

# Impact of Consumer-Directed Health Plans on Low-Value Healthcare

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**L**ow-value healthcare services are medical tests and procedures that provide unclear or no clinical benefit to patients, but still expose them to both risk and expense. Despite evidence of their lack of clinical benefit to patients, these unnecessary services remain frequently ordered and contribute substantially toward wasteful spending within the US healthcare system.<sup>1-4</sup> Reducing the use of low-value services offers an opportunity to decrease wasteful spending while improving access and quality. One influential effort to reduce low-value services is the American Board of Internal Medicine Foundation's Choosing Wisely campaign. This initiative, which assembled recommendations from 75 physician and professional societies on low-value services to avoid in their specialty, has garnered support and partnership from patient and payer organizations alike.<sup>5-7</sup>

An emerging body of research has begun to measure low-value services in the US healthcare system. Some study results have demonstrated that the volume of low-value services delivered to Medicare patients varies across regions and physician organizations.<sup>8-11</sup> Another recent study's results demonstrated regional variation among commercially insured patients and that patients from more advantaged groups (ie, white, higher-income) receive more low-value services.<sup>12</sup>

In a related trend, consumer-directed health plans (CDHPs) are growing in popularity. These plans combine high deductibles with tax-sheltered health savings accounts (HSAs) that allow patients to pay out-of-pocket costs using pretax dollars. This benefit structure results in greater cost sharing for patients, which is intended to spur value-conscious care choices and reduce wasteful spending. In the employer-sponsored insurance market, CDHP enrollment increased from 4% to 29% over the last decade.<sup>13</sup> In the individual market, nearly 90% of Affordable Care Act Marketplace enrollees are in CDHPs.<sup>14</sup> Prior research has shown that CDHPs do reduce overall healthcare spending.<sup>15-17</sup> If CDHPs encourage more value-conscious choices, then these spending reductions should be concentrated among low-value services that offer unclear or no clinical benefit. However, the effects of CDHPs on low-value services have not been

## ABSTRACT

**OBJECTIVES:** To assess the impact of consumer-directed health plan (CDHP) enrollment on low-value healthcare spending.

**STUDY DESIGN:** We performed a quasi-experimental analysis using insurance claims data from 376,091 patients aged 18 to 63 years continuously enrolled in a plan from a large national commercial insurer from 2011 to 2013. We measured spending on 26 low-value healthcare services that offer unclear or no clinical benefit.

**METHODS:** Employing a difference-in-differences approach, we compared the change in spending on low-value services for patients switching from a traditional health plan to a CDHP with the change in spending on low-value services for matched patients remaining in a traditional plan.

**RESULTS:** Switching to a CDHP was associated with a \$231.60 reduction in annual outpatient spending (95% CI, -\$341.65 to -\$121.53); however, no significant reductions were observed in annual spending on the 26 low-value services [-\$3.64; 95% CI, -\$9.60 to \$2.31] or on these low-value services relative to overall outpatient spending [-\$7.86 per \$10,000 in outpatient spending; 95% CI, -\$18.43 to \$2.72]. Similarly, a small reduction was noted for low-value spending on imaging [-\$1.76; 95% CI, -\$3.39 to -\$0.14], but not relative to overall imaging spending, and no significant reductions were noted in low-value laboratory spending.

**CONCLUSIONS:** CDHPs in their current form may represent too blunt an instrument to specifically curtail low-value healthcare spending.

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## TAKEAWAY POINTS

- ▶ Consistent with prior study findings, switching from a traditional plan to a consumer-directed health plan (CDHP) was associated with reduced overall outpatient spending.
- ▶ However, switching to a CDHP did not reduce spending on low-value healthcare services that offer unclear or no clinical benefit and represent a significant source of waste.
- ▶ This pattern was consistent for laboratory services, imaging services, and services both more and less sensitive to patient preferences.
- ▶ CDHPs may encourage patients to curb spending indiscriminately rather than specifically reducing low-value services; more targeted consumer incentives in CDHPs may be necessary to reduce this source of waste.

studied. In this study, we assessed the impact of enrolling in a CDHP on low-value healthcare service spending.

## METHODS

### Study Design

In this quasi-experimental analysis, we used a difference-in-differences (DID) approach to compare the change in patients' spending after switching to a CDHP from a traditional plan with that of matched patients who remained in a traditional plan.

### Data

We used a 25% random sample of 2011 to 2013 Optum Clinformatics Datamart insurance claims for UnitedHealthcare-affiliated commercial plan members across all 50 states. To enable comparisons across patients and geographic areas, Optum standardizes allowed payments in their data as follows: facility outpatient charges are priced at a percent of the submitted charge, professional services are priced at approximately 130% of Medicare fee-for-service pricing for the relative value units (RVUs) assigned to the service, and ancillary services are priced at approximately 120% of the Medicare pricing for the RVUs assigned to the service.

Patient demographic data included age, sex, race, household income, and geographic region via census divisions. Race and household income were estimated by Optum via proprietary algorithms using residential address and other personal information. Health plan information included plan type and whether the plan included CDHP features. We measured comorbidity as the count of diagnoses contributing to the Charlson Comorbidity Index using 2011 claims.<sup>18</sup>

### Inclusion Criteria

We included patients aged 18 to 63 years in 2012 who were continuously enrolled from 2011 to 2013. We excluded patients without complete sociodemographic information, those who were enrolled in a CDHP before 2013, and those enrolled in health maintenance organization and exclusive provider organization plans, as these plan types only rarely offered CDHP options.

### Matching

We compared 2 groups of patients. The first group comprised patients who switched from a traditional plan to a CDHP between 2012 and 2013; the second included patients who remained in a traditional plan. To reduce the impact of selection bias, we matched the traditional-plan patients to the CDHP patients on observable characteristics (ie, age, sex, race, household income, census division, comorbidity, and 2012 health plan type). To do so,

we employed exact matching, which is more stringent and robust than propensity score methods.<sup>19</sup> First, we identified patients in the traditional-plan group who exactly matched patients in the CDHP group based on the observable patient characteristics described above. We allowed more than 1 patient in the traditional-plan group to match each patient in the CDHP group. Then, we excluded patients within each group who did not have at least 1 patient who was an exact match in the other group. Finally, to account for one-to-many matching, we weighted the patients within the traditional-plan group so that their distribution of characteristics was the same as the CDHP group.

### Measuring of Low-Value Service Spending

We employed 26 previously published measures of low-value services, focusing on services delivered in the outpatient setting, where the impact of CDHPs on consumer behavior is greatest (**Table 1**).<sup>8,9,12,20,21</sup> These measures are based on Choosing Wisely recommendations, expert consensus, or literature evidence. Detailed specifications are provided in **eAppendix Table 1** (eAppendices available at [ajmc.com](http://ajmc.com)).

We measured spending for instances of low-value services using 3 approaches. First, for most low-value services, we simply used the cost from the service's claim as the spending for that service. Second, for low-value services for which there are predictable related services that co-occur (eg, venipuncture for a blood test), we also included the cost for any claims for a narrow set of related services that occurred on the same day in the spending for that low-value service. We applied this approach to the following measures: homocysteine testing in cardiovascular disease, parathyroid hormone testing for stage I-III chronic kidney disease, hypercoagulability testing for venous thromboembolism, preoperative chest radiography, preoperative pulmonary function testing, stress testing in stable coronary artery disease, and inferior vena cava filters to prevent pulmonary embolism. (Specifications for the co-occurring services are provided in eAppendix Table 1.) Finally, for complex services where the true cost of the service included a wider array of co-occurring related services, we summed outpatient costs for the entire day of the low-value service. We applied this approach to the following low-value services: renal artery

angioplasty or stent, arthroscopic surgery for knee osteoarthritis, spinal injection for lower back pain, and vertebroplasty or kyphoplasty for osteoporotic vertebral fractures.

After measuring spending for each instance of a low-value service, we summed each patient’s annual spending for each low-value service. Then, we summed each patient’s annual spending across all low-value and all outpatient services. To reduce the impact of spending outliers on our analyses, we winsorized annual spending for each low-value service and for overall outpatient spending by imputing the spending amounts at the 5th and 95th percentiles for any patients whose spending fell outside these percentiles.

We used these spending calculations to assess 3 spending outcomes: 1) annual outpatient spending overall, 2) annual low-value spending (ie, spending on the 26 low-value service measures), and 3) annual low-value spending per \$10,000 in overall outpatient spending. In essence, this proportional outcome allowed us to analyze low-value spending controlling for overall spending.

**Regression Analyses**

Employing a DID approach to estimate spending, our regression models included a variable identifying patients in the CDHP group, a variable identifying the year after the switch, and an interaction term between these variables that assessed the association between CDHP enrollment and spending. This approach accounts for both spending trends over time and any observed or unobserved differences between the CDHP and traditional-plan groups that were stable over time. We used 2-part models because of the frequency of patients with zero spending. In these models, the first part (a probit model) estimated the probability of any spending and the second part (a generalized linear model with a  $\gamma$ -distribution and a log link function) estimated the amount of spending for those patients who had any spending.<sup>22</sup> Our models adjusted for patient and plan characteristics, including age, sex, race, household income, census division, comorbidity, and plan type. We present our results as average marginal effects, or the average change in spending attributable to switching from a traditional plan to a CDHP.

To address whether CDHP effects differed by service type, we repeated these analyses limited to laboratory (Current Procedural Technology [CPT] codes 80000-89999) or imaging (CPT codes 70000-79999) spending. Although a physician or provider is the one ultimately ordering the low-value services, some services are more likely to be subject to patient demand or preferences than others. Therefore, we repeated these analyses for 8 services deemed more sensitive to patient preferences (sinus CT for uncomplicated acute rhinosinusitis, head imaging for syncope, head imaging for uncomplicated headache, back imaging for patients with nonspecific low back pain, imaging for diagnosis of plantar fasciitis, stress testing for stable coronary artery disease, arthroscopic surgery for knee osteoarthritis, and spinal injections for lower back pain) versus the remaining 18 services.

**TABLE 1.** Low-Value Service Measures

<b>Cardiovascular Testing and Procedures</b>
IVC filters to prevent PE
Renal artery angioplasty or stent
Screening for carotid artery disease for syncope
Screening for carotid artery disease in asymptomatic adults
Stress testing for stable coronary artery disease
<b>Diagnostic and Preventive Testing</b>
1,25-OH vitamin D testing without hypercalcemia or CKD
Homocysteine testing in cardiovascular disease
HPV testing in those younger than 30
Hypercoagulable testing for venous thromboembolism
Imaging for adnexal cysts
PTH test for stage I-III CKD
T3 testing for hypothyroidism
<b>Head and Neurologic Testing</b>
EEG for headache
Head imaging for syncope
Head imaging for uncomplicated headache
Sinus CT for uncomplicated acute rhinosinusitis
<b>Musculoskeletal Testing and Procedures</b>
Arthroscopic surgery for knee osteoarthritis
Frequent bone-density testing
Imaging for nonspecific low back pain
Imaging for plantar fasciitis
Spinal injection for lower back pain
Vertebroplasty or kyphoplasty for osteoporotic vertebral fractures
<b>Preoperative Testing</b>
Preoperative chest radiography
Preoperative echocardiography
Preoperative pulmonary function testing
Preoperative routine stress tests

CKD indicates chronic kidney disease; CT, computed tomography; EEG, electroencephalogram; HPV, human papillomavirus; IVC, inferior vena cava; PE, pulmonary embolism; PTH, parathyroid hormone.

The University of Southern California Institutional Review Board exempted this study. We used SAS version 9.2 (SAS Institute; Cary, North Carolina) for descriptive analyses and STATA (StataCorp LP; College Station, Texas) for regression analyses.

**RESULTS**

**Study Cohort and Matching**

A total of 11,149 CDHP patients and 408,019 traditional-plan patients met inclusion criteria. Of these, 11,075 (99.3%) CDHP patients and

**TABLE 2.** Characteristics of Patients in CDHPs and Traditional Health Plans, Before and After Matching and Weighting

Enrollee Characteristics	Before Matching			After Matching			
	Traditional Plan (%) n = 408,019	CDHP (%) n = 11,149	P <sup>a</sup>	Traditional Plan (%) n = 365,016	CDHP (%) n = 11,075	P <sup>a</sup>	
Age, years							
18-34	28.5	28.4		28.4	28.4		
35-49	36.1	37.1		.09	37.1		37.1
50-63	35.3	34.5			34.5		34.5
Sex							
Female	49.8	49.9		49.9	49.9		
Male	50.2	50.1		.92	50.1		50.1
Race/ethnicity <sup>b</sup>							
White	72.5	72.8	<.001	73.2	73.2		
Black	8.0	8.0		8.0	8.0		
Hispanic	11.1	8.3		8.3	8.3		
Asian	4.4	6.7		6.6	6.6		
Unknown	4.0	4.2		4.0	4.0		
Household income <sup>c</sup>							
Unknown	11.8	11.9	<.001	11.9	11.9		
<\$40K	8.8	8.0		8.0	8.0		
\$40-\$49K	5.3	5.0		4.9	4.9		
\$50-\$59K	6.0	5.6		5.5	5.5		
\$60-\$74K	9.5	9.0		8.9	8.9		
\$75-\$99K	15.1	15.2		15.2	15.2		
≥\$100K	43.4	45.4		45.6	45.6		
Census divisions							
East North Central	17.4	18.5	<.001	18.6	18.6		
East South Central	3.6	4.0		3.9	3.9		
Middle Atlantic	9.3	5.6		5.6	5.6		
Mountain	9.3	13.3		13.2	13.2		
New England	4.5	3.0		3.0	3.0		
Pacific	7.4	9.4		9.4	9.4		
South Atlantic	18.6	19.4		19.4	19.4		
West North Central	10.1	11.3		11.3	11.3		
West South Central	19.8	15.6		15.6	15.6		
Comorbidity count							
0	84.5	86.4	<.001	86.9	86.9		
1	12.5	11.0		10.8	10.8		
2	2.3	1.9		1.8	1.8		
≥3	0.7	0.7		0.6	0.6		

(continued)

365,016 (89.5%) traditional-plan patients had at least 1 exact match in the other group. After weighting, the groups were exactly matched on patient characteristics and had similar 2012 spending (Table 2).

### Effect of CDHP Enrollment on Low-Value Spending

We found that between 2012 and 2013, overall outpatient spending decreased by \$100.93 for CDHP enrollees but increased by \$130.67 for traditional-plan patients; accordingly, switching to a CDHP was associated with a \$231.60 (95% CI, -\$341.65 to -\$121.53) reduction in annual outpatient spending. Low-value spending decreased by \$7.93 for CDHP patients and by \$4.29 for traditional-plan patients, resulting in no significant association between switching to a CDHP and low-value spending (-\$3.64; 95% CI, -\$9.60 to \$2.31). Finally, low-value spending per \$10,000 in overall outpatient spending decreased by \$15.54 for CDHP patients and by \$7.68 for traditional-plan patients, again resulting in no significant association between switching to a CDHP and relative low-value spending (-\$7.86 per \$10,000 in overall outpatient spending; 95% CI, -\$18.43 to \$2.72) (Table 3).

Among analyses restricted to imaging, we observed a similar association between switching to a CDHP and reduced spending on outpatient imaging overall (-\$22.17; 95% CI, -\$38.60 to -\$5.74). We also observed a small association between switching to a CDHP and reduced low-value outpatient imaging spending (-\$1.76; 95% CI, -\$3.39 to -\$0.14), but no difference in low-value imaging spending relative to outpatient imaging spending overall (-\$50.63 per \$10,000 in outpatient imaging spending overall; 95% CI, -\$119.22 to \$17.96). Among analyses restricted to laboratory services, we again observed an association between switching to a CDHP and reduced outpatient laboratory spending overall (-\$13.44; 95% CI, -\$22.59 to -\$4.28), but no differences for low-value laboratory spending in general (-\$0.19; 95% CI, -\$0.56 to \$0.19) or relative to outpatient laboratory spending overall (-\$3.90 per \$10,000 in outpatient laboratory spending overall; 95% CI, -\$26.39 to \$18.58) (Table 4).

Stratifying services by their sensitivity to patient preferences, we observed no association between switching to a CDHP and spending on low-value services more sensitive to patient preferences, in general (-\$2.56; 95% CI, -\$8.51 to \$3.39) or relative to overall outpatient spending (-\$6.94 per \$10,000 in outpatient spending overall; 95% CI, -\$16.00 to \$2.13). The same was true for those low-value services less sensitive to patient preferences, both in general (-\$0.87; 95% CI, -\$2.22 to \$0.47) or relative to overall outpatient spending (-\$3.06 per \$10,000 in outpatient spending overall; 95% CI, -\$8.16 to \$2.04) (Table 4).

The results of unadjusted analyses are qualitatively similar and are available in [eAppendix Table 2](#).

### Sensitivity Analyses

To ensure that our approach to spending outliers did not affect our conclusions, we repeated our main regression analyses without winsorization and found the results to be similar ([eAppendix Table 3](#)).

Patients who are planning to switch to a CDHP might try to obtain extra medical services immediately before their switch in anticipation of higher cost sharing after. Indeed, we observed that CDHP patients' overall outpatient spending increased in the last 3 months before their switch compared with traditional-plan patients, suggestive of this anticipatory spending ([eAppendix Figure 1](#)). This was not true for low-value spending, however. This pattern could cause selection bias in our analyses, attributing savings to CDHPs that are only detected due to this anticipatory spending. To address this concern, we repeated our analyses including spending in the last 3 months of 2012 in our postswitch measurement period and found that this did not meaningfully change our results ([eAppendix Table 4](#)).

If patients who switched into a CDHP already had declining spending before their switch, this could also cause selection bias in our analyses, inappropriately attributing savings to CDHPs that would have occurred even without a change in coverage. To address this concern, we compared trends in monthly spending for CDHP and traditional-plan patients in the 2 years before the switch and found similar spending trends between the 2 groups ([eAppendix Figure 1](#)).

**TABLE 2.** Characteristics of Patients in CDHPs and Traditional Health Plans, Before and After Matching and Weighting (*continued*)

Enrollee Characteristics	Before Matching			After Matching		
	Traditional Plan (%) n = 408,019	CDHP (%) n = 11,149	P <sup>a</sup>	Traditional Plan (%) n = 365,016	CDHP (%) n = 11,075	P <sup>a</sup>
Health plan type						
POS or other	95.7	95.5	.45	95.9	95.9	.99
PPO or indemnity	4.3	4.5		4.1	4.1	
2012 spending (\$)						
Outpatient overall	2584.80	2474.60	.002	2503.90	2458.40	.22
Low-value	28.28	23.16	.02	27.57	23.01	.04
Low-value per \$10,000 outpatient overall	66.28	60.16	.11	65.33	60.08	.17

CDHP indicates consumer-directed health plan; POS, point-of-service; PPO, preferred provider organization.

<sup>a</sup>Test of significance was  $\chi^2$  for categorical sociodemographic characteristics and Satterthwaite *t* test for 2012 spending.

<sup>b</sup>In Optum data, this is derived from a combination of information from public records, self-reported surveys, and a proprietary ethnic code table from the KBM Group.

<sup>c</sup>In Optum data, this is derived from a demographic-based analytical model.

**TABLE 3.** Adjusted Average Marginal Effect of CDHP Enrollment on Outpatient Low-Value Healthcare Spending

	Mean Annual Spending in \$			
	Pre-to-Post Difference	DID	(95% CI)	P
Outpatient spending overall				
CDHP	-100.93	-231.60	[-341.65 to -121.53]	<.001
Traditional	130.67			
Low-value spending				
CDHP	-7.93	-3.64	[-9.60 to 2.31]	.23
Traditional	-4.29			
Low-value spending per \$10,000 outpatient spending overall				
CDHP	-15.54	-7.86	[-18.43 to 2.72]	.15
Traditional	-7.68			

CDHP indicates consumer-directed health plan; DID, difference-in-differences.

## DISCUSSION

Switching to a CDHP is associated with decreased outpatient spending overall, but no change in spending on 26 common low-value services. This pattern of decreased overall spending, but not low-value spending, was paralleled among imaging and laboratory services and services both more and less sensitive to patient preferences.

It was not possible for us to know patients' reasons for switching to a CDHP. Accordingly, we cannot know whether patients decided to switch to these plans with lower premiums and higher cost

**TABLE 4.** Adjusted Average Marginal Effect of CDHP Enrollment on Spending for Subgroups of Low-Value Healthcare Services

	Mean Annual Spending in \$			
	Pre-to-Post Difference	DID	(95% CI)	P
<b>Imaging</b>				
Outpatient spending overall				
CDHP	-20.15	-22.17	[-38.60 to -5.74]	.008
Traditional	2.02			
Low-value spending				
CDHP	-2.44	-1.76	[-3.39 to -0.14]	.03
Traditional	-0.68			
Low-value spending per \$10K outpatient spending overall				
CDHP	-59.72	-50.63	[-119.22 to 17.96]	.15
Traditional	-9.09			
<b>Laboratory</b>				
Outpatient spending overall				
CDHP	-2.06	-13.44	[-22.59 to -4.28]	.004
Traditional	11.38			
Low-value spending				
CDHP	-0.13	-0.19	[-0.56 to 0.19]	.33
Traditional	0.06			
Low-value spending per \$10K outpatient spending overall				
CDHP	-5.42	-3.90	[-26.39 to 18.58]	.73
Traditional	-1.52			
<b>More sensitive to patient preference</b>				
Low-value spending				
CDHP	-6.63	-2.56	[-8.51 to 3.39]	.40
Traditional	-4.07			
Low-value spending per \$10K outpatient spending overall				
CDHP	-13.70	-6.94	[-16.00 to 2.13]	.13
Traditional	-6.76			
<b>Less sensitive to patient preference</b>				
Low-value spending				
CDHP	-0.90	-0.87	[-2.22 to 0.47]	.20
Traditional	-0.03			
Low-value spending per \$10K outpatient spending overall				
CDHP	-2.98	-3.06	[-8.16 to 2.04]	.24
Traditional	0.08			

CDHP indicates consumer-directed health plan; DID, difference-in-differences.

sharing because they anticipated low medical spending in the coming year or because of some other reason unrelated to their healthcare needs (eg, their employer changed their plan offerings). This raises concerns that patients who switch to CDHPs might have different spending patterns than those who do not, which could create selection bias in our analyses. This has been observed in

prior studies of CDHPs.<sup>23-27</sup> To minimize the impact of selection bias, we used stringent exact matching to ensure that patients in the traditional-plan group were as comparable as possible with those in the CDHP group on characteristics we could directly observe. We also used a DID approach, in which each group was compared with itself over time, to account for the influence of any confounders that we could not observe that were stable over time. We also performed sensitivity analyses to address whether there were differences in the CDHP group's spending over time that could account for our results. Although we did observe an anticipatory increase in spending immediately before a switch to a CDHP, accounting for this pattern did not materially change our results. Moreover, monthly spending trends in the preswitch period were parallel for the CDHP and traditional-plan groups, which further mitigates concerns about selection bias. If our analyses were impacted by selection bias, it would result in our attributing a difference in low-value spending to CDHP enrollment that was actually due to this bias. For example, if patients who became more cost-conscious over time switched to CDHPs, our analyses would find less low-value spending after the switch, even if CDHPs actually had no effect on low-value spending. Despite this possibility, we found no association between low-value spending and CDHP enrollment, suggesting that CDHP enrollment likely does not affect low-value services.

Additionally, the modest reduction in overall outpatient spending associated with CDHP enrollment we found is comparable with that seen in prior research. Haviland and colleagues found a \$114 reduction per patient in outpatient spending in the first year that companies began to include CDHPs in their plan offerings.<sup>15</sup> Buntin and colleagues found a \$45 monthly reduction per family in outpa-

tient spending among those who enrolled in a CDHP compared with those not offered these plans.<sup>16</sup>

Prior research dating to the RAND Health Insurance Experiment shows that plans with greater cost sharing, like CDHPs, produce reductions in spending on healthcare, both needed and not.<sup>28,29</sup> CDHPs have shown mixed effects or modest reductions on receipt

of high-value care (ie, preventive or chronic disease services and adherence or continuation of chronic medications), particularly among more vulnerable populations.<sup>16,17,27,30-37</sup> Additionally, CDHP patients have shown limited understanding or ability to act upon the increased cost sharing or other features of their plan's benefit design through price shopping.<sup>17,38-40</sup> Our finding of no reduction in low-value service spending adds an additional dimension to the evidence that patients may not discriminate well between high- and low-value services when responding to increased cost sharing.

Some point to value-based insurance design (VBID), which offers lower cost sharing for high-value services and higher cost sharing for low-value services, as a more targeted alternative to CDHPs to steer patients toward value-conscious care.<sup>41-43</sup> In several settings in the employer-sponsored market, VBID has resulted in increased quality and medication adherence, but not necessarily cost savings.<sup>44</sup> The Center for Medicare and Medicaid Innovation is currently testing VBID in Medicare Advantage in multiple states.<sup>45</sup> VBID may offer a more nuanced mechanism than CDHPs to spur value-based behavior, but cost savings are unproven and patients face similar challenges in understanding benefit design features.

Alternatively, the lack of effect of CDHP enrollment on even those low-value services more sensitive to patient preferences and demand may support the argument that the most effective locus to spur value-conscious decisions may not be patients, but providers. Price transparency does not consistently result in patient price shopping, even for those in CDHPs.<sup>40,46</sup> However, payment arrangements that give providers "skin in the game," like Blue Cross Blue Shield of Massachusetts' Alternative Quality Contract, have achieved cost savings by steering patients toward lower-priced services.<sup>47</sup> Additionally, use of low-value services appears to vary substantially among provider organizations.<sup>10</sup> This suggests that providers can influence demand for value-conscious care and that appropriately targeted provider incentives have potential to reduce wasteful low-value spending. More research is needed to understand how provider and group characteristics influence delivery of low-value services.

## Limitations

Our study has several limitations. We cannot observe benefit package details (ie, employers' HSA contributions, deductible levels), but the effect of CDHP enrollment on spending could vary with benefit generosity.<sup>15,16,48</sup> Also, although the 26 low-value services assessed are common, represent professional consensus, and encompass many service types and clinical areas, they are inherently limited in scope. The impact of CDHP enrollment on other low-value services may differ. Additionally, we observe only 1 year after patients' switch. Patients may take time to adapt to CDHPs' cost sharing to specifically reduce low-value spending. However, prior research has shown CDHPs' largest outpatient spending effects to occur in the first year.<sup>15,37,49</sup> Finally, our data are derived

from a single insurer, which may limit generalizability; however, this insurer spans many markets nationally.

## CONCLUSIONS

Switching to a CDHP was associated with reduced overall outpatient spending, but not with reduced spending on low-value services in particular. As CDHP enrollment continues to grow, our findings suggest that their broadly increased overall cost sharing may encourage patients to cut spending indiscriminately, rather than to specifically reduce low-value care. Modification of the consumer incentives in CDHPs, more targeted VBIDs, or efforts focused on providers, rather than patients, may be necessary to expressly reduce wasteful spending. ■

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**eAppendix Table 1.** Specifications for Low-Value Healthcare Service Measures

<b>Procedure</b>	<b>Definition</b>	<b>Criteria</b>	<b>Applicable Codes</b>
<b>Cardiovascular Testing and Procedures</b>			
IVC filters to prevent PE	Any IVC filter placement	Identifying CPTs	Before 2012: 75940 In and After 2012: 37191
		Inclusion	
		Exclusion	
		Additional Costs	Any of the following: CPT: 36010, 37620, 75825, 76937 on the same day
Renal artery angioplasty or stent	Renal/visceral angioplasty or stent placement with renal atherosclerosis or renovascular hypertension diagnosis in procedure claim	Identifying CPTs	35471, 35450, 37205, 37207, 75966, 75960
		Inclusion	ICD9: 4401, 40501, 40511, 40591
		Exclusion	
		Additional Costs	All procedures occurring on the same day
Screening for carotid artery disease for syncope	Carotid imaging with syncope diagnosis for patients without stroke or TIA history, and without diagnosis of stroke, TIA, or focal neurologic symptoms in claim	Identifying CPTs	36222, 36223, 36224, 70498, 70547, 70548, 70549, 93880, 93882, 3100F
		Inclusion	1 year look-back, ICD9:7802, 9921
		Exclusion	Stroke/TIA by CCW, ICD9: 430, 431, 43301, 43311, 43321, 43331,43381, 43391, 43400, 43401, 43410, 43411,43490, 43491, 4350, 4351, 4353, 4358, 4359, 436, 99702, V1254, 3623, 36284, 781xx, 7820, 78451, 78452, 78459, 781xx
		Additional Costs	
Screening for carotid artery disease in asymptomatic adults	Carotid imaging not associated with inpatient or emergency care for patients without a history of stroke or TIA and without a diagnosis of stroke, TIA, or focal neurologic symptoms in claim	Identifying CPTs	36222, 36223, 36224, 70498, 70547, 70548, 70549, 93880, 93882, 3100F
		Inclusion	1 year look-back
		Exclusion	Stroke/TIA by CCW, Hospitalization associated with ED or ED up to 14 days before procedure, ICD9: 430, 431, 43301, 43311, 43321, 43331, 43381, 43391, 43400, 43401, 43410, 43411, 43490, 43491, 4350, 4351, 4353, 4358, 4359, 436, 99702, V1254, 3623, 36284, 7802, 781xx, 7820, 78451, 78452, 78459, 781xx
		Additional Costs	
Stress testing for stable coronary artery disease	Stress test not associated with inpatient or ED care for patients with an established diagnosis of acute myocardial infarction ( $\geq 3$ mo before)	Identifying CPTs	93015, 93016, 93017, 93018, 93350, 93351, 78451, 78452, 78453, 78454, 78460, 78461, 78464, 78465, 78472, 78473, 78481, 78483, 78491, 78492
		Inclusion	AMI by CCW > 3 months before procedure, 1 year look-back

		Exclusion	Hospitalization associated with ED, or ED up to 14 days before procedure
		Additional Costs	Any of the following: CPT: 93303-93352, 93000-93042, 78414-78499, 75552-75564, 75571-75574, A9500-A9700, J0150, J0152, J0280, J1245, J1250, J2785 on the same day
<b>Diagnostic and Preventive Testing</b>			
1,25-OH Vitamin D testing without hypercalcemia or CKD	Calcitriol test without hypercalcemia, secondary hyperparathyroidism, or other hypercalcemia condition (sarcoidosis, TB, or selected neoplasms) in claim, or CKD history; no hypercalcemia diagnosis in past 30d	Identifying CPTs	82652
		Inclusion	1 year look-back
		Exclusion	CKD by CCW, ICD9: 27542, 58881, 1890, 1891, 1830, 135xx, 173xx, 174xx, 175xx, 188xx, 200xx, 201xx, 202xx, 203xx, 204xx, 205xx, 206xx, 207xx, 208xx, 01xxx
		Additional Costs	
Homocysteine testing in cardiovascular disease	Homocysteine test with no diagnoses of folate or vitamin B12 deficiencies in claim and no folate or vitamin B12 test in prior claims	Identifying CPTs	83090
		Inclusion	1 year look-back
		Exclusion	History of B12 or Folate Disorders (2662, 2704, 2810, 2811, 2812, 2859)
		Additional Costs	CPT: 36415 on the same day
HPV testing younger than 30	HPV test in female patients younger than age 30	Identifying CPTs	87622, 87620, 90649, 87621, 90650
		Inclusion	Female, <30 years old
		Exclusion	
		Additional Costs	
Hypercoagulable testing for VTE	Hypercoagulable state laboratory test within 30d after lower extremity DVT or PE diagnosis; no evidence of recurrent thrombosis (i.e., DVT or PE diagnosis >90 d before claim)	Identifying CPTs	83090, 85300, 85303, 85306, 85613, 86147
		Inclusion	Deep Vein Thrombosis/Pulmonary Embolism diagnosis within 30 days (4151, 4510, 45111, 45119, 4512, 45181, 4519, 4534, V1251), 1 year look-back
		Exclusion	Recurrent Deep Vein Thrombosis/Pulmonary Embolism (defined as a DVT/PE diagnosis >90 days before the current diagnosis)
		Additional Costs	CPT: 83890-83914 on the same day
Imaging for adnexal cysts	2 or more echography procedures within 60d of primary diagnosis of adnexal cyst	Identifying CPTs	76857, 76830
		Inclusion	1 year look-back, Prior cyst testing within 60 days, ICD9: 6200, 6201, 6202

		Exclusion	
		Additional Costs	
PTH test for stage I-III CKD	PTH test for CKD; no dialysis services before or ≤30 d after test, no hypercalcemia diagnosis during year	Identifying CPTs	83970
		Inclusion	CKD by CCW, 1 year look-back
		Exclusion	No prior dialysis, no upcoming dialysis within 30 days, no hypercalcemia in 2009
		Additional Costs	36415 on the same day
T3 testing for hypothyroidism	Total or free T3 measurement in patient with hypothyroidism diagnosis during year	Identifying CPTs	84480, 84481
		Inclusion	Hypothyroidism within 1 year (244xx), 1 year look-back
		Exclusion	
		Additional Costs	
<b>Head and Neurologic Testing</b>			
EEG for headache	EEG with headache diagnosis in claim, and no epilepsy or convulsions in current or prior claims	Identifying CPTs	95812, 95813, 95816, 95819, 95822, 95827, 95830, 95957
		Inclusion	1 year look-back, ICD9: 30781, 7840, 339xx, 346x
		Exclusion	History of epilepsy (7803x, 7810x)
		Additional Costs	
Head imaging for syncope	Head CT or MR imaging with syncope diagnosis and no diagnoses in claim warranting imaging	Identifying CPTs	70450, 70460, 70470, 70551, 70552, 70553
		Inclusion	ICD9: 7802, 9921
		Exclusion	ICD9: 78097, 7820, V1254, 345xx, 800xx, 801xx, 802xx, 803xx, 804xx, 850xx, 851,,852xx, 853xx, 854xx, 870xx, 871xx, 872xx, 873xx, 910xx, 920xx, 921xx, 781xx, V10xx, 7803x, 7845x, 9590x, 43xxx
		Additional Costs	
Head imaging for uncomplicated headache	Brain CT or MR imaging with non-posttraumatic, non-thunderclap headache diagnosis, and no diagnoses in claim warranting imaging	Identifying CPTs	70450, 70460, 70470, 70551, 70552, 70553
		Inclusion	ICD9: 30781, 7840, 339xx, 346x
		Exclusion	ICD9: 33920, 33921, 33922, 33943, 4465, 78097, V1254, 345xx, 800xx, 801xx, 802xx, 803xx, 804xx, 850xx, 851xx, 852xx, 853xx, 854xx, 870xx, 871xx, 872xx, 873xx, 781xx, V10xx, 3463x, 3466x, 7803x, 7845x, 9590x, 43xxx, 140xx-208xx, 230xx-239xx
		Additional Costs	

		Additional Costs	
Sinus CT for uncomplicated acute rhinosinusitis	Maxillofacial CT with sinusitis diagnosis and no sinusitis complications, immune deficiencies, nasal polyps, or head/face trauma in claim and no sinusitis diagnosis 30-365 d before imaging	Identifying CPTs	70486, 70487, 70488
		Inclusion	1 year look-back, 461xx, 473xx
		Exclusion	No chronic sinusitis (previous sinusitis procedure occurring between 30days and 1 year before the current claim), ICD9: 07953, 37600, 2770x, 9590x, 471xx, 373xx, 800xx, 801xx, 802xx, 803xx, 804xx, 850xx, 851xx, 852xx, 853xx, 854xx, 870xx, 871xx, 872xx, 873xx, 910xx, 920xx, 921xx, 042xx, 279xx
		Additional Costs	
<b>Musculoskeletal Testing and Procedures</b>			
Arthroscopic surgery for knee osteoarthritis	Knee arthroscopic debridement or chondroplasty with osteoarthritis or chondromalacia diagnosis in procedure claim and no meniscal tears in procedure claim	Identifying CPTs	29877, 29879, G0289
		Inclusion	1 year look-back
		Exclusion	Arthritis within 2 years, ICD9: 8360, 8361, 8362, 7170, 71741
		Additional Costs	All procedures occurring on the same day
Frequent bone density testing	Bone density test within 2y of prior bone density test, with established osteoporosis diagnosis	Identifying CPTs	76977, 77078, 77079, 77080, 77083, 78350, 78351
		Inclusion	Prior bone density testing within 2 years, osteoporosis diagnosis within the last year (73300, 73301, 73302, 73303, 73309), 2 year look-back
		Exclusion	
		Additional Costs	
Imaging for nonspecific low back pain	Back imaging with low back pain diagnosis occurring within 6 wk of initial back pain diagnosis and no diagnoses in claim warranting imaging	Identifying CPTs	72010, 72020, 72052, 72100, 72110, 72114, 72120, 72200, 72202, 72220, 72131, 72132, 72133, 72141, 72142, 72146, 72147, 72148, 72149, 72156, 72157, 72158
		Inclusion	Within 6 weeks of first diagnosis of back pain, 1 year look-back, ICD9: 7213, 72190, 72210, 72252, 7226, 72293, 72402, 7242, 7243, 7244, 7245, 7246, 72470, 72471, 72479, 7385, 7393, 7394, 8460, 8461, 8462, 8463, 8468, 8469, 8472

		Exclusion	No chronic history of back pain (former diagnosis > 6 weeks prior), ICD9: 92611, 92612, 304460, 4210, 4211, 4219, 78079, 01xxx, 86xxx, 952xx, 958xx, 959xx, 038xx, 730xx, 929xx, 7292x, 7830x, 7832x, 7808x, 2859x, 140xx-208xx, 230xx-239xx, 850xx-854xx, 800xx-839xx, 905xx-909xx, 3054x-3057x, 3040x-3042x
		Additional Costs	
Imaging for plantar fasciitis	Radiographic or MR imaging with plantar fasciitis diagnosis within 2w of initial diagnosis	Identifying CPTs	73620, 73630, 73650, 73718, 73719, 73720, 76880, 76881, 76882
		Inclusion	ICD9: 72871, 7294
		Exclusion	
		Additional Costs	
Spinal injection for lower-back pain	Outpatient epidural, facet, or trigger point injections for low back pain, excluding etanercept; no radiculopathy diagnoses in claim	Identifying CPTs	62311, 64483, 20552, 20553, 64493, 64475
		Inclusion	Must be Outpatient or Office visit, ICD9: 7213, 72190, 72210, 7222, 72252, 7226, 72280, 72283, 72293, 72400, 72402, 72403, 7242, 7245, 7246, 72470, 72471, 72479, 7384, 7385, 7393, 7384, 7385, 7393, 7394, 75612, 8460, 8461, 8462, 8463, 8468, 8469, 8472
		Exclusion	ICD9: 72142, 72191, 72270, 72273, 7243, 7244
		Additional Costs	All procedures occurring on the same day
		Identifying CPTs	22520, 22521, 22523, 22524
Vertebroplasty or kyphoplasty for osteoporotic vertebral fractures	Vertebroplasty or kyphoplasty for vertebral fracture; no bone cancers, myeloma, or hemangioma in procedure claim	Inclusion	Osteoporosis diagnosis within the last year (ICD 73300, 73301, 73302, 73303, 73309), 1 year look-back
		Exclusion	ICD9: 1702, 1985, 20300, 20301, 20302, 2132, 22809, 2380, 2386, 2392
		Additional Costs	All procedures occurring on the same day
		Identifying CPTs	
<b>Preoperative Testing</b>			
Preoperative chest radiography	Chest radiograph not associated with inpatient or ED care, ≤30d before low/intermediate risk non-cardiothoracic surgery	Identifying CPTs	71010, 71015, 71020, 71021, 71022, 71023, 71030, 71034, 71035
		Inclusion	Non-Cardiothoracic surgery happening up to 30 days in the future (CPT: 19120, 19125, 47562, 47563, 49560, 58558; BETOS: P1x, P3D, P4A, P4B, P4C, P5C, P5D, P8A, P8G)
		Exclusion	Inpatient or Emergency Setting
		Additional Costs	CPT: 93303-93352 on the same day

Preoperative echocardiography	Echocardiogram not associated with inpatient or ED care, ≤30d before low/ intermediate-risk non-cardiothoracic surgery	Identifying CPTs	93303, 93304, 93306, 93307, 93308, 93312, 93315, 93318
		Inclusion	Non-Cardiothoracic surgery happening up to 30 days in the future (CPT: 19120, 19125, 47562, 47563, 49560, 58558; BETOS: P1x, P3D, P4A, P4B, P4C, P5C, P5D, P8A, P8G)
		Exclusion	Inpatient or Emergency Setting
		Additional Costs	
Preoperative pulmonary function testing	PFT not associated with inpatient or ED care, ≤30d before low/intermediate-risk surgery	Identifying CPTs	94010
		Inclusion	Specified surgery happening up to 30 days in the future (BETOS: P1x, P2x, P3D, P4A, P4B, P4C, P5C, P5D, P8A, P8G)
		Exclusion	Inpatient or Emergency Setting
		Additional Costs	CPT: 94010-94799, 93720-93722 on the same day
Preoperative routine stress tests	Stress EKG, echocardiogram, or nuclear imaging, not associated with inpatient or ED care, ≤30d before low/intermediate-risk non-cardiothoracic surgery	Identifying CPTs	78451, 78452, 78453, 78454, 78460, 78461, 78464, 78465, 78472, 78473, 78481, 78483, 78491, 78492, 93015, 93016, 93017, 93018, 93350, 93351
		Inclusion	Non-Cardiothoracic surgery happening up to 30 days in the future (CPT: 19120, 19125, 47562, 47563, 49560, 58558; BETOS: P1x, P3D, P4A, P4B, P4C, P5C, P5D, P8A, P8G)
		Exclusion	Inpatient or Emergency Setting
		Additional Costs	

**eAppendix Table 2.** Unadjusted Mean Outpatient Low-Value Healthcare Spending for Low-Value Services

	Mean Annual Spending in \$				
	2012	2013	Unadjusted Difference-in- Differences	(95%CI) <sup>a</sup>	<i>p</i>
<b>All Low-Value Services</b>					
Outpatient spending overall					
CDHP	2,458.44	2,384.76	-232.95	(-337.43,-128.48)	<0.001
Traditional	2,503.86	2,663.14			
Low-value outpatient spending					
CDHP	23.00	17.54	-1.45	(-6.92, 4.01)	0.60
Traditional	27.57	23.57			
Low-value spending per \$10,000 in outpatient spending overall					
CDHP	60.08	45.83	-6.96	(-16.56, 2.64)	0.16
Traditional	65.33	58.05			
<b>Imaging</b>					
Outpatient spending overall					
CDHP	266.30	249.90	-22.65	(-38.64, -8.16)	0.006
Traditional	271.90	278.10			
Low-value outpatient spending					
CDHP	8.65	6.84	-1.37	(-2.96, 0.23)	0.09
Traditional	8.55	8.11			
Low-value spending per \$10,000 in outpatient spending overall					
CDHP	247.40	179.00	-60.52	(-144.07, 23.03)	0.16
Traditional	225.20	217.30			
<b>Laboratory</b>					
Outpatient spending overall					
CDHP	208.40	207.80	-13.81	(-22.71, -4.91)	0.002
Traditional	216.30	229.60			
Low-value outpatient spending					
CDHP	1.90	1.66	-0.16	(-0.57, 0.25)	0.44

Traditional	2.06	1.98			
Low-value spending per \$10,000 in outpatient spending overall					
CDHP	99.69	77.32			
Traditional	101.20	79.27	-0.40	(-58.27, 58.47)	0.99
<b>More sensitive to patient preference</b>					
Low-value outpatient spending					
CDHP	17.65	12.57			
Traditional	21.04	16.90	-0.94	(-6.20, 4.33)	0.73
Low-value spending per \$10,000 in outpatient spending overall					
CDHP	37.24	26.02			
Traditional	41.41	35.29	-5.09	(-13.16, 2.98)	0.22
<b>Less sensitive to patient preference</b>					
Low-value outpatient spending					
CDHP	5.38	4.99			
Traditional	6.57	6.86	-0.67	(-1.99, 0.64)	0.31
Low-value spending per \$10,000 in outpatient spending overall					
CDHP	22.84	19.81			
Traditional	23.92	22.88	-1.98	(-7.17, 3.20)	0.45
<sup>a</sup> Confidence intervals derived from the difference in difference estimator from an unadjusted OLS regression of the spending outcome					

**eAppendix Table 3.** Average Marginal Effect of CDHP Enrollment on Outpatient Low-Value Healthcare Spending – with Different Cost Variation Rules

	Annual Spending in \$					
	Main Analysis (i.e., Winsorized at 5 <sup>th</sup> & 95 <sup>th</sup> %ile)			No Winsorization (i.e., Full Cost Variation)		
	Difference-in-Differences	(95%CI)	<i>p</i>	Difference-in-Differences	(95%CI)	<i>p</i>
Outpatient spending overall	-231.60	(-341.70, -121.50)	<0.001	-330.96	(-574.60,-87.3)	0.01
Low-value outpatient spending	-3.64	(-9.60, 2.32)	0.23	-6.64	(-14.20, 0.92)	0.09
Low-value spending per \$10,000 in outpatient spending overall	-7.86	(-18.43, 2.72)	0.15	-8.35	(-19.45, 2.75)	0.14

**eAppendix Table 4.** Analyses Accounting for Anticipation Spending in Q4 of 2012 prior to Switch to CDHP

	Mean Annual Spending in \$					
	Main Analyses			Anticipation Effect Analysis Pre: 2012 Quarters 1-3 Post: 2012 Quarter 4 and 2013		
	Difference- in- Differences	(95%CI)	<i>p</i>	Difference- in- Differences	(95%CI)	<i>p</i>
Outpatient spending overall	-231.60	(-341.65, -121.53)	<0.001	-113.73	(-222.10, -5.35)	0.04
Low-value outpatient spending	-3.64	(-9.60, 2.31)	0.23	-1.64	(-7.68, 4.40)	0.59
Low-value spending per \$10,000 in outpatient spending overall	-7.86	(-18.43, 2.72)	0.15	-0.78	(-17.35, 15.78)	0.93

**eAppendix Figure 1.** Monthly Overall and Low-Value Outpatient Spending Among CDHP and Traditional Plan Enrollees in 2012 and 2013

