



# Varied Rates of Implementation of Patient-Centered Medical Home Features and Residents' Perceptions of Their Importance Based on Practice Experience

M. Patrice Eiff, MD; Larry A. Green, MD; Geoff Jones, MD; Alex Verdick Devlaeminck, MD; Elaine Waller; Eve Dexter, MS; Miguel Marino, PhD; Patricia A. Carney, PhD

**BACKGROUND AND OBJECTIVES:** Little is known about how the patient-centered medical home (PCMH) is being implemented in residency practices. We describe both the trends in implementation of PCMH features and the influence that working with PCMH features has on resident attitudes toward their importance in 14 family medicine residencies associated with the P4 Project.

**METHODS:** We assessed 24 residency continuity clinics annually between 2007–2011 on presence or absence of PCMH features. Annual resident surveys (n=690) assessed perceptions of importance of PCMH features using a 4-point scale (not at all important to very important). We used generalized estimating equations logistic regression to assess trends and ordinal-response proportional odds regression models to determine if resident ratings of importance were associated with working with those features during training.

**RESULTS:** Implementation of electronic health record (EHR) features increased significantly from 2007–2011, such as email communication with patients (33% to 67%), preventive services registries (23% to 64%), chronic disease registries (63% to 82%), and population-based quality assurance (46% to 79%). Team-based care was the only process of care feature to change significantly (54% to 93%). Residents with any exposure to EHR-based features had higher odds of rating the features more important compared to those with no exposure. We observed consistently lower odds of the resident rating process of care features as more important with any exposure compared to no exposure.

**CONCLUSIONS:** Residencies engaged in educational transformation were more successful in implementing EHR-based PCMH features, and exposure during training appears to positively influence resident ratings of importance, while exposure to process of care features are slower to implement with less influence on importance ratings.

(Fam Med 2017;49(3):183-92.)

The patient-centered medical home (PCMH) has been proposed as a model to achieve the Triple Aim: a better experience of care leading to better health outcomes at lower costs.<sup>1-7</sup> Implementation of PCMH components has been described in various practice settings.<sup>8-12</sup> However, limited information exists about this in family medicine residency program continuity clinics. The I3 PCMH Collaborative, a network of 25 primary care teaching sites in North Carolina, South Carolina, and Virginia, conducted a 20-month study on PCMH implementation,<sup>13</sup> and another study of 18 residencies in the University of Washington Family Medicine Network (WWAMI) reported on PCMH features present in programs in 2010.<sup>14</sup>

A medical home is comprised of multiple interdependent elements including team-based care, care coordination, population management, and quality improvement, and building a PCMH is a complex

---

From the Department of Family Medicine, Oregon Health & Science University (Dr Eiff, Dr Devlaeminck, Ms Waller, Ms Dexter, Dr Marino, and Dr Carney); Department of Family Medicine, University of Colorado (Dr Green); Hendersonville Family Medicine Residency, Hendersonville, NC (Dr Jones).

developmental process requiring disruptive innovation.<sup>15</sup> Practices are under increased pressure to ensure that fully functional medical home features are in place, as new methods of primary care reimbursement depend on these features. However, some believe that a checklist of features required by payers or as part of a PCMH recognition process is costly, inefficient, not well aligned with patients' needs, and does not necessarily lead to improved outcomes.<sup>16-18</sup>

While much has been written from the perspective of practicing primary care physicians, we found no research reports on how the next generation of family physicians view the medical home model. The clinical training environment has been shown to influence future practice patterns,<sup>19,20</sup> so understanding how training in a PCMH during residency affects resident attitudes will help educators understand how best to create high-functioning continuity practices for trainees to learn in.

The PCMH was an important component in the Preparing the Personal Physician for Practice (P4), family medicine's residency redesign experiment.<sup>21</sup> The PCMH concept was relatively new when P4 started. The EHR-based and process of care PCMH features, included in this study, that were in place when P4 launched in 2007 have been described.<sup>22</sup> However, trends in implementation over time have not been assessed. Nor has how working with PCMH features influences residents' ratings of their importance. We studied these variables in the 14 family medicine residencies associated with P4. We explored the hypotheses that EHR-based PCMH features would be implemented at a faster rate than process of care features based on prior reports that transformation to a medical home is not "plug and play."<sup>8,15</sup> Additionally, we explored the hypothesis that residents would rate PCMH features as important regardless of their work with it during training, given so much has been written about the importance of the

PCMH, and more residency curricular time was devoted to it in the P4 programs.

## Methods

### *Study Setting*

The P4 project was a 5-year (2007–2012) national demonstration project involving changes in the length, structure, content, and location of training.<sup>21</sup> The overall P4 project and characteristics of the 14 participating programs and their specific innovations are described elsewhere.<sup>23,24</sup> Briefly, participating sites in P4 varied in size and location in the United States and represented community-based and university-based programs. Oregon Health & Science University's (OHSU) Institutional Review Board granted a waiver (IRB# 3788) for this project. In addition, each P4 site received an IRB review and was granted an exemption, waiver, or approval from their sponsoring institutions.

### *Data Management and Study Measures*

All surveys used in this study underwent extensive pilot testing using cognitive interviewing techniques.<sup>25</sup> Assessment of PCMH implementation was obtained using a Continuity Clinic Survey administered annually to participating programs' clinic leadership team. Survey items included patient demographics, practice characteristics, implementation of PCMH features, and PCMH recognition status. The PCMH features selected for this study were guided by the Executive and Steering Committees of the P4 Project, based on existing literature. This survey allowed us to assess the extent to which residents were working with these features as part of their patient care activities. The rating scale used to assess implementation status annually was: 1=Absent/No plans (not likely to be implemented), 2=Planning (implementation likely in 12–24 months), 3=Present/Implemented (major upgrades likely), 4=Mature (fully functional, minor upgrades). Clinic surveys were

retrospectively completed for the prior academic year, so the overlap between clinic data and resident data was only available for the years 2007 through 2010. The response rate for clinic surveys was 100% (all years combined).

Residents' attitudes about PCMH features were obtained using a Resident Survey, completed annually during the In-Training Exam testing period. This survey measured demographic information, satisfaction with program, quality of faculty, and perceived importance of PCMH features. The rating scale for importance included six response categories: 1=Don't Know, 2=Neutral/No Opinion, 3=Not at all important, 4=Somewhat important, 5=Moderately important, 6=Very important. The response rate for the resident surveys was 98% (all years combined).

The dependent variable for the importance analysis was residents' ratings of the importance of PCMH features thus far, given that the resident ratings may change over time. The independent variables included presence of PCMH features in their continuity practices as (present/mature) or absence (absent/planning) at the resident's site of clinical training for a given year. A cumulative exposure rating was calculated for each feature for every year and was categorized as: "no exposure" indicating 0 years of training with that feature, "some exposure" indicating 1–2 years of training with that feature, and "full exposure" indicating 3 or more years of training with that feature."

### *Data Analyses*

We included 24 of 30 possible continuity clinics in this analysis. Clinics in P4 programs that were in operation for less than 4 years were excluded (n=6). Twenty-two clinics were in place during study years 1 through 5, and two clinics were added by two programs in year 2 and were present through year 5. The PCMH features were subdivided into two categories: EHR-based

features (eg, secure remote access, chronic disease registries) and process of care features (eg, case management, team-based care).

### *Clinic-Level Analyses*

Descriptive statistics were used to characterize continuity clinic characteristics. The relationship between program year and the binary outcome of presence or absence of PCMH features was examined through a series of generalized estimating equations (GEE) logistic regression models. Each feature was modeled separately, and all models utilized a robust sandwich variance estimator to account for temporal correlation of observations within clinics over time. Time (ie, program year) was modeled as a continuous variable with 1-year intervals to produce a one-degree of freedom linear trend test. The percentage of P4 clinics with PCMH features present or mature was calculated from the GEE model for each year and feature.

### *Resident-Level Analyses*

We estimated the association between exposure to features of PCMH and resident ratings of importance separately for each study year. This was done to account for features of PCMH that were not necessarily stable for each resident over time. The presence of some PCMH features was quite variable from year to year, often due to changes in the EHR or clinic processes. Additional variation in exposure to features occurred when residents switched continuity clinics, left the program, or some of their training occurred either before P4 started or after P4 ended. In addition, analyses were not stratified by resident program year because exposure is highly correlated with program year (eg, first-year residents cannot have full exposure of 3 years). As such, all residents were included in yearly analyses for which they provided data.

For the importance scale, we excluded Don't Know and Neutral/No Opinion from modeling due to low residents' responses for these

categories (~5% for most outcomes and very few up to 18%). This also allowed the importance scale to have an equally spaced rating of importance. To ensure that this exclusion was not biasing our study results, we performed a sensitivity analysis that included these two response categories.

Analysis of the 4-point Likert scale of importance is challenging due to its lack of normality and having greater than two categories. To account for the ordinal nature of this scale, we used a series of ordinal logistic regression models.<sup>26</sup> This approach assumes proportional odds of a predictor's effect on rating of importance: the predictor's effect on the probability of rating the feature more important is the same for every level of the 4-point importance scale and therefore only requires a single regression coefficient for each predictor. A test for this proportional odds assumption was carried out for each model.<sup>27</sup> A violation of the proportional-odds assumption indicates that a single model may not fit the data (four of the 28 models involving process of care features and six of the 48 models of EHR-based features failed the assumption test) and in such cases, a multinomial logistic regression was used. Also, since residents' exposure to different PCMH features could change from year to year, we modeled exposure to each PCMH feature separately for each year of the study. Odds ratios and 95% confidence intervals were calculated from the ordinal logistic regression models. All proportional/multinomial logistic models controlled for resident characteristics (age, gender, and US medical school training) and a robust variance estimator was implemented to account for correlation of residents within residency program. All calculations were performed using Stata version 12<sup>28</sup> and R version 3.2.1.<sup>29</sup>

## **Results**

### *Trends in PCMH Implementation*

The majority of continuity clinics were owned by a hospital or health

system, and most of the visits were conducted by family physician faculty and physician assistants and nurse practitioners combined (Table 1). On average, approximately 38% of patients seen were covered by private insurance, 19% by Medicare and 26% by Medicaid. Of the 14 P4 programs, six were university based or university administered, and eight were community based, university affiliated. Residents ranged in age from 23 to 55, with a mean age of 31 years (Table 1). Most were Caucasian (64%), female (60%), and attended medical school in the United States (74%).

Table 2 illustrates trends in implementation of EHR-based and process of care features in continuity clinics. Nine of 12 (75%) EHR-based features showed a significant upward implementation trend. The magnitude of change in the presence of these nine features over the 5-year study ranged from an increase of 17% for full secure remote access to an increase of 43% in computerized physician order entry in the hospital EHR. The only process of care feature that increased significantly over the 5 years was team-based care (55% to 96%). The upward trend for most process features was not statistically significant.

In Years 4 and 5 of the Project, representing clinic status in 2009–2010 and 2010–2011, we measured National Committee for Quality Assurance (NCQA) PCMH recognition status. In Year 4, 3/24 clinics (13%) achieved some level of NCQA recognition (two clinics reached Level 3, one reached Level 1, and eight clinics were pending) (data not shown). In Year 5, 14/24 clinics (58%) achieved NCQA recognition (11 clinics reached Level 3, three reached Level 1) (data not shown).

### *Residents' Ratings of PCMH Importance*

Residents with some or full exposure to EHR-based features had higher odds of rating the component important compared to those with no exposure, and most of these findings

**Table 1: Characteristics of Residents and Continuity Clinics**

| Characteristics† of Continuity Clinic Sites 2010-2011 (n=24)      | Value              |
|---|--------------------|
| Number of residents—mean (standard deviation-SD)                  | 15.1 (10.7)        |
| Total annual patient visits                                       |                    |
| • Family physician faculty  | 10,513.5 (10378.9) |
| • Physician assistants and nurse practitioners                    | 3,338.9 (4989.2)   |
| • Residents   | 8,188.5 (6583.6)   |
| Payer mix—mean % (SD)   |                    |
| • Private health insurance  | 38.1 (23.8)        |
| • Medicare  | 19.0 (10.4)        |
| • Medicaid  | 26.3 (17.1)        |
| • Uninsured   | 9.6 (15.6)         |
| • Other   | 13.4 (19.7)        |
| Practice affiliation ownership—% of all clinics                   |                    |
| • Hospital or health system                                       | 71.9%              |
| • Community health center   | 10.2%              |
| • University School of Medicine                                   | 7.3%               |
| Resident Characteristics†† (n=690)                                | Value*             |
| Mean age in years (standard deviation or SD)                      | 30.8 (5.5)         |
| • Male  | 277 (40.3%)        |
| • Female  | 410 (59.7%)        |
| Race  |                    |
| • Caucasian   | 438 (63.5%)        |
| • African American  | 52 (7.5%)          |
| • Asian/Pacific Islander  | 115 (16.7%)        |
| • American Indian/Native Alaskan                                  | 3 (0.4%)           |
| • Other   | 82 (11.9%)         |
| Ethnicity—Hispanic  | 51 (7.6%)          |
| Marital status  |                    |
| • Single, never married   | 238 (34.7%)        |
| • Married/partnered   | 433 (63.1%)        |
| • Divorced  | 15 (2.2%)          |
| Have children   | 208 (30.4%)        |
| Entered med school immediately after completing bachelor's degree | 345 (50.5%)        |
| Attended medical school in US                                     | 424 (73.6%)*       |

\* Missing data 0%–6% except where noted by (\*\*) for missing data > 6%

† Characteristics from the final P4 data collection year

†† Based on the first time they completed the survey

occurred in 2009 and 2010 (Table 3). Many EHR-based features had over double the odds of a higher importance rating when residents had any exposure to the feature. For example, residents with full exposure to preventive service registries had nearly three times the odds of rating this feature at a higher level

of importance than residents with no exposure in 2009 (OR 2.86, 95% CI 1.18, 6.91,  $P < .05$ ). Findings were similar for this feature in 2010 and were similar to findings for any exposure to chronic disease registries in 2009 and 2010. Full exposure to population-based quality assurance using the EHR in 2010 also led to

significantly higher odds of rating these features at a higher level of importance (OR 1.99, 95% CI 1.24, 3.18,  $P < .01$ ).

Table 4 shows the odds of rating PCMH care process features as important according to exposure to the feature during training over time. In 2010, we observed lower odds of the

**Table 2: Trends in PCMH\* Electronic Health Record Features and Process of Care Features According to Project Year**

|   | Year 1<br>2006-7<br>n=22                                | Year 2<br>2007-8<br>n=24 | Year 3<br>2008-9<br>n=24 | Year 4<br>2009-10<br>n=24 | Year 5<br>2010-11<br>n=24 | P Value*** |
|---|---|--------------------------|--------------------------|---------------------------|---------------------------|------------|
| <b>PCMH* EHR-Based Features</b>   | <b>% of Clinics With PCMH Feature Present or Mature</b> |                          |                          |                           |                           |            |
| EHR (electronic health record) in practice  | 70.8  | 79.2                     | 84.6                     | 84.6                      | 85.7                      | .93        |
| Full secure remote access   | 79.2  | 79.2                     | 92.3                     | 88.5                      | 96.4                      | .05        |
| Electronic scheduling system integrated with EHR  | 62.5  | 68.0                     | 69.2                     | 80.8                      | 82.1                      | .02        |
| Full asynchronous patient-accessible scheduling (web-based)                                       | 8.7   | 16.0                     | 19.2                     | 42.3                      | 32.1                      | .002       |
| Electronic orders (eg, lab, x-ray) integrated with EHR  | 45.8  | 56.0                     | 65.4                     | 69.2                      | 77.8                      | .001       |
| Hospital EHR with full-computerized physician order entry   | 16.7  | 48.0                     | 53.8                     | 50                        | 59.3                      | .01        |
| Secure HIPAA**-compliant asynchronous communications (eg, e-mail or text messaging) with patients | 33.3  | 40.0                     | 30.8                     | 53.8                      | 66.7                      | .03        |
| Asynchronous communication with other providers   | 54.2  | 56.0                     | 69.2                     | 69.2                      | 66.7                      | .26        |
| EHR-based preventive services registries  | 22.7  | 20.0                     | 46.2                     | 53.8                      | 64.3                      | .001       |
| Chronic disease management registries   | 62.5  | 52.0                     | 73.1                     | 76.9                      | 82.1                      | .01        |
| Ongoing population-based quality assurance using an EHR/Registry                                  | 45.8  | 68.0                     | 73.1                     | 73.1                      | 78.6                      | .003       |
| Practice-based research using an EHR  | 16.7  | 29.2                     | 30.8                     | 26.9                      | 53.6                      | .01        |
| <b>Process of Care Features</b>   |   |                          |                          |                           |                           |            |
| Advanced or open-access scheduling  | 50.0  | 56.0                     | 53.8                     | 57.7                      | 53.6                      | .94        |
| Expanded hours (eg, clinic hours after 6 pm on weekdays or weekend clinic)                        | 58.3  | 60.0                     | 65.4                     | 73.1                      | 64.3                      | .78        |
| Credible, reliable patient satisfaction survey (to at least the practice level)                   | 58.3  | 75.0                     | 73.1                     | 73.1                      | 82.1                      | .09        |
| Using teams to manage patient care  | 54.2  | 66.7                     | 80.8                     | 88.5                      | 92.9                      | .001       |
| Integrated behavioral health  | 70.8  | 75.0                     | 73.1                     | 84.6                      | 82.1                      | .021       |
| Group visits  | 50.0  | 50.0                     | 53.8                     | 57.7                      | 35.7                      | .58        |
| Clinical pharmacy support   | 39.1  | 50.0                     | 50.0                     | 53.8                      | 46.4                      | .53        |
| Integrated case management  | 54.2  | 58.3                     | 57.7                     | 69.2                      | 67.9                      | .88        |

\* Patient-centered medical home

\*\* Health Insurance Portability and Accountability Act

\*\*\* P value based on generalized estimating equations logistic regression model accounting for within-clinic correlation.

resident rating process of care features as more important with any exposure (some or full) compared to no exposure for a few features. For example, with no exposure as the referent group, the odds of rating the feature of integrated case management as important was significantly lower with full exposure (OR 0.27, 95% CI=0.12, 0.60,  $P<.01$ ). Some or full exposure to using teams to manage care compared to no exposure

in 2010 also resulted in significantly lower odds of rating this feature important (OR 0.42, 95% CI=0.28, 0.63,  $P<.01$  for some exposure and OR 0.33, 95% CI=0.17, 0.64,  $P<.01$  for full exposure). This was a change from findings in 2008 when residents with some exposure to team care had nearly double the odds of rating this feature important compared to residents with no exposure (OR 1.79, 95% CI=1.11, 2.87,  $P<.05$ ).

## Discussion

This report is the first to our knowledge that describes both trends in implementation of PCMH features and the influence that working with PCMH features has on resident attitudes toward their importance. Our findings support our hypothesis that EHR-based features would be implemented at faster rates than process of care features. Outside influences such as the Meaningful Use

**Table 3: Adjusted Odds of Resident Rating Feature Important According to Exposure to EHR-Based Features of PCMH During Training**

| EHR-Based Features  | Odds* of Rating Feature Important    |                     |                                      |                     |                                      |                     |                                      |                      |
|---|--------------------------------------|---------------------|--------------------------------------|---------------------|--------------------------------------|---------------------|--------------------------------------|----------------------|
|   | 2007<br>Odds Ratio (95% CI)<br>n=347 |                     | 2008<br>Odds Ratio (95% CI)<br>n=375 |                     | 2009<br>Odds Ratio (95% CI)<br>n=393 |                     | 2010<br>Odds Ratio (95% CI)<br>n=389 |                      |
| EHR in continuity practice                                      |                                      |                     |                                      |                     |                                      |                     |                                      |                      |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent             |
| Some exposure (1–2 years)                                       | <b>1.58†</b>                         | <b>(1.06, 2.35)</b> | <b>2.39‡</b>                         | <b>(1.53, 3.74)</b> | <b>3.19‡</b>                         | <b>(1.91, 5.33)</b> | <b>8.80‡</b>                         | <b>(5.34, 14.51)</b> |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | <b>3.57‡</b>                         | <b>(2.18, 5.84)</b> | <b>6.20‡</b>                         | <b>(4.12, 9.33)</b>  |
| Asynchronous patient-accessible scheduling                      |                                      |                     |                                      |                     |                                      |                     |                                      |                      |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent             |
| Some exposure (1–2 years)                                       | <b>2.22‡</b>                         | <b>(1.51, 3.26)</b> | 0.57                                 | (0.28, 1.16)        | 1.03                                 | (0.47, 2.23)        | 1.18                                 | (0.89, 1.56)         |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | 1.81†                                | (1.08, 3.03)        | 0.59‡                                | (0.43, 0.81)         |
| Chronic disease management registries                           |                                      |                     |                                      |                     |                                      |                     |                                      |                      |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent             |
| Some exposure (1–2 years)                                       | <b>2.13‡</b>                         | <b>(1.24, 3.65)</b> | 1.46                                 | (0.93, 2.29)        | 1.34                                 | (0.80, 2.26)        | <b>1.95‡</b>                         | <b>(1.20, 3.17)</b>  |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | <b>5.24‡</b>                         | <b>(2.75, 9.99)</b> | 1.65                                 | (0.95, 2.86)         |
| EHR-based preventive services registries                        |                                      |                     |                                      |                     |                                      |                     |                                      |                      |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent             |
| Some exposure (1–2 years)                                       | 1.21                                 | (0.57, 2.56)        | 1.42                                 | (0.77, 2.65)        | <b>1.81‡</b>                         | <b>(1.23, 2.65)</b> | 1.83                                 | (0.92, 3.67)         |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | <b>2.86†</b>                         | <b>(1.18, 6.91)</b> | <b>2.11†</b>                         | <b>(1.17, 3.82)</b>  |
| Ongoing population-based QA using EHR                           |                                      |                     |                                      |                     |                                      |                     |                                      |                      |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent             |
| Some exposure (1–2 years)                                       | 1.61                                 | (0.95, 2.72)        | <b>2.53‡</b>                         | <b>(1.62, 3.94)</b> | <b>1.73†</b>                         | <b>(1.07, 2.79)</b> | <b>2.37‡</b>                         | <b>(1.46, 3.84)</b>  |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | 1.74                                 | (0.90, 3.35)        | <b>1.99‡</b>                         | <b>(1.24, 3.18)</b>  |
| Practice-based research using EHR                               |                                      |                     |                                      |                     |                                      |                     |                                      |                      |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent             |
| Some exposure (1–2 years)                                       | <b>2.14‡</b>                         | <b>(1.31, 3.51)</b> | <b>2.17‡</b>                         | <b>(1.24, 3.79)</b> | 1.12                                 | (0.64, 1.97)        | 1.55                                 | (0.95, 2.52)         |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | 1.49                                 | (0.99, 2.24)        | 1.30                                 | (0.67, 2.51)         |
| Asynchronous communication with other providers                 |                                      |                     |                                      |                     |                                      |                     |                                      |                      |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent             |
| Some exposure (1–2 years)                                       | 1.11                                 | (0.65, 1.90)        | 1.27                                 | (0.77, 2.11)        | 1.18                                 | (0.80, 1.75)        | <b>2.58‡</b>                         | <b>(1.90, 3.50)</b>  |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | <b>1.69†</b>                         | <b>(1.03, 2.77)</b> | <b>1.93†</b>                         | <b>(1.07, 3.47)</b>  |
| Secure HIPAA-compliant asynchronous communication with patients |                                      |                     |                                      |                     |                                      |                     |                                      |                      |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent             |
| Some exposure (1–2 years)                                       | 0.95                                 | (0.58, 1.55)        | <b>0.63 †</b>                        | <b>0.40, (0.99)</b> | 0.91                                 | (0.53, 1.55)        | 0.85                                 | (0.56, 1.29)         |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | 1.11                                 | (0.63, 1.95)        | 0.63                                 | (0.29, 1.39)         |

(continued on next page)

Table 3: Continued

| EHR-Based Features  | Odds* of Rating Feature Important    |                     |                                      |                     |                                      |                     |                                      |              |
|---|--------------------------------------|---------------------|--------------------------------------|---------------------|--------------------------------------|---------------------|--------------------------------------|--------------|
|   | 2007<br>Odds Ratio (95% CI)<br>n=347 |                     | 2008<br>Odds Ratio (95% CI)<br>n=375 |                     | 2009<br>Odds Ratio (95% CI)<br>n=393 |                     | 2010<br>Odds Ratio (95% CI)<br>n=389 |              |
| Secure HIPAA-compliant asynchronous communication with patients |                                      |                     |                                      |                     |                                      |                     |                                      |              |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent     |
| Some exposure (1–2 years)                                       | 0.95                                 | (0.58, 1.55)        | <b>0.63†</b>                         | <b>(0.40, 0.99)</b> | 0.91                                 | (0.53, 1.55)        | 0.85                                 | (0.56, 1.29) |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | 1.11                                 | (0.63, 1.95)        | 0.63                                 | (0.29, 1.39) |
| Hospital EHR with full physician order entry                    |                                      |                     |                                      |                     |                                      |                     |                                      |              |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent     |
| Some exposure (1–2 years)                                       | 1.56                                 | (0.78, 3.13)        | 1.12                                 | (0.53, 2.40)        | 1.18                                 | (0.65, 2.14)        | 1.79                                 | (0.87, 3.66) |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | 1.36                                 | (0.69, 2.65)        | 0.90                                 | (0.33, 2.46) |
| Electronic orders integrated in the EHR                         |                                      |                     |                                      |                     |                                      |                     |                                      |              |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent     |
| Some exposure (1–2 years)                                       | 0.91                                 | (0.50, 1.67)        | 1.24                                 | (0.79, 1.94)        | 1.20                                 | (0.59, 2.47)        | 1.80                                 | (0.78, 4.14) |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | <b>2.89‡</b>                         | <b>(1.48, 5.65)</b> | 1.85                                 | (0.88, 3.89) |
| Electronic scheduling integrated in the EHR                     |                                      |                     |                                      |                     |                                      |                     |                                      |              |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent     |
| Some exposure (1–2 years)                                       | 0.99                                 | (0.63, 1.54)        | 1.44                                 | (0.90, 2.29)        | 1.09                                 | (0.65, 1.83)        | <b>2.36‡</b>                         | (1.65, 3.37) |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | <b>1.96†</b>                         | <b>(1.16, 3.33)</b> | 1.45                                 | (0.86, 2.45) |
| Full secured remote access to EHR                               |                                      |                     |                                      |                     |                                      |                     |                                      |              |
| No exposure (0 years)   | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent     |
| Some exposure (1–2 years)                                       | <b>2.23†</b>                         | <b>(1.18, 4.22)</b> | 1.28                                 | (0.92, 1.77)        | <b>1.61†</b>                         | <b>(1.03, 2.53)</b> | 1.92                                 | (1.00, 3.71) |
| Full exposure (3 years)   | —                                    | —                   | —                                    | —                   | <b>2.48†</b>                         | <b>(1.12, 5.48)</b> | 1.64                                 | (0.92, 2.93) |

\* Adjusted for age, gender, US medical school training, and residency program

† Indicates *P* value <.05

‡ Indicates *P* value <.01

**bold—**

Program, NCQA PCMH Recognition, and alternative payment methods in primary care were likely drivers of the more rapid rate of change for EHR-based features.<sup>30,31</sup> Along with educational innovation, transformation toward a PCMH was a central focus in the P4 Project, which likely accelerated the push to implement EHR features.

The EHR implementation rate of 83% by year 5 is consistent with the rate reported for the WWAMI Residency Network (88% of 16 programs

in 2010).<sup>14</sup> All 25 practices in the I3 Collaborative used an EHR in 2010, but only 64% were fully implemented.<sup>13</sup> The EHR adoption rate for family physicians was reported to be 68% in 2011.<sup>32</sup> P4 programs that achieved PCMH recognition in the final project year (58%) is slightly higher than that reported for other residency networks in 2010 (WWAMI Network=44% and I3 Collaborative=48%).<sup>13,14</sup>

Team-based care was the only process of care feature to change

significantly with a near doubling of this feature from project Year 1 to Year 5, and 93% of clinics had this feature in place by year 5. In comparison, during a similar time period, a national study of small to medium practices conducted found that 28% of these practices were using primary care teams.<sup>9</sup> Team-based care may have been the process of care feature most aided by the enhanced data capacities from implementation of EHR-based features, and it takes a skilled team to

**Table 4: Adjusted Odds of Resident Rating Feature Important According to Exposure to Process of Care PCMH Features During Training**

| Process of Care Features              | Odds* of Rating Feature Important    |                     |                                      |                     |                                      |                     |                                      |                     |
|---------------------------------------|--------------------------------------|---------------------|--------------------------------------|---------------------|--------------------------------------|---------------------|--------------------------------------|---------------------|
|                                       | 2007<br>Odds Ratio (95% CI)<br>n=347 |                     | 2008<br>Odds Ratio (95% CI)<br>n=375 |                     | 2009<br>Odds Ratio (95% CI)<br>n=393 |                     | 2010<br>Odds Ratio (95% CI)<br>n=389 |                     |
| Using teams to manage patient care    |                                      |                     |                                      |                     |                                      |                     |                                      |                     |
| No exposure (0 years)                 | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            |
| Some exposure (1–2 years)             | 1.84                                 | (0.98, 3.45)        | <b>1.79†</b>                         | <b>(1.11, 2.87)</b> | 0.87                                 | (0.48, 1.59)        | <b>0.42‡</b>                         | <b>(0.28, 0.63)</b> |
| Full exposure (3 years)               | —                                    | —                   | —                                    | —                   | 1.03                                 | (0.48, 2.23)        | <b>0.33‡</b>                         | <b>(0.17, 0.64)</b> |
| Group visits                          |                                      |                     |                                      |                     |                                      |                     |                                      |                     |
| No exposure (0 years)                 | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            |
| Some exposure (1–2 years)             | <b>2.23†</b>                         | <b>(1.00, 1.06)</b> | 0.91                                 | (0.65, 1.26)        | 1.28                                 | (0.77, 2.13)        | 0.94                                 | (0.55, 1.59)        |
| Full exposure (3 years)               | —                                    | —                   | —                                    | —                   | 1.05                                 | (0.46, 2.37)        | 0.65                                 | (0.27, 1.56)        |
| Clinical pharmacy support             |                                      |                     |                                      |                     |                                      |                     |                                      |                     |
| No exposure (0 years)                 | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            |
| Some exposure (1–2 years)             | 1.63                                 | (0.91, 2.94)        | 1.08                                 | (0.60, 1.96)        | 1.15                                 | (0.60, 2.22)        | 0.92                                 | (0.44, 1.93)        |
| Full exposure (3 years)               | —                                    | —                   | —                                    | —                   | 1.14                                 | (0.53, 2.48)        | 0.93                                 | (0.43, 1.98)        |
| Integrated case management            |                                      |                     |                                      |                     |                                      |                     |                                      |                     |
| No exposure (0 years)                 | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            |
| Some exposure (1–2 years)             | <b>0.38‡</b>                         | <b>(0.20, 0.71)</b> | 0.85                                 | (0.43, 1.67)        | 0.78                                 | (0.45, 1.35)        | 0.90                                 | (0.54, 1.52)        |
| Full exposure (years)                 | —                                    | —                   | —                                    | —                   | 0.70                                 | (0.22, 2.27)        | <b>0.27‡</b>                         | (0.12, 0.60)        |
| Integrated behavioral health          |                                      |                     |                                      |                     |                                      |                     |                                      |                     |
| No exposure (0 years)                 | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            |
| Some exposure (1–2 years)             | 0.59                                 | (0.31, 1.12)        | 1.13                                 | (0.56, 2.29)        | 0.89                                 | (0.45, 1.74)        | 0.79                                 | (0.40, 1.53)        |
| Full exposure (3 years)               | —                                    | —                   | —                                    | —                   | 0.80                                 | (0.29, 2.26)        | 0.39                                 | (0.15, 1.01)        |
| Credible, patient satisfaction survey |                                      |                     |                                      |                     |                                      |                     |                                      |                     |
| No exposure (0 years)                 | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            |
| Some exposure (1–2 years)             | 0.85                                 | (0.46, 1.57)        | 0.63                                 | (0.36, 1.12)        | 1.62                                 | (1.04, 2.54)        | 0.84                                 | <b>(0.43, 1.64)</b> |
| Full exposure (3 years)               | —                                    | —                   | —                                    | —                   | <b>1.62†</b>                         | <b>(1.13, 2.34)</b> | 0.83                                 | (0.40, 1.73)        |
| Expanded clinic hours                 |                                      |                     |                                      |                     |                                      |                     |                                      |                     |
| No exposure (0 years)                 | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            | 1                                    | referent            |
| Some exposure (1–2 years)             | 0.96                                 | (0.61, 1.52)        | <b>1.51†</b>                         | <b>(1.03, 2.21)</b> | 1.75                                 | (0.79, 3.85)        | 1.25                                 | (0.86, 1.80)        |
| Full exposure (3 years)               | —                                    | —                   | —                                    | —                   | 1.69                                 | (0.90, 3.17)        | 0.70                                 | (0.41, 1.19)        |

\* Adjusted for age, gender, US medical school training, and residency program

† Indicates *P* value<.05‡ Indicates *P* value<.01

bold—



effectively use and integrate those features into day-to-day patient care.

The progress residency programs made in achieving PCMH recognition status while not reporting much change in most of the process of care features supports what others have found, that you can be a PCMH level 3 clinic and not have transformed care.<sup>18,33-35</sup> While residencies may have taken advantage of the financial incentives of gaining PCMH recognition, implementing crucial aspects of patient-centered care remained a challenge. Further research is needed to determine the contributions of financial incentives, basic rules changes, and leadership in transforming residency practices.

Making important changes to the structure and content of training and simultaneously improving the clinical learning environment, as occurred in P4, is a significant undertaking. Our findings are important in that residency programs should be leaders in practice transformation since clinical training during residency strongly influences future practice patterns.<sup>19,20</sup> The new strategic plan in family medicine, Family Medicine for America's Health, calls for the discipline to lead the continued evolution of the PCMH toward the target of the Triple Aim and work to ensure that the country has a well-trained primary care workforce.<sup>36</sup> To help meet this goal, residencies must strive to have exemplary practices to produce exemplary physicians.

Our initial hypothesis assumed that residents would rate PCMH features as important regardless of exposure because so much has been written about PCMH and improved care. However, we found mixed results on residents' rating of the importance of PCMH features according to working with these features during residency. Many of the EHR-based features in the PCMH resulted in higher odds of rating the feature important, while exposure to process of care features resulted in lower odds of rating those features important.

Notably, resident exposure to chronic disease and preventive services registries and ongoing population-based quality assurance led to higher odds of rating those features as important compared to those with no exposure. These aspects of practice are becoming increasingly important to achieve the Triple Aim,<sup>37</sup> and our findings support the premise that exposing residents to these features appears to affect their attitudes about importance. Future studies could explore how these attitudes influence practice choice after residency. Exposure to team-based care and integrated case management resulted in lower odds of the resident rating these features as important, particularly in the final year of the study. While this may seem paradoxical, since these features have been shown to be associated with high-functioning medical homes,<sup>38</sup> it is true that during the time period of this study (2007 to 2010), these features may have been in significant flux in many P4 practices. It is possible that residents perceived chaos with practice-level changes that involved complex staffing changes and rated their level of importance lower than other features.

The strengths of our study include the very high response rates we achieved to our surveys and a large sample of residents from multiple residency programs across the country. A limitation of our study is that our clinic sample size was small, which could explain why the implementation trends for some PCMH features did not achieve significance. We only included P4 residencies, which were selected based, in part, on their ability to transform toward a PCMH, so resident exposure to and perceptions of these features may not be generalizable to other residencies. Additionally, our results may have been affected by social response bias where residents felt more pressure to rate PCMH features as more important since this would be viewed as more acceptable in a residency focused on PCMH transformation.

In conclusion, residencies engaged in significant educational change made substantial progress toward incorporating important features necessary for transformed care. However, transforming care processes except team-based care trailed behind. Exposure to EHR-based features appears to positively influence resident ratings of importance, while exposure to process of care features has less influence on importance ratings. Further study of how exposure in training to PCMH features affects the types of practices family medicine residency graduates choose is needed to help educators better prepare physicians for the medical homes our patients need.

**CORRESPONDING AUTHOR:** Address correspondence to Dr Eiff, Oregon Health and Science University, Department of Family Medicine, 3181 SW Sam Jackson Park Road, Mail Code: FM, Portland, OR 97239. 503-494-6610. Fax: 503-494-4496. eiff@ohsu.edu.

## References

1. Patient-Centered Primary Care Collaborative: pilots and demonstrations. <http://www.pccpc.net/topic/pilotdemonstration>. Accessed June 8, 2015.
2. McNellis RJ, Genevro JL, Meyers DS. Lessons learned from the study of primary care transformation. *Ann Fam Med* 2013;11(Suppl 1):S1-S5.
3. Kern LM, Edwards A, Kaushal R. The patient-centered medical home, electronic health records, and quality of care. *Ann Intern Med* 2014;160(11):741-9.
4. Sandy LG, Haltson H, Metfessel BA, Reese C. Measuring physician quality and efficiency in an era of practice transformation: PCMH as a case study. *Ann Fam Med* 2015;13:264-8.
5. Nelson KM, Helfrich C, Sun H, et al. Implementation of the patient-centered medical home in the Veterans Health Administration: associations with patient satisfaction, quality of care, staff burnout and hospital and emergency department use. *JAMA Intern Med* 2014;174(8):1350-8.
6. Hoff T, Weller W, DePuccio M. The patient-centered medical home: a review of recent research. *Med Care Res Rev* 2012 May;69(5):619-44.
7. Nielsen M, Gibson A, Buel L, Grundy P, Grumbach K. The patient-centered medical home's impact on cost & quality: an annual update of the evidence, 2013-2014. Patient-Centered Primary Care Collaborative, 2015. Accessed June 2, 2015 at <http://www.pccpc.org/resource/patient-centered-medical-homes-impact-cost-and-quality>.

8. Jaen CR, Ferrer RL, Miller WL, et al. Patient outcomes at 26 months in the Patient-Centered Medical Home National Demonstration Project. *Ann Fam Med* 2010;8(Suppl 1):s57-s67.
9. Rittenhouse DR, Casalino LP, Shortell SM, et al. Small and medium size physician practices use few patient-centered medical home processes. *Health Aff* 2011;30(8):1575-84.
10. Goldberg DG, Kuzel AJ. Elements of the patient-centered medical home in family practices in Virginia. *Ann Fam Med* 2009;7:301-8.
11. Alexander JA, Paustian M, Wise CG, et al. Assessment and measurement of patient-centered medical home implementation: the BCB-SM experience. *Ann Fam Med* 2013;11(Suppl 1):S74-S81.
12. Yoon J, Rose DE, Canelo I, et al. Medical home features of VHA primary care clinics and avoidable hospitalizations. *J Gen Intern Med* 2013;28(9):1188-94.
13. Reid MA, Baxley E, Stanek M, Newton W. Practice transformation in teaching settings: lessons from the I3 PCMH Collaborative. *Fam Med* 2011;43(7):487-94.
14. Lesko S, Hughes L, Fitch W, Pauwels J. Ten-year trends in family medicine residency productivity and staffing: impact of electronic health records, resident duty hours, and the medical home. *Fam Med* 2012;44(2):83-9.
15. Crabtree BF, Nutting PA, Miller WL, Stange KC, Stewart EE, Jaen CR. Summary of the National Demonstration Project and recommendations for the patient-centered medical home. *Ann Fam Med* 2010;8(suppl 1):s80-s90.
16. Reid RJ, Parchman ML. Is there value in medical home implementation beyond the electronic health record? *Ann Intern Med* 2014;160(11):802-3.
17. Berenson RA, Hammons T, Gans DN, et al. A house is not a home: keeping patients at the center of practice redesign. *Health Aff (Millwood)* 2008;27(5):1219-30.
18. Ho L, Antonucci J. The dissenter's viewpoint: there has to be a better way to measure a medical home. *Ann Fam Med* 2015;13(3):269-72.
19. Asch DA, Nicholson S, Srinivas SK, Herrin J, Epstein AJ. How do you deliver a good obstetrician? Outcome-based evaluation of medical education. *Acad Med* 2014;89(1):24-6.
20. Sirovich BE, Lipner RS, Johnston M, Holmboe ES. The association between residency training and internists' ability to practice conservatively. *JAMA Intern Med* 2014;174(10):1640-8.
21. Green LA, Jones SM, Fetter G, Pugno PA. Preparing the personal physician for practice: changing family medicine residency training to enable new model practice. *Acad Med* 2007;82(12):1220-7.
22. Carney PA, Eiff MP, Saultz JW, et al. Aspects of the patient-centered medical home currently in place: initial findings from the P4 (Preparing the Personal Physician for Practice) project. *Fam Med* 2009;41(9):633-40.
23. Carney PA, Eiff MP, Green LA, et al. Preparing the Personal Physician for Practice (P4): site-specific innovations, hypotheses, and measures at baseline. *Fam Med* 2011;43(7):464-71.
24. Carney PA, Eiff MP, Saultz JW, et al. Assessing the impact of innovative training of family physicians for the patient-centered medical home. *J Grad Med Educ* 2012;4(1):16-22.
25. Beatty PC, Willis GB. Research synthesis: the practice of cognitive interviewing. *Public Opin Q* 2007;71(2):287-311.
26. McCullagh P. Regression models for ordinal data. *J Roy Statist Soc Series B (Methodological)* 1980;42(2):109-42.
27. Brant R. Assessing proportionality in the proportional odds model for ordinal logistic regression. *Biometrics* 1990;46(4):1171-8.
28. StataCorp. 2011. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP.
29. R Core Team. R: a language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing, 2015. <http://www.R-project.org/>.
30. Blumenthal D, Tavenner M. The "Meaningful Use" regulation for electronic health records. *N Engl J Med* 2010;363:501-4.
31. NCQA patient centered medical home recognition. <http://www.ncqa.org/Programs/Recognition/PatientCenteredMedicalHomePCMH.aspx>. Accessed October 10, 2015.
32. Xierali IM, Hsiao CJ, Puffer JC, et al. The rise of electronic health record adoption among family physicians. *Ann Fam Med* 2013;11(1):14-19.
33. Nutting PA, Crabtree BF, Miller WL, Stange KC, Stewart E, Jaén C. Transforming physician practices to patient-centered medical homes: lessons from the National Demonstration Project. *Health Aff (Millwood)* 2011;30(3):439-45.
34. Friedberg MW, Chen PG, Van Busum KR, et al. Factors affecting physician professional satisfaction and their implications for patient care, health systems and health policy. Rand Corporation, 2013. [http://www.rand.org/content/dam/rand/pubs/research\\_reports/RR400/RR439/RAND\\_RR439.pdf](http://www.rand.org/content/dam/rand/pubs/research_reports/RR400/RR439/RAND_RR439.pdf). Accessed August 15, 2015.
35. Lewis SE, Nocon RS, Tang H, et al. Patient-centered medical home characteristics and staff morale in safety net clinics. *Arch Intern Med* 2012;172(1):23-31.
36. Phillips RL, Pugno PA, Saultz JW, et al. Health is primary: Family Medicine for America's Health. *Ann Fam Med* 2014;12(Suppl 1):S1-S12.
37. Bodenheimer T, Ghorob A, Willard-Grace R, Grumbach K. The 10 building blocks of high-performing primary care. *Ann Fam Med* 2014;12(2):166-71.
38. Solberg LI, Crain AL, Tillema J, Scholle SH, Fontaine P, Whitebird R. Medical home transformation: a gradual process and a continuum of attainment. *Ann Fam Med* 2013;11(Suppl 1):S108-14.