Does Pay for Performance Improve Cardiovascular Care in a "Real-World" Setting?

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Abstract

The objective was to investigate the impact of a pay-for-performance program (P4P) on quality care and outcomes among cardiovascular disease (CVD) patients. Claims data were used to identify CVD patients in a commercial plan in 1999-2006. Multivariate analyses were employed to examine the impact of P4P on quality care (lipid monitoring and treatment) and quality care on outcomes (new coronary events, hospitalizations, and lipid control). Patients who were treated by physicians participating in P4P were more likely to receive quality care than patients who were not. Patients who received quality care were less likely to have new coronary events (odds ratio [OR] = 0.80; 95% confidence interval [CI] = 0.69-0.92), be hospitalized (OR = 0.76; 95% CI = 0.69-0.83), or have uncontrolled lipids (OR = 0.67; 95% CI = 0.61-0.73) than patients who did not. A P4P program was associated with increased lipid monitoring and treatment. Receipt of this quality care was associated with improved lipid control and reduced likelihood of new coronary events and hospitalizations.

Keywords

cardiovascular disease, pay for performance, quality care, outcomes

Cardiovascular disease (CVD) is the leading cause of death in the United States.[1] The benefits of statins (ie, HMG-CoA reductase inhibitors), including reducing new cardiovascular events or mortality among CVD patients with elevated,[2] normal, or slightly elevated[3-9] cholesterol levels, have been demonstrated in several large randomized controlled trials. The 2006 American Heart Association guideline recommended that statins be started and continued indefinitely in high-risk CVD patients. In addition, the American Heart Association/American College of Cardiology stated that it is reasonable to treat to a low-density lipoprotein (LDL) level of <70 in such patients.[10] However, this guideline is not always followed in real-world clinical practice.[11,12] In addition, studies have shown that adherence to statins remains low in the usual care setting.[13,14]

Pay for performance (P4P), the concept of financially incentivizing physicians to perform high-quality care, is increasingly being adopted by payers as a mechanism to increase adherence to guidelines, such as performing at least 1 LDL test annually and prescribing statins for patients with CVD. The effectiveness of a P4P program at increasing the receipt of LDL testing among patients has been mixed.

The Integrated Healthcare Association reported a 10.2% increase in cholesterol screening for cardiac care patients after the implementation of their P4P program.[15] However, Young et al found that the Rochester Individual Practice

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Association P4P program had no significant impact on receipt of LDL testing among patients with diabetes.[16]

Observational studies of the benefits of specific aspects of quality cardiovascular care (ie, statin therapy) for higher risk patients with CVD have been reported. Among patients who were hospitalized for acute coronary syndrome, Spencer et al found that patients who were taking statins at presentation and continued to take them during hospitalization were significantly less likely to have new cardiovascular events or to die than patients who never received statins.[17] A recent study demonstrated cardioprotective effects, including decreased rates of myocardial infarction and stroke, associated with the combination of statins and angiotensin-converting enzyme inhibitors in a high-risk CVD population (>55 years old and the majority with diabetes) in a usual care setting.[18] However, the impact of the receipt of high-quality care on health outcomes (as implemented in the context of a P4P program) in a general population with CVD in a real-world setting is less clear. One study found that a nationally implemented P4P program in England was associated with significantly greater cholesterol control for diabetes patients with comorbidity and no impact on diabetes patients without comorbidity.[19] The first objective of the current study was to assess the impact of a physician P4P program on the receipt of high-quality care (ie, receipt of at least 1 laboratory test for LDL and at least 1 prescription for a statin within a 1-year period) among patients 18 to 75 years of age with CVD. The second objective of this study was to assess the effect of receipt of this high-quality care on subsequent health outcomes (ie, new coronary events, hospitalization, LDL control).

Methods

Pay-for-Performance Program Description

The P4P program was implemented by a large health plan in Hawaii since 1998. The program incentivized participating physicians an additional 3.5% of their base professional fees (maximum $16 000 per year), on average, as P4P payments to perform high-quality care. Although participation in the P4P program was voluntary, the majority of physicians (87.4% in year 2000 to 97.9% in year 2006) elected to participate each year. Characteristics of this P4P program have been described in detail earlier.[20,21] This P4P program included 2 CVD quality measures: (*a*) at least 1 LDL test within a 1-year period and (*b*) at least 1 prescription for a statin within a 1-year period.

Data Sets and Sample

We used the health plan's administrative claims data from 1999 through 2006. The study sample consisted of CVD patients 18 to 75 years of age, consistent with the 2008

Healthcare Effectiveness Data and Information Set specification for patients with CVD.[22] CVD patients were defined as patients who had 1 inpatient visit for an acute myocardial infarction (AMI), receipt of percutaneous transluminal coronary angioplasty (PTCA), receipt of coronary artery bypass graft (CABG) surgery, or at least 1 visit per year during a 2-year period with a diagnosis of stable angina, other forms of ischemic heart disease, peripheral artery disease, stroke, atheroembolism, or renal artery atherosclerosis. We excluded patients with contraindications for statins (ie, pregnancy, myositis, rhabdomyolysis, acute renal disease, liver dysfunction). There were 16 341 patients in the sample after applying the aforementioned inclusion and exclusion criteria. To isolate the experimental variable (eg, P4P), we excluded patients who were treated by providers who both did and did not participate in the P4P program (n = 2130). We limited the study to patients who were continuously enrolled for both medical and pharmacy benefits over a 2-year period to ensure we had complete data. The final sample size was 12 106 patients and 27 239 patient-years.

Laboratory data (ie, LDL value, date of service) were available for 63% of our sample. The LDL value was missing if patients either failed to have their LDL checked or the LDL test was performed by a smaller laboratory or in a physician's office. We merged laboratory data with administrative data by patient identifier.

Outcomes

Outcomes for this study were receipt of high-quality care (yes/no), new coronary events (yes/no), hospitalization (yes/no), and LDL ≥100 mg/dL (yes/no). We measured all covariates, including receipt of high-quality care, in the same year as P4P participation because we hypothesized that the covariates would affect the receipt of high-quality care within the same time frame. Outcomes (new coronary events [yes/no], hospitalizations [yes/no], and LDL ≥100 mg/dL [yes/no]) were measured in the year after the covariate measurement because we hypothesized that covariates would have a delayed impact on outcomes. New coronary events were defined as patients who had an AMI or underwent PTCA or CABG.

Main Independent Variables and Covariates

The main independent variables of interest in this study were treatment by P4P participating physicians only (yes/no) and receipt of high-quality care (yes/no). Covariates included age (≤55, 56-65, >66 years), sex, the Elixhauser comorbidity index, medication burden, prior hospitalization (yes/no), treated by a cardiologist (yes/no), treated by multiple primary care providers (PCPs; yes/no), and calendar year. The Elixhauser comorbidity index, calculated using
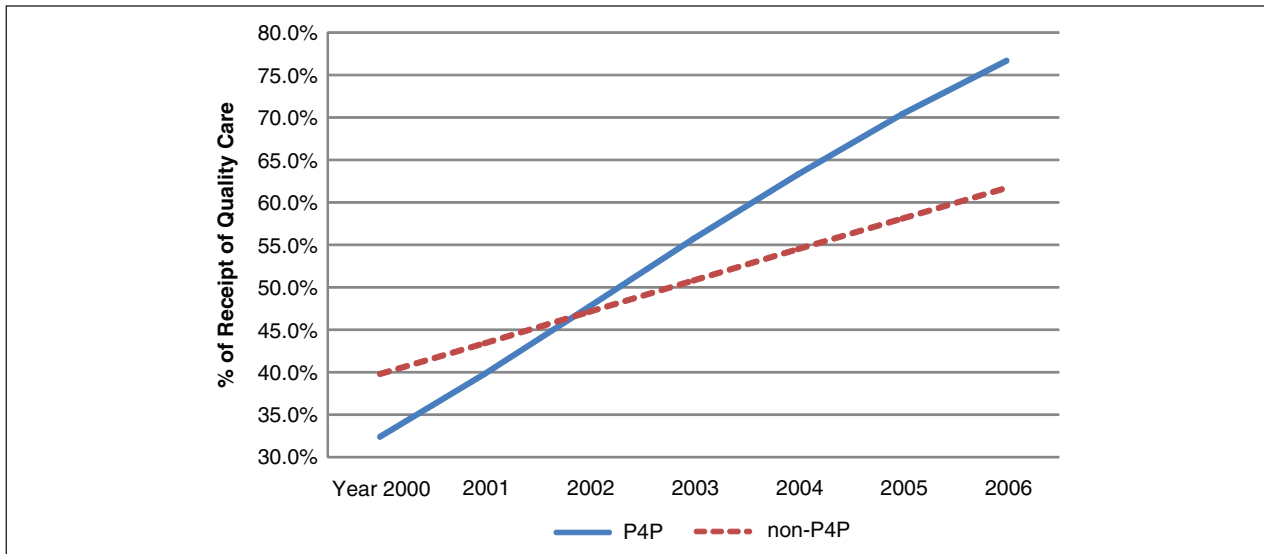
Figure 1. Adjusted receipt of quality care of members treated by P4P participating physician versus non-P4P participating physicians
Abbreviation: P4P, pay for performance.

the *International Classification of Diseases, 9th Revision, Clinical Modification*, represents the sum of comorbid conditions at baseline and has been shown to predict a variety of patient outcomes including inpatient mortality and health care cost.[23] Medication burden is the number of distinct medication types that patients have filled in a year, excluding statins. We included treatment by multiple PCPs as a proxy measure of health care continuity and coordination.

Statistical Analyses

We used patient-year as the unit of analysis in this longitudinal retrospective study because 1 patient generally had multiple years of follow-up. We first used a hierarchical logistic regression model to account for the nesting of years within patients to examine the associations between treatment by P4P participating physicians and receipt of high-quality care in the same year, while controlling for age, sex, comorbidity index, medication burden, treatment by multiple PCPs, treatment by a cardiologist, calendar year, as well as a treatment by P4P participating physicians and calendar year interaction term. Given that the only incentivized components of CVD care in the P4P program were lipid monitoring and receipt of a statin, only these care processes were included in the high-quality care variable. In addition, because the majority of physicians participated in the P4P program, especially in the later years, using physicians who did not participate in P4P as a control group was not ideal. Thus, we performed a sensitivity analysis limiting the time frame to an earlier period when fewer physicians participated in the P4P program (2000-2003) to examine the associations between treatment by physicians who participated in P4P

and receipt of high-quality care. We then performed 3 hierarchical logistic regressions to assess the impact of receipt of high-quality care on outcomes in the following year (any new coronary event, any hospitalization, and LDL ≥100 mg/dL) while controlling for age, sex, comorbidity index, calendar year, and baseline clinical characteristics (medication burden, treatment by multiple PCPs, treatment by a cardiologist, prior hospitalization, and prior LDL level).

All independent variables were checked for collinearity and significant interaction terms prior to their inclusion in the final model. The results for the logistic regressions were presented as odds ratios (OR), 95% confidence intervals (CIs), and *P* values. A *P* value of <.05 was considered to be significant. To facilitate interpretation of the statistically significant interaction term between calendar year and P4P participation, we calculated the adjusted percent of receipt of high-quality care by calendar year for patients treated by P4P participating physicians and non-P4P participating physicians separately using the multivariate model estimates (Figure 1). SAS Proprietary Software, Release 9.1 (SAS Institute Inc, Cary, NC) and STATA version 8.0 (Stata Corporation, College Station, TX) were used for all statistical analyses. Only de-identified data were used for this study, and ours is a Health Insurance Portability and Accountability Act–certified institution; therefore, this study was not submitted to an institutional review board.

Results

Table 1 displays the baseline demographic and clinical characteristics of the study sample by calendar year. The mean

Table 1. Baseline Characteristics of Patients With Cardiovascular Disease

	Year 2000	Year 2001	Year 2002	Year 2003	Year 2004	Year 2005	Year 2006
Sample size (n)	4551	4169	4820	4844	5120	5015	5007
Age, mean (SD)	62.1 (8.8)	62.0 (8.8)	62.0 (8.7)	61.5 (8.8)	61.7 (8.6)	61.5 (8.4)	61.5 (8.4)
Female (%)	29.9	30.2	29.7	29.3	29.5	28.9	28.3
Treated by P4P participating physicians only (%)	87.4	86.5	92.2	95.0	96.6	97.0	97.9
High-quality care[a] (%)	42.4	45.1	47.4	57.9	55.6	66.3	70.8
New coronary event[b] (%)	5.7	4.8	5.5	5.5	6.1	5.7	5.1
Hospitalization (%)	14.3	13.3	15.0	14.5	15.5	14.9	12.8
LDL ≥100 mg/dL (%)	14.9	30.9	36.3	32.5	26.2	23.6	21.0
LDL <100 mg/dL (%)	11.4	25.6	29.1	37.3	47.4	48.9	49.7
LDL missing (%)	73.7	43.5	34.6	30.2	26.5	27.5	29.4
Comorbidity index,[c] mean (SD)	2.0 (1.5)	2.0 (1.5)	2.1 (1.5)	2.2 (1.6)	2.2 (1.6)	2.3 (1.6)	2.3 (1.6)
Medication burden,[d] mean (SD)	7.1 (4.6)	6.9 (4.4)	7.1 (4.6)	7.3 (4.6)	7.4 (4.7)	7.5 (4.6)	7.5 (4.6)
Treated by multiple primary care physicians (%)	14.0	14.6	17.8	21.9	23.2	24.7	30.0
Treated by a cardiologist (%)	67.5	65.6	68.4	70.6	72.3	74.8	76.4

Abbreviations: P4P, pay for performance; LDL, low-density lipoprotein.
[a]High-quality care is defined as receipt of LDL test and >1 prescription for a statin in a 1-year period.
[b]New cardiovascular events are defined as hospitalization for acute myocardial infarction, receipt of percutaneous transluminal coronary angioplasty, or receipt of coronary artery bypass graft surgery.
[c]The code for the Elixhauser comorbidity index was downloaded from http://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp.
[d]The number of distinct medication types that patients have filled in a 1-year period, excluding statins.

patient age was 62, and the majority were male (>70%). The mean comorbidity index trended higher in 2006 than in 2000 (2.3 vs 2.0, $P < .01$), and mean medication burden exhibited the same upward trend (7.5 vs 7.1, $P < .01$). Similarly, in 2006, more patients were treated by multiple PCPs (30%) and/or a cardiologist (76.4%) than in 2000 (multiple PCP = 14%, $P < .01$; treated by a cardiologist = 67.5%, $P < .01$). The proportion of patients treated by P4P participating providers and receiving high-quality care increased every year as well. By 2006, the majority of patients were treated by P4P participating physicians (97.9%) and were receiving high-quality care (70.8%). The highest percentage of new coronary events occurred in 2004 (6.1%), and the lowest in 2001 (4.8%). The highest percentage of hospitalizations also occurred in 2004 (15.5%), but the lowest was in 2006 (12.8%).

Impact of Pay for Performance on Quality Care

Figure 1 disaggregated the interaction effect from the net effect of the results in Table 1. In the index year of the P4P program (2000), patients who were treated by P4P participating physicians (32%) were less likely to receive high-quality care compared with patients who were treated by physicians who did not participate in P4P (40%), when controlling for demographic and clinical characteristics (Figure 1). However, in the final year of P4P for which data were available (2006), patients who were treated by

P4P participating physicians (76%) were significantly more likely to receive high-quality care than patients who were treated by physicians who did not participate in P4P (61%). Results of the sensitivity analysis limiting the time frame to an earlier period when fewer physicians were participating in the P4P program (2000-2003) revealed an even greater effect size.

In subgroup analyses, patients 56 to 65 years of age were significantly more likely to receive high-quality care than patients 18 to 55 years of age (OR = 1.61; 95% CI = 1.40-1.85; $P < .01$; Table 2). However, patients 66 to 74 years of age were significantly less likely to receive high-quality care than patients 18 to 55 years of age (OR = 0.57; 95% CI = 0.49-0.66; $P < .01$). Females were less likely to receive high-quality care than males (OR = 0.50; 95% CI = 0.43-0.57; $P < .01$). Patients who were treated by a cardiologist were more likely to receive high-quality care than patients who were not (OR = 1.77; 95% CI = 1.59-1.97; $P < .01$).

Impact of Quality Care on Patient Outcomes

Patients who received high-quality care in the baseline year were less likely to have any new coronary events (adjusted percent 4.8% vs 6.0%; OR = 0.80; 95% CI = 0.69-0.92; $P < .01$) in the follow-up year than patients who did not (Table 3). Similarly, patients who received high-quality care in the baseline year were less likely to be hospitalized (adjusted percent 12.4% vs 15.8%; OR = 0.76; 95% CI = 0.69-0.83; $P < .01$) and have LDL ≥100 mg/dL (adjusted percent 38.1%

Table 2. Impact of Being Treated by P4P Participating Physicians Only on the Receipt of High-Quality Care[a]

	Year 2000-2006, High-Quality Care[b] (n = 14 211 Patients, 33 566 Patient-years), OR (95% CI)	Year 2000-2003,[c] High-Quality Care[b] (n = 9735 Patients, 18 424 Patient-years), OR (95% CI)
Treated by P4P participating physicians only (Reference: no)	0.70 (0.54-0.90)[d]	0.59 (0.43-0.81)[d]
Calendar year	1.18 (1.07-1.29)[d]	1.10 (0.92-1.31)
Treated by P4P participating physicians only * calendar year	1.21 (1.11-1.36)[d]	1.44 (1.20-1.74)[d]
Age (Reference: 18-55 years)		
56-65 years	1.61 (1.40-1.85)[d]	1.48 (1.20-1.83)[d]
66-74 years	0.57 (0.49-0.66)[d]	0.60 (0.48-0.75)[d]
Female (Reference: male)	0.50 (0.43-0.57)[d]	0.51 (0.42-0.61)[d]
Comorbidity index[e] (Reference: 0)		
1	1.72 (1.47-2.01)[d]	1.60 (1.28-1.02)[d]
2	2.23 (1.89-2.64)[d]	2.18 (1.70-2.78)[d]
≥3	2.23 (1.87-2.66)[d]	1.93 (1.50-2.50)[d]
Medication burden[f] (Reference: <5)		
5-9	1.60 (1.44-1.78)[d]	1.45 (1.25-1.69)[d]
≥10	1.68 (1.47-1.92)[d]	1.52 (1.24-1.86)[d]
Treated by multiple primary care physicians (Reference: no)	0.97 (0.88-1.08)	0.93 (0.78-1.10)
Treated by a cardiologist (Reference: no)	1.77 (1.59-1.97)[d]	2.01 (1.71-2.36)[d]

Abbreviations: P4P, pay for performance; OR, odds ratio; CI, confidence interval; LDL, low-density lipoprotein.
[a]Covariates were measured in the same year as receipt of quality care for this model.
[b]High-quality care is defined as receipt of LDL test and >1 prescription for a statin within a 1-year period.
[c]This is the result of the sensitivity analysis limiting the time frame of our analysis to an earlier period when more physician were not participating in the P4P program (2000-2003).
[d]$P < .01$.
[e]The code for the Elixhauser comorbidity index was downloaded from http://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp.
[f]The number of distinct medication types that patients have filled in a 1-year period, excluding statins.

vs 46.3%; OR = 0.67; 95% CI = 0.61-0.73; $P < .01$) than patients who did not.

In the subgroup analyses, patients 56 to 65 years of age were more likely to be hospitalized than younger patients (OR = 1.23; 95% CI = 1.08-1.40; $P < .01$) but were less likely to have LDL >100 mg/dL (OR = 0.85; 95% CI = 0.75-0.95). Patients 66 to 74 years of age were more likely to have new coronary events (OR = 1.29; 95% CI = 1.06-1.59; $P < .01$) or to be hospitalized (OR = 1.59; 95% CI = 1.40-1.81; $P < .01$) than younger patients but were less likely to have LDL >100 mg/dL (OR = 0.68; 95% CI = 0.61-0.76; $P < .01$). Although females were less likely to have new coronary events (OR = 0.68; 95% CI = 0.58-0.80; $P < .01$) or be hospitalized (OR = 0.90; 95% CI = 0.81-0.99; $P < .05$) than males, females were more likely to have LDL >100 mg/dL than males (OR = 1.39; 95% CI = 1.27-1.53; $P < .01$).

Patients who were treated by multiple PCPs in the year prior were more likely to be hospitalized (OR = 1.18; 95% CI = 1.06-1.31; $P < .01$) in the following year than patients who were not, but there was no significant impact on LDL levels. In contrast, patients who were treated by a cardiologist were less likely to have LDL >100 mg/dL (OR = 0.91;

95% CI = 0.83-0.99; $P < .05$) than patients who were not, but there was no significant impact on hospitalizations.

Discussion

This study showed that after starting at a low baseline rate (42%), overall more patients with CVD received high-quality care as time went on, reaching a rate of 71% in 6 years. Being treated by P4P participating providers was associated with a greater increase in the receipt of high-quality care over time. The effect of the P4P program steadily grew; by the sixth year, there was a 15% difference in receipt of quality care between the 2 groups, after adjusting for demographic and clinical characteristics. More important, we showed that lipid monitoring and statin treatment for CVD patients in a real-world setting (eg, outside of a randomized controlled trial) were associated with significantly improved lipid control, fewer coronary events, and fewer hospitalizations. Characteristics that contribute to the success of this P4P program may have included a quality process of care target with a sufficiently low baseline rate for improvement and incentivizing P4P participating

Table 3. Impact of Receipt of High-Quality Care on Health Outcomes[a]

	New Coronary Events (n = 12 106 Patients, 27 239 patient-years), OR (95% CI)	Hospitalization (n = 12 106 Patients, 27 239 Patient-years), OR (95% CI)	LDL >100 mg/dL (n = 6754 Patients, 13 952 Patient-years), OR (95% CI)
High-quality care[b]	0.80 (0.69-0.92)[c,d]	0.76 (0.69-0.83)[c,e]	0.67 (0.61-0.73)[c,f]
Age (Reference: 18-55 years)			
56-65 years	1.15 (0.95-1.39)	1.23 (1.08-1.40)[c]	0.85 (0.75-0.95)[c]
66-74 years	1.29 (1.06-1.59)[c]	1.59 (1.40-1.81)[c]	0.68 (0.61-0.76)[c]
Female	0.68 (0.58-0.80)[c]	0.90 (0.81-1.00)[g]	1.39 (1.27-1.53)[c]
Comorbidity index[h] (Reference: 0)			
1	1.09 (0.83-1.44)	1.14 (0.94-1.37)	1.02 (0.88-1.19)
2	1.27 (0.96-1.68)	1.37 (1.14-1.65)[c]	0.86 (0.74-1.00)
≥3	1.78 (1.35-2.36)[c]	2.12 (1.76-2.56)[c]	0.88 (0.75-1.03)
Medication burden[i] (Reference: <5)			
5-9	1.22 (1.03-1.45)[g]	1.37 (1.23-1.54)[c]	0.92 (0.83-1.02)
≥10	2.02 (1.67-2.46)[c]	2.33 (2.04-2.65)[c]	0.77 (0.68-0.87)[c]
Multiple primary care physicians	1.07 (0.91-1.25)	1.18 (1.06-1.31)[c]	0.98 (0.88-1.10)
Treated by a cardiologist	1.14 (0.97-1.33)	0.92 (0.84-1.02)	0.91 (0.83-0.99)[g]
Hospitalization	1.12 (0.96-1.32)	1.32 (1.19-1.48)[c]	1.06 (0.95-1.19)
LDL level in the baseline year (reference: LDL <100 mg/dL)			
LDL ≥100 mg/dL	0.77 (0.65-0.92)[c]	0.95 (0.85-1.07)	5.28 (4.76-5.86)[c]
LDL value missing	0.97 (0.82-1.14)	1.19 (1.06-1.32)[c]	2.56 (2.28-2.88)[c]
Year (Reference: 2000)			
2001	0.90 (0.72-1.13)	0.99 (0.85-1.15)	1.03 (0.89-1.19)
2002	1.01 (0.81-1.25)	1.14 (0.99-1.32)	0.67 (0.58-0.78)[c]
2003	0.99 (0.79-1.23)	1.10 (0.95-1.27)	0.47 (0.40-0.54)[c]
2004	1.08 (0.87-1.35)	1.23 (1.06-1.43)[c]	0.42 (0.36-0.49)[c]
2005	1.06 (0.85-1.32)	1.21 (1.04-1.41)[c]	0.40 (0.34-0.47)[c]

Abbreviations: OR, odds ratio; CI, confidence interval; LDL, low-density lipoprotein.
[a]All covariates were measured in the baseline year and the outcomes were assessed in the follow-up year.
[b]High-quality care is defined as the receipt of LDL test and >1 statin prescription in the baseline year.
[c]P < .01.
[d]The adjusted percents of new coronary events by quality care were 4.8% for yes versus 6.0% for no.
[e]The adjusted percents of hospitalization by quality care were 12.4% for yes versus 15.8% for no.
[f]The adjusted percents of patients with LDL >100 by quality care were 38.1% for yes and 46.3% for no.
[g]P < .05.
[h]The code for the Elixhauser comorbidity index was downloaded from http://www.hcup-us.ahrq.gov/toolssoftware/comorbidity/comorbidity.jsp.
[i]The number of distinct medication types that patients have filled in a 1-year period, excluding statins.

providers at an individual level. This finding is consistent with the recommendations for effective P4P design from a recently published systematic review of P4P programs.[24]

We found the impact of age on LDL testing and statin prescriptions had an inverse-U shape, with patients 66 to 75 years of age least likely to receive lipid monitoring and treatment. This is a very concerning finding because more than 80% of patients who die from CVD are 65 years of age and older; 3 randomized controlled trials[6,8,25,26] have found statin treatment to have similar efficacy in preventing mortality and new coronary events in elderly CVD patients compared with younger patients.

Consistent with previously published literature,[27,28] we found significant disparity between the sexes with regard to receipt of lipid monitoring and statin treatment among CVD patients. Females were significantly less likely to receive lipid monitoring and statin treatment, even after controlling for demographic and clinical factors. Similarly, this finding is of concern because there is evidence that statins are equally effective in reducing coronary events and mortality for both women and men.[29,30] Not surprisingly, we found that patients who had been treated by a cardiologist were more likely to receive lipid monitoring and statin treatment. These patients also were significantly less likely to have an LDL level >100 mg/dL, although there was no difference in the likelihood of them having new coronary events or being hospitalized.

This study has 5 main limitations. First, the self-selection of higher performing physicians to participate in the P4P program may account for the difference in receipt of quality

Table 4. Receipt of High-Quality Care[a] in the Previous Year Among CVD Members Treated by New P4P Participating Physicians Versus Non-P4P Participating Physicians

Year	Members Treated by New P4P Participating Physicians Only	Members Treated by Non-P4P Participating Physicians Only	P Value
2001	n = 149, 40.3%	n = 2326, 45.9%	.183
2002	n = 734, 41.7%	n = 1361, 49.4%	.000[b]
2003	n = 487, 45.0%	n = 1192, 52.8%	.004[b]
2004	n = 338, 61.8%	n = 1869, 57.7%	.185
2005	n = 122, 55.7%	n = 978, 56.1%	.934
2006	n = 215, 70.2%	n = 798, 68.8%	.686

Abbreviations: CVD, cardiovascular disease; P4P, pay for performance; LDL, low-density lipoprotein.
[a]High-quality care is defined as receipt of LDL test and >1 prescription for a statin in the baseline year.
[b]Although the P values for this comparison are statistically significant, members who were treated by new P4P participating physicians were significantly less likely to receive high-quality care compared with members who were treated by non-P4P participating physicians.

observed between patients who were treated by providers who did and did not participate in P4P. To disaggregate a "P4P effect" from a self-selection effect, we performed a sensitivity analysis that was limited to physicians in their first year of P4P participation. If the main effect was related to self-selection, we would expect to see a substantial difference in quality care for physicians starting the program compared with nonparticipating physicians (eg, before the incentive has a chance to influence care). For the majority of years, we found no significant differences between these 2 groups (Table 4). Second, the majority of P4P providers participated in the P4P program, especially in the later years when program participation reached 98%. There may be too few providers who did not participate in P4P to make a valid comparison. However, we conducted a sensitivity analysis limiting the time frame of our analysis to an earlier period when more physicians converted from a nonparticipating to a P4P participating status (2000-2003). Results revealed an even greater effect size. Third, the selection bias of patients who received an LDL test and a statin may contribute to the outcomes presented. Although some evidence suggests a paradoxical risk–treatment relationship, where elderly patients at high risk are associated with fewer statin prescriptions,[31] our data indicated that, when controlling for age, patients at higher risk (ie, patients with higher comorbidity scores, higher medication burdens) were more likely to receive high-quality care and clinicians were more likely to provide care for these patients (Table 2). Therefore, this potential selection bias may have led to an underestimation of the benefits of quality care rather than an overestimation. Fourth, approximately a third of the members had missing LDL values each year. Comparisons between patients with LDL values and patients with missing LDL values showed that the latter were more likely to have coronary events (missing LDL = 5.9% vs nonmissing LDL = 5.3%, P < .01) and more likely to be hospitalized (missing LDL = 16.2% vs nonmissing LDL = 13.3%, P < .01). Because patients who

had missing LDL values were also significantly less likely to receive quality care (missing LDL = 40% vs nonmissing LDL = 65%, P < .01), this observation is consistent with our hypothesis that receipt of quality of care leads to improved LDL control. Last, there were many unmeasured factors that may have contributed to the likelihood of having new coronary events or hospitalization (eg, obesity, smoking status, family history of heart disease, sedentary lifestyle, excessive alcohol consumption, uncontrolled hypertension or diabetes) that cannot be accounted for in the multivariate analyses.

In conclusion, we found that a P4P program in the preferred provider organization setting was associated with increased receipt of lipid monitoring and statin treatment among patients with CVD. Additionally, the beneficial effect of the P4P program appeared to increase with time. We also found that receiving this high-quality care in a real-world setting was associated with improved LDL control and reduced the likelihood of new coronary events and hospitalizations. Because of the limitations of this study, such as selection bias of the comparison group, future studies assessing the impact of a P4P program on cardiovascular care need to verify the findings in studies with experimental designs and address the cost-effectiveness of such a program. Women and older patients with CVD were significantly less likely to receive lipid monitoring and statin treatment despite clear evidence in the literature of the benefit of statin treatment among these CVD patients. Interventions targeting women and older patients are needed to ensure that these at-risk populations can also take full advantage of these effective therapies.

Declaration of Conflicting Interests

The authors declared a potential conflict of interest (eg, a financial relationship with the commercial organizations or products discussed in this article) as follows: Drs Juarez and Chung and Ms Hodges are employees of Hawaii Medical Services Association. Any conflicts of interest were resolved during the

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