An Assessment of Patient-Based and Practice Infrastructure–Based Measures of the Patient-Centered Medical Home: Do We Need to Ask the Patient?

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Objective. To examine the importance of patient-based measures and practice infrastructure measures of the patient-centered medical home (PCMH).

Data Sources. A total of 3,671 patient surveys of 202 physicians completing the American Board of Internal Medicine (ABIM) 2006 Comprehensive Care Practice Improvement Module and 14,457 patient chart reviews from 592 physicians completing ABIM's 2007 Diabetes and Hypertension Practice Improvement Module.

Methodology. We estimated the association of patient-centered care and practice infrastructure measures with patient rating of physician quality. We then estimated the association of practice infrastructure and patient rating of care quality with blood pressure (BP) control.

Results. Patient-centered care measures dominated practice infrastructure as predictors of patient rating of physician quality. Having all patient-centered care measures in place versus none was associated with an absolute 75.2 percent increase in the likelihood of receiving a top rating. Both patient rating of care quality and practice infrastructure predicted BP control. Receiving a rating of excellent on care quality from all patients was associated with an absolute 4.2 percent improvement in BP control. For reaching the maximum practice-infrastructure score, this figure was 4.5 percent.

Conclusion. Assessment of physician practices for PCMH qualification should consider both patient based patient-centered care measures and practice infrastructure measures.

Key Words. Patient-centered care, practice infrastructure, medical home, blood pressure control

Nearly 10 years ago the Institute of Medicine (IOM) released its seminal report on the state of the quality of health care in the United States entitled *Crossing the Quality Chasm* (IOM 2001). In addition to providing ample evidence about the deficiencies of the quality of care, the IOM laid out six aims

for improving quality; medical care should be effective, efficient, equitable, timely, safe, and patient centered. Progress in improving the quality of health care since the release of this report has been slow, and one hypothesis for the lack of more substantial progress is the eroding state of primary care in the United States. Multiple lines of evidence include the increased administrative hassles faced in a primary care practice, poor reimbursement, loss of physicians from primary care, and declining interest among medical students (Lipner et al. 2006; American College of Physicians 2008; Hauer et al. 2008).

However, others also point to the failure of primary care to adopt new approaches to care delivery, quality improvement, and systems science (Baron and Cassel 2008). These concerns led to the creation of, and subsequently intense interest in, a new model of primary care called the patient-centered medical home (PCMH) that is now the subject of multiple demonstration projects across the United States (American College of Physicians 2007; Landon et al. 2010). Principles for the PCMH were developed collaboratively and released by four primary care-related societies in 2007 (American College of Physicians 2007). This PCMH group then worked with the National Committee for Quality Assurance (NCQA) to revise NCQA's existing Physician Practice Connections (PPC) program to create a process for "qualifying" practices as a PCMH at one of three levels (American College of Physicians 2007). NCQA's current tool, the Provider Practice Connections – Patient Centered Medical Home (PPC-PCMH), is being used to "qualify" medical homes for many of these pilots and is almost exclusively focused on the primary care practice's infrastructure (NCQA 2010b). This tool has become the "industry standard" operational definition of the PCMH and is being used by Medicare and private sector payers to qualify physician practices as a medical home (Abrams 2008; Mathematica 2008; Bitton et al. 2010).

Recent policy discussion has emphasized adoption of key practice infrastructure capabilities to improve patient care by promoting care management and coordination, and establishing processes to improve access to care and communication (Berenson et al. 2008; Friedberg et al. 2009). Advocacy for the PCMH has formalized assumptions about the link between these

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infrastructure capabilities and patient-centered care, offering enhanced reimbursement for practices that provide evidence of having such capabilities. However, two recent studies have raised questions about the association between presence of system infrastructure components and quality of care (Friedberg et al. 2009; Holmboe et al. 2010a). In the end, the ultimate success of the PCMH will depend on whether patients' health care needs are being met.

A substantial shortcoming to the current approach to "qualifying" PCMHs is the lack of assessment of patient experience with the practice. One might reasonably ask, "how can we provide patient-centered care if we do not ask the patient about their experience of care?" Yet the 2008 revisions to the PPC-PCMH criteria included only a modest component for patient assessment of the practice (NCQA 2008), despite substantial progress in developing instruments to assess patients' experiences with their care, such as the Consumer Assessment of Health Plans and Systems (CAHPS) surveys (Safran et al. 1998; Hays et al. 1999). Recognizing the importance of this, NCQA is currently proposing an optional patient experience module to the PCMH process (NCQA 2010a).

With this in mind, we examined four hypotheses central to the debate around the importance of the patient's voice when evaluating PCMH qualification. First, NCQA's PCMH infrastructure measure was not strongly associated with patient rating of physician quality. Second, patient-centered care measures from the CAHPS patient survey were strongly associated with patient rating of physician quality. Third, PCMH infrastructure measure was unrelated to patient-centered care measures. Final, PCMH infrastructure measure and patient rating of care quality rendered by their physician accounted for important but distinctly different aspects of an intermediate outcome quality measure (blood pressure [BP] control).

METHODS

We tested these hypotheses by applying a cross-sectional study design that utilized two data sources. The first source was a CAHPS survey administered to patients by general internists who participated in a trial of a web-based assessment tool, the Comprehensive Care Practice Improvement Module (CC-PIM) (Holmboe et al. 2010b). The second source was from chart audits and patient surveys from the Diabetes and Hypertension Practice Improvement Modules (DH-PIMs). Internists completed the DH-PIMs to satisfy the

self-evaluation of practice performance requirement of ABIM's maintenance of certification (MOC) program. ABIM requires that physician complete the MOC program every 10 years to maintain their certification. Completing a practice infrastructure survey is part of CC-PIM and DH-PIMs' requirement. The practice infrastructure survey is a variant on NCQA's former PPC – Readiness Survey version 2 (PPC-RS) and used 173 identical PPC-RS survey items (Holmboe et al. 2010a,b).

We used the first data source to examine the relationship of patient rating of physician quality to both patient-centered care measures from the CAHPS survey and NCQA's PCMH infrastructure measure. We used the second data source to relate patient-level BP control to the PCMH infrastructure measure and patient rating of care quality.

Physician and Patient Samples

To construct the CC-PIM sample ABIM recruited 254 general internists from a pool of 534 volunteers with time-limited board certification due to expire between 2007 and 2009 (Holmboe et al. 2010b). Physicians were chosen from the metropolitan regions of 18 cities in 13 states. Regions were based on the 2005 Agency for Healthcare Research and Quality (2007) state rankings of medical care quality to ensure a diverse sample. Two hundred and two internists completed the study. Patient surveys were distributed to physicians between July and September 2006. Physicians were instructed to sequentially distribute surveys to patients who visited their office during the study period. Patients completed the CAHPS survey via ABIM telephone or Internet collection systems. Each physician needed to have 25 patient surveys completed. Physicians did not record the number of surveys distributed. Therefore, response rates were not available. We merged each of the completed 4,763 patient surveys with the physicians' PCMH infrastructure measure.

The CC-PIM includes patients of varying tenure. To assure that the patients included in our CC-PIM analysis had enough time to assess the quality of their physicians, we limited the sample to patients who have seen their physician for at least 1 year and had more than two visits with the physician in question. The number of visits restriction reduced the sample of patients from 4,763 to 3,671 but did not affect the physicians sample size or materially affect any result presented in the study.

Data drawn from the DH-PIMs were patient chart audits of physicians who completed a specific version of the Diabetes or Hypertension PIM

during the year 2008. We were able to increase the power of our analysis by concatenating the diabetes and hypertension PIMs because hypertension is a common comorbidity for diabetic patients and BP is a common measure across these two PIMs. Furthermore, BP is considered a significant risk factor for longer-term outcomes (Chobanian et al. 2003).

Among the 6,473 physicians who fulfilled the MOC requirement of completing a self-evaluation of practice performance during the period of our study, 17.6 percent self-selected to complete a hypertension or diabetes PIM as opposed to another self-evaluation activity. Due to PIM version change, our sample was limited to 592 internists and 14,457 patient chart reviews. Compared to the 6,473 recertifying internists, the gender (32 percent female in both cases), age (44 versus 45), and geographic distributions of our DH-PIMs sample were very similar. However, our sample was comprised of mostly general internists (76 versus 47 percent) and more solo practitioners (19 versus 13 percent). This is because diabetes and hypertension are prevalent chronic diseases treated by general internists.

To complete DH-PIMs, physicians were instructed to select 25 patients of age 15–90 years with diabetes/hypertension who had been with the physician for at least 1 year and had at least one visit within the past 12 months. Physicians chose their patient sample through prospective/retrospective sequential sampling strategy. Chart audits were completed by participating physicians. The accuracy of this type of chart audit has been verified by Chobanian et al. (2003) and Gilchrist (2004). Patients whose charts were audited were given a patient survey. Patient survey questions were adapted from the Picker and CAHPS patient surveys (Lipner et al. 2007). To meet the goal of 25 completed surveys, additional surveys were distributed applying the same sampling strategy. Patients completed surveys via ABIM telephone or Internet collection systems. Because physicians did not record the number of surveys distributed, response rates were not available. To determine whether nonresponse affected the representativeness of our patient survey sample, we compared patient demographics of the survey sample to the chart audit sample. Since, the chart audit sample is not subject to patient nonresponse, similarities in the patient and chart audit samples suggested that the nonresponse is not a major concern. For the diabetes PIM, the mean age and share of female patients in the survey were 62.0 and 50.0 percent, respectively, versus 62.0 and 49.4 percent in the chart audit. For the hypertension PIM, the mean age and share of female for the survey sample were 63.4 and 49.7 percent, respectively, versus 63.7 and 48.5 percent for the chart audit.

Variable Definition and Measurement

We constructed our measures based on the principle of identifying excellent quality. For the CC-PIM, patients were asked to rate the quality of their physicians on a scale of 0–10. We defined patient rating of physician quality as one for a top rating (10) and zero otherwise. For the DH-PIMs, patients were asked to rate the overall quality of diabetes/hypertension care they received from their physician using a five-point scale (excellent, very good, good, fair, poor). Patient rating of care quality was defined as one for an “Excellent” rating and zero otherwise.

A physician level PPC-RS scale was constructed based on the practice infrastructure survey for all physicians (Holmboe et al. 2010a,b). The PPC-RS ranges from 0 to 100. A score of 75 or higher qualifies a practice as the advanced designation and a score above 25 met the minimum standard to be qualified as a NCQA designated medical home (NCQA 2008). Appendix Table A1 describes the practice infrastructure survey items used to construct the PPC-RS scale.

Applying the CC-PIM patient survey data, we constructed six scales of patient-centered care: access to care when needed (four items), short waiting times (1), general communication (5), communication about illness (8), care coordination (5), and office staff interaction (2). Since our guiding strategy was to construct indicators for excellent care, we used “all-or-none” scoring strategy (see Appendix Table A2 for detailed item description). When all items within a scale met criteria, then the value of the scale was 1 and otherwise 0. For scales with two or more items, we used standardized Cronbach's alpha (α) coefficient to measure the internal consistency of the items. High scores for “Access to care when needed” ($\alpha = .79$), “General communication” ($\alpha = .80$), “Communication about illness” ($\alpha = .83$), “Care coordination” ($\alpha = .60$), “Office staff interaction” ($\alpha = .80$) indicated that items within these scales measure the same unidimensional factor.

Our intermediate health outcome measure for the DH-PIM, patient BP control, was a dichotomous (1 or 0) indicator based on patient BP reading at the last visit. A value of one was assigned if BP was lower than 130/80 for patients with diabetes or chronic kidney disease or lower than 140/90 for the remaining patients. As described earlier, BP is a significant risk factor for longer term outcomes.

Patient rating of care quality could not be linked directly to our chart-based patient-level BP control but could be linked at the physician level. Therefore, we merged the physician-level mean value of patient rating of care

quality measure into our patient-level chart audit sample. The resulting analytical data file includes an indicator for each patient's BP control (the unit of analysis) and the average patient rating of care quality for the physician who treated that patient.

Analytic Methods

The unit of analysis for regressions used to test our first three hypotheses was the patient who completed a patient survey. To test our first hypothesis, we regressed patient rating of physician quality against the PPC-RS scale and a set of controls. We excluded patient-centered care measures to account for the possibility that better practice infrastructure triggered better patient-centered care (e.g., reminder prompts physicians to communicate with patients). To test our second hypothesis we added our six scales of patient-centered care to this regression. We controlled for the PPC-RS scale because we wanted to measure this association allowing for the possibility that practice infrastructure might relate to physicians ability to practice patient-centered care. To examine the sensitivity of including or excluding the PPC-RS scale, we also included a regression where we dropped the PPC-RS scale and included our patient-centered care measures. The set of controls used in these regressions account for differences in patient populations (e.g., age, race, ethnicity gender, education, insurance) as well as level of contact with the physician in question (e.g., number of visits) and census region location (see Appendix Table A3, for a full set of covariates). To test our third hypothesis, we regressed each one of our six patient-centered care measures and an indicator for meeting all six patient-centered care criteria against the PPC-RS scale applying the same set of controls as above.

To test our fourth hypothesis, we regressed BP control on the PPC-RS scale and a set of risk adjusters (see Table A4 for a full set of covariates). The unit of analysis was the patients in the chart audit sample. We excluded patient rating of care quality measure to account for the possibility that practice infrastructure affected patient rating. Next, we added patient rating of care quality measure to this regression. In our final regression, we dropped the PPC-RS scale and included patient rating of care quality measure. The robustness of estimates across these models tests the hypothesis that our practice infrastructure measure and patient rating of quality capture important but distinctly different dimensions of care quality.

Reflecting the dichotomous nature of all dependent measures, we applied a Probit regression to model patient rating of physician quality,

patient-centered care measures and BP control. We also considered the hierarchical nature of our data (i.e., patients nested within physician) when constructing statistical tests by applying Huber White cluster adjusted standard errors (White 1980) in all of our regressions.

Policy Simulations

By applying the coefficient estimates drawn from our Probit regressions, we ran simulations designed to test our hypotheses. The maximum effect simulations, which are equivalent to a treatment versus nontreatment simulation in a clinical trial, examined the differences between predictions after setting the policy variables to their maximum and minimum value (i.e., all six patient-centered care measures had a value of 1 versus 0). The potential for quality improvement simulations estimated the maximum potential effects from the observed levels (i.e., a PPC-RS scale of 100 versus the observed value for each physician). Using our coefficients estimates, we simulated the probability of either receiving a physician rating of 10 or having BP control for each patient in our sample under three possible scenarios for the policy variable in question (minimum value, maximum value, and observed value). We applied the delta method to construct a statistical test of significance across these simulations (Norton, Wang, and Chunrong 2004). As before, these tests apply Huber White adjusted standard errors.

RESULTS

Table 1 presents the mean comparisons of PPC-RS scale and patient-centered care measures between two groups of patients (group 1: patients rated the quality of their physician as 10 [top rating]; group 2: patients rated the quality of their physician as <10). Tests of statistical difference exhibited on this table account for the hierarchical nature of our data (SAS Institute Inc 2008).

Overall, 67 percent of the patients rated the quality of their physician as 10. Mean comparisons between groups 1 and 2 supported our first two hypotheses. The small difference (.52) in PPC-RS scale between the two groups (48.36 versus 47.84) indicated PCMH infrastructure measure was not associated with patient rating of physician quality. The reverse is true for patient-centered care measures. For example, 38.38 percent of group 1 had

Table 1: Comparisons of Physicians' Physician Practice Connections Readiness Survey (PPC-RS) Scale and Patient-Centered Care Measures between Patients Who Rated Their Physician's Quality as 10 (out of 10) versus Less Than 10

	<i>Patients Rating of Physician Quality</i>			
	<i>10 (67% of patients)</i>	<i>< 10 (33% of patients)</i>	<i>Difference</i>	<i>t-statistic[†]</i>
Practice infrastructure				
PPC-RS scale (0–100)	48.36	47.84	0.52	0.67
Patient-centered care measures				
(% of patients with value 1) [‡]				
All six patient-centered care measures	38.38	8.83	29.55	24.06**
Access to care when needed	87.69	67.53	20.16	13.22**
Short waiting time	70.59	47.73	22.86	15.05**
General communication	85.95	56.46	29.50	19.62**
Communication about illness	77.96	39.85	38.11	26.39**
Care coordination	71.07	39.65	31.42	22.83**
Office staff interaction	88.95	69.88	19.08	12.50**

[†]t-statistics were adjusted for the hierarchical nature of the data (patients within physicians).

[‡]When all items within the domain of a patient-centered care scale met criteria, then the value of the scale was 1 and otherwise 0.

**Significant at the $p < .01$ level.

the value 1 for all six dichotomous patient-centered care measures versus 8.83 percent of group 2.

As exhibited in Table 2, simulation results drawn from our Probit regressions (see Appendix Table A5 for coefficient estimates) also supported our first two hypotheses. Supporting our first hypothesis, simulations indicated that the PPC-RS scale had, at most, a small association with patient ratings of the quality of their physician. For the simulation which excluded our patient-centered care measures, having a PPC-RS scale of 100 versus 0 (maximum effect) was associated with only a 7.96 percent absolute increase in the likelihood of patient rating of physician quality as 10 (p -value>.10). As described above, this association accounts for both the direct effect of the PPC-RS on patient rating of physician quality as well as any indirect effects through its possible effect on patient-centered care measures.

Supporting hypothesis 2, simulation results suggested that after controlling for the PPC-RS scale, patient-centered care measures were the key determinants of patient rating of physician quality. Having value of one for all six patient-centered care measures versus having value of zero (maximum effect) was associated with an average 75.16 percent absolute increase in the

Table 2: Simulated Probability of Receiving 10 out of 10 in Patient Rating of Physician Quality[†]

<i>Model Number</i>	<i>Policy Variables Simulated</i>	<i>Maximum Effect on Probability (%)[‡]</i>	<i>Potential for Quality Improvement on Probability (%)[§]</i>
1.1	PPC-RS scale	7.96	4.05
	Patient-centered care measures	Not included	Not included
1.2	PPC-RS scale	6.78	3.35
	Meeting all patient-centered care criteria	75.16**	21.30**
	Individual patient-centered care measures		
	Access to care when needed	8.58**	1.68**
	Short waiting time	6.08**	2.40**
	General communication	13.68**	3.51**
	Communication about illness	21.61**	7.30**
	Care coordination	15.24**	6.88**
	Office staff interaction	7.83**	1.41**
1.3	PPC-RS scale	Not included	Not included
	Meeting all patient-centered care criteria	75.15**	21.30**
	Individual patient-centered care measures		
	Access to care when needed	8.46**	1.66**
	Short waiting time	6.02**	2.38**
	General communication	13.83**	3.54**
	Communication about illness	21.54**	7.27**
	Care coordination	15.32**	6.41**
	Office staff interaction	7.83**	1.41**

[†]Calculations of test statistics are based on the delta method and reflect the hierarchical nature of the data.

[‡]Measures the mean individual-level absolute difference in simulated probabilities between the simulations with maximum versus minimum level for the policy measure(s) in question; the remaining explanatory variables in the regression were at the observed level.

[§]Measures the mean individual-level absolute difference in simulated probabilities between the simulations with maximum versus observed level for the policy measure(s); the remaining explanatory variables were at the observed level.

**Significant at the $p < .01$ level.

likelihood of a patient rating of physician quality as 10 (p -value $< .01$). In terms of potential for quality improvement, this association was, on average, a 21.30 percent absolute (p -value $< .01$) increase or about a 30 percent relative improvement over current levels. Further supporting our second hypothesis, simulation results indicated that including or excluding the PPC-RS scale had almost no effect on the magnitude of the association of patient-centered care measures with patient rating of physician quality (within a 1 percent

Table 3: Simulated Effect of Changing in the PPC-RS Scale from 0 to 100 on the Probability of Having Patient-Centered Care Measure with Value 1 (versus 0)

<i>Dependent Measures</i>	<i>Maximum Effect on Probability[†]</i>			
	<i>Absolute Difference (%)</i>	<i>Standard Error[‡] (%)</i>	<i>p-Value[‡]</i>	<i>p-Value - Hochberg[§]</i>
Meeting all patient-centered care criteria	3.48	7.18	0.63	—
Individual patient-centered care measures				
Access to care when needed	−3.45	5.92	0.56	0.94
Short waiting time	−6.51	9.93	0.51	0.94
General communication	8.76	5.74	0.13	0.64
Communication about illness	−1.44	6.10	0.81	0.94
Care coordination	9.65	6.04	0.11	0.64
Office staff interaction	−0.47	5.82	0.94	0.94

[†]Maximum effect on probability measures the mean individual-level difference in simulated probabilities between the simulations with the PPC-RS scale set at 100 and 0; the remaining explanatory variables are at the observed level.

[‡]The calculations of standard errors and test statistics are based on the delta method and reflect the hierarchical nature of the data.

[§]Hochberg adjustment procedure to control for multiple testing on the same data.

absolute differences for both the maximum effect and potential for quality improvement simulations).

Looking at individual patient-centered care measures, controlling for the PPC-RS scale, for the maximum effect simulation, communication about illness had the largest association with patient rating of physician quality (an absolute 21.61 percent increase). For all measures, the maximum effects resulted in at least an absolute 6 percent increase and all were statistically significant (p -value $< .01$). In terms of potential for quality improvement, the measures with the largest estimated effect on patient rating of physician quality were communication about illness and care coordination (an absolute 7.30 and 6.88 percent increase, respectively). However, the potential for quality improvement was small for the access to care when needed and office staff interaction scales (both under 2 percent in absolute terms).

Predicting the Association of PPC-RS Scale with Patient-Centered Care Measures

Table 3 lists the maximum effect and potential for quality improvement simulations for all six patient-centered care measures regressions (see Appendix

Table 4: Simulated Probability of Having Blood Pressure under Control[†]

<i>Model</i>	<i>Policy Variables Simulated</i>	<i>Maximum Effect on Probability (%)</i> [‡]		<i>Potential for Quality Improvement on Probability (%)</i> [§]	
		<i>Absolute Difference</i>	<i>Percentage Change</i>	<i>Absolute Difference</i>	<i>Percentage Change</i>
Model 2.1	PPC-RS scale	9.96*	21.68*	4.51*	9.99*
Model 2.2	PPC-RS scale	9.98*	21.77*	4.52*	10.03*
	Patient rating of care quality	11.46**	24.97**	4.20*	9.15**
Model 2.3	Patient rating of care quality	11.44**	24.89**	4.19**	9.12**

[†]Calculations of test statistics are based on the delta method and reflect the hierarchical nature of the data.

[‡]Measures the difference in simulated probabilities between the simulations with maximum versus minimum level for the policy measure(s) in question; the remaining explanatory variables were at the observed level.

[§]Measures the difference in simulated probabilities between the simulations with maximum versus observed level for the policy measure(s); the remaining explanatory variables were at the observed level.

*Significant at the $p < .05$ level.

**Significant at the $p < .01$ level.

Table A6 for estimated coefficients). Table 3 lists both p -values of single test statistics based on the delta method and p -values using the Hochberg adjustment to control for multiple testing (Hochberg 1988). The PPC-RS scale was never statistically significant (p -value >10 percent) in any regression. These results support our third hypothesis, that patient-centered care measures were unrelated to the PPC-RS scale.

Supporting our fourth hypothesis, simulation estimates indicated that both the PPC-RS scale and patient rating of care quality were statistically and clinically significant predictors of BP control. Table 4 exhibits the results of these simulations (see Appendix Table A7 for coefficient estimates used in these simulations). Focusing on the model where both measures are included, our two key variables were statistically significant (p -value <.05) in terms of the maximum effect and potential for quality improvement simulations. The potential for quality improvement simulation results suggests the association of our two variables with BP control were very similar. For the PPC-RS scale, this resulted in a 4.52 percent absolute improvement in share of patients with BP under control (p -value <.05). For patient rating of care quality, this resulted in a 4.20 percent absolute improvement in share of patients with BP under control (p -value <.05). These figures were more than doubled in the

maximum effect simulations and in terms of percentage change in the share of patients with BP control.

The simulated effects had no material differences across model specifications that included only one or both measures. This result suggests that our two measures related to different but important aspects of care. For PPC-RS scale, the potential for quality improvement simulation result changed from a 4.51 percent absolute increase when the patient rating of physician quality was excluded to 4.52 percent when it was included. For patient rating of physician quality, the potential for quality improvement simulation result changed from a 4.19 percent absolute increase when the PPC-RS scale was excluded to 4.20 percent when it was included.

DISCUSSION AND CONCLUSION

We found evidence supporting our four hypotheses. We found that practice infrastructure designed to support PCMH was not associated with patient rating of physician quality, while patient-centered care measures were seemingly a determining factor for patient rating of physician quality. Furthermore, practice infrastructure was not related to any patient-centered care measure. Finally, analysis of patient chart data suggested that both patient rating of care quality and the existence of an infrastructure to support PCMH were clinically important predictors of BP control among diabetic and hypertensive patients. These are important findings as the linkage between patient perceptions about their quality-of-care and actual quality outcomes have been difficult to demonstrate (Chang et al. 2006). Prior studies did find a positive association between better BP control and higher quality of perceived physician communication (Stewart 1995).

While based on different patients, as a whole, our results implied that patient-centered care measures were the driving forces behind patient rating of physician quality and that patient rating of care quality is, in turn, predictive of an important measure of intermediate health outcomes (BP control). Furthermore, although practice infrastructure was not strongly associated with patient rating of physician quality, it may capture factors, unobserved to the patient, that affect health outcomes. This second implication is based on our findings that the association between PPC-RS scale and BP control remained largely unchanged regardless of whether including patient rating of care quality in our regression. Similarly, the effects of patient rating of care quality

remained about the same vis-a-vis inclusion or exclusion of the PPC-RS scale.

One limitation of our paper is that we relied on only one intermediate outcome measure to validate the effects of patient perception of care quality and the PPC-RS scale. It is conceivable that these variables might be related to this measure but not other more important measures of long-term health. However, BP control has been shown to be strongly related to long-term health outcome measures such as life expectancy and risk of stroke and heart attack (Chobanian et al. 2003). Another issue to consider is that the PPC-RS scale might not be the best measure of PCMH practice infrastructure, as another recent study could not find a relationship between the PPC-RS scale and overall quality assessed by composite measures (Holmboe et al. 2010a). However, practice infrastructure, although not associated with patient rating of physician quality, was associated with better BP control. A similar limitation is that our measure of patient rating of care quality drawn from a patient survey administered by physicians who completed DH-PIM was likely subject to nonresponse bias. However, the fact that we found an association between patient rating of care quality and BP control indicates that the patients who did respond are capturing information related to the quality of care that is more generally rendered by the physician. Furthermore, demographic characteristics of patients who completed the chart audit and patient survey were very similar.

Another study limitation is that the link between BP control and patient-centered care measures relies on an indirect connection between patient rating of physician quality drawn from the CC-PIM data and the relationship between patient rating of care quality and BP control drawn from the DH-PIM. An additional issue is that, rather than being chosen by researchers, physicians participating in the DH-PIM did so to complete a certification requirement and these physicians selected their patients for chart audit. To examine the representativeness of this sample, we compared sample characteristics (age race/ethnicity, BP control) to the characteristics of diabetes and hypertension patients whose charts were audited as part of the 2007 National Ambulatory Medical Care Survey (NAMCS) and who visited board-certified internists. The NAMCS relies on rigorous sampling, data collection, and analysis procedures developed by the National Center for Health Statistics and is thought to be representative of ambulatory visits (Woodwell 2000; Gilchrist 2004). This comparison indicated that our chart audit patient sample was fairly representative of the population of diabetes and hypertension patients treated by board-certified physicians.

Finally, although significant from an assessment perspective, it is important to emphasize that our results did not imply a causal relationship from patient rating of quality to better BP control but instead pointed to importance of including a measure of patient assessment of quality for PCMH qualification. In addition, the association between higher patient rating of care quality and better BP control might be triggered by a confounding factor: patient health status. Healthier patients tend to give higher ratings of care quality and also have better BP control. However, since our patient-level BP control was not linked directly with that patient's rating of care quality, but the practice-level average patient rating of care quality, this problem is alleviated.

The message from our study is that an assessment tool that solely relies on either practice infrastructure or patient rating of care quality will likely miss important determinants of quality of care (BP control). The strong association between patient-centered care measures and patient rating of physician quality gave guidance as to the underlying factors by which patient rating of physician quality are based. Overall, our results support the recent initiative by NCQA to include a patient survey component in the medical home qualification process (NCQA 2010) and shed light on what survey items to emphasize.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Author Matrix.

Table A1: Seven Steps in PPC-RS Scale.

Table A2: Description of Patient-Centered Care Measures: Questions Refer to Care in the Last 12 Months.

Table A3: Descriptive Statistics for Variables Included in Probit Model of Patient Rating of Physician Quality.

Table A4: Descriptive Statistics for Variables Included in Probit Model of Blood Pressure Control.

Table A5: Regression Coefficients for Probit Model with Patient Rating of Physician Quality as Dependent Variable.

Table A6: Regression Coefficients for Probit Model with Patient-Centered Care Measures as Dependent Variables.

Table A7: Regression Coefficients for Probit Model with Blood Pressure Control as Dependent Variable.

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