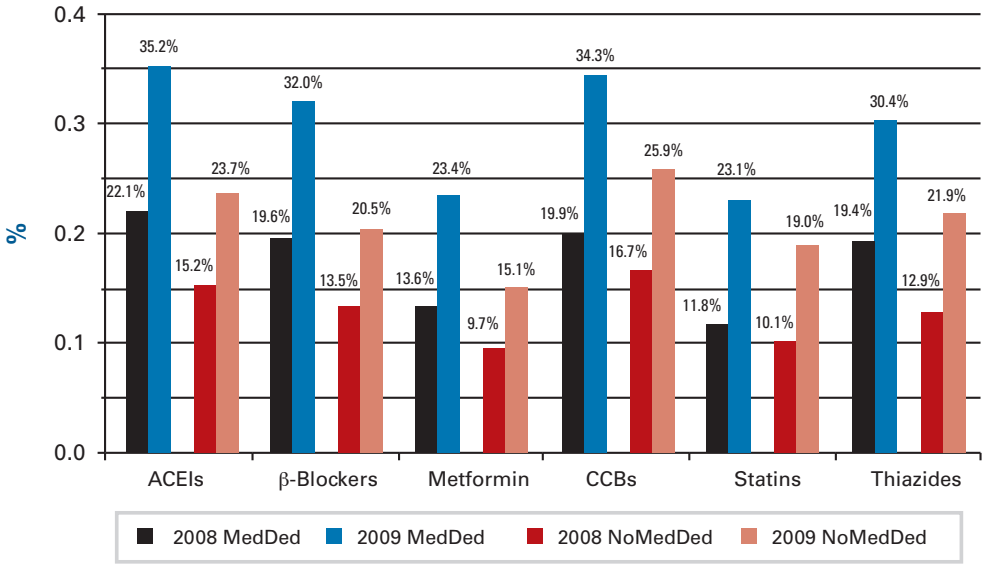
[l]$P < .001$.

in disease control from an 8.8% adherence improvement associated with VBID participation.[21]

In a sensitivity analysis (**Figure 4**), we estimate that 4.1% to 11.5% of VBID participants who were nonadherent (≤50%) in 2007 became fully adherent (≥80%) by 2009. This represents an adherence improvement of *at least* 30 percentage points, which is likely to be clinically meaningful. These subgroup results suggest that estimates of adherence changes across all patients may mask more clinically meaningful improvements occurring in significant numbers of patients whose nonadherence is driven by CRN.

Despite broader adoption of VBID policies, there remains considerable skepticism surrounding the evidence for VBID programs published in peer-reviewed journals.[16,17] Although adherence is an important consideration in examining the benefit of VBID policies, important questions remain. In particular, it is suggested that improvements in adherence resulting from VBID policies should result in better clinical management of health conditions, leading to reductions in the use of high-cost intensive services such as emergency departments and inpatient facilities. The few economic evaluations of VBID to date have suggested that VBID is cost neutral.[15,22] However, the need to manage spiraling healthcare costs requires benefit design decisions to be based on more compelling evidence than null results for cost differences. It will be important to establish whether more optimal benefit designs can result in sufficient healthcare cost reductions to offset the increased expense incurred by payers offering VBID products.

Figure 4. Percentage of Patients With Baseline MPR <50% With Adherence Improvements to MPR ≥80% in 2008 and 2009



ACEI indicates angiotensin-converting enzyme inhibitor; CCB, calcium channel blocker; MedDed, Medication Dedication; MPR, medication possession ratio; NoMedDed, No Medication Dedication.

Further examination of VBID policies will be necessary to better understand the overall effect of VBID on the care of patients with chronic illness and to inform optimal benefit design as VBID is implemented in healthcare reform. Under section 2713(c) of the Act it is stated, "The Secretary may develop guidelines to permit a group health plan and a health insurance issuer offering group or individual health insurance coverage to utilize value-based insurance designs." The results of this study should be informative for establishing these guidelines.

This study adopted a number of design features to improve internal validity of our results, including the use of a propensity score–matched nonequivalent comparator group. In addition, the lack of adherence improvement among 2 therapeutic classes (ARBs and CAIs) that experienced the same degree of copayment reduction shifting from tier 3 to tier 2 in both the VBID and comparison groups suggested that the adherence improvements observed in the other therapeutic classes were not simply a design phenomenon. However, as with any observational study, our results should be interpreted in light of potential limitations. Adherence estimates stemming from health claims data assume medication consumption once a prescription is filled, which may not always be true. Although this study controlled for numerous covariates that were thought to influence the relationship of VBID on medication adherence, there remains the possibility for additional unobservable confounders to influence our study results. Finally, caution should be used when extrapolating results to other insured populations or populations of patients using medications for other chronic health conditions that were not examined. Additionally, the results are generalizable to patients previously using medications for chronic health conditions prior to the initiation of the policy and do not account for potential adherence improvements related to initiating new treatments following VBID.

CONCLUSIONS

The results from this study suggest that VBID implementation was associated with improvements in medication adherence ranging from 2% to 5% 2 years following VBID adoption. These adherence changes were most notable among patients who were previously nonadherent to treatment prior to VBID. These adherence results adds to a small but growing body of literature suggesting that VBID copayment policies may improve the clinical management of chronic health conditions.

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