

## **Supplemental materials for:**

Burton RA, Zuckerman S, Haber SG, Keyes V. Patient-centered medical home activities associated with low Medicare spending and utilization. *Ann Fam Med.* 2020;18(6):503-510.

## **Supplemental Appendix**

### Study Sample

To be eligible for participation in the MAPCP Demonstration, Medicare beneficiaries had to meet the following eligibility criteria:

- Be alive;
- Have Medicare Parts A and B;
- Be covered under traditional Medicare FFS;
- Have Medicare as the primary payer for health care expenses;
- Reside in the state-specified geographic area for its initiative; and
- Be attributed to a MAPCP Demonstration participating practice.

All Medicare beneficiaries meeting these six criteria also had to be attributed to a participating PCMH for at least 3 months over the course of the demonstration evaluation period. Beneficiaries were attributed to practices quarterly. We attributed beneficiaries to practices based on the plurality of evaluation and management (E&M) visits to providers with primary care

specialties. States chose the exact E&M codes they wanted to use for purposes of attribution to a demonstration practice.

Medicare beneficiaries were allowed to enter the demonstration on a rolling basis. Rolling entry meant that the date on which a beneficiary was introduced to the MAPCP Demonstration could be after the state began its participation in the MAPCP Demonstration. Once a Medicare beneficiary was eligible for the MAPCP Demonstration for at least 3 months, the beneficiary was always included in the evaluation sample even if they were no longer attributed to a demonstration practice. Thus, we considered the MAPCP Demonstration an intent-to-treat study design.

We constructed an eligibility fraction variable reflecting the length of time the beneficiary was eligible each quarter and used it as an analytic weight in the regression analyses. The eligibility fraction for each quarter was defined as the total number of eligible days during the quarter, divided by the total number of days alive in the quarter.

### Regression Model

We used difference-in-differences (D-in-D) regression models to estimate changes in utilization and expenditures before and after the start of the MAPCP Demonstration, comparing beneficiaries attributed to practices that engaged in a given PCMH activity to beneficiaries attributed to practices that did not engage in the activity. We adjusted standard errors in all models for beneficiary clustering within practices. Observations were weighted by the beneficiary's eligibility fraction. Since different numbers of Medicare beneficiaries participated in each of the eight demonstration states (including a disproportionately large number of

participants in Michigan), we also weighted the claims data so that each state's contribution to our results was equalized.

The model is written as follows:

$$Y_{ijt} = \alpha_0 + \alpha_1 \text{Engage}_{ij} + \beta_t Q_t + \delta X_{ij} + \lambda \text{Assign}_{ijt} + \gamma_1 \text{Assign}_{ijt} * \text{Engage}_{ij} * Q_{t=dq\_1} + \gamma_2 \text{Assign}_{ijt} * \text{Engage}_{ij} * Q_{t=dq\_2} + \dots + \gamma_s \text{Assign}_{ijt} * \text{Engage}_{ij} * Q_{t=dq\_12} + \varepsilon_{ijt}. \quad (\text{A.1})$$

In Equation A.1 we define the following variables:

$Y_{ijt}$ —the outcome in quarter  $t$  for beneficiary  $i$  attributed to practice  $j$ .

$\text{Engage}_{ij}$  ( $= 0,1$ )—a time-invariant indicator equal to 1 if the beneficiary  $i$  is attributed to a practice that engaged in the PCMH activity, and 0 otherwise.

$Q_t$  ( $= 0,1$ )—a series of indicators identifying each calendar quarter of data. To account for differences in the start dates of the demonstrations, quarter variables ( $Q_t$ ) were defined relative to the start of a state's demonstration, rather than based on a calendar quarter.

Because the quarter variables represent different calendar quarters depending on a state's demonstration start date, we also included seasonal variables to control for seasonal variation in outcomes. The seasonal variable associated with a demonstration quarter differs depending on the quarter the state's demonstration began.

$\text{Assign}_{ijt}$  ( $= 0,1$ )—an indicator that switches from 0 to 1 in the first quarter  $t$  that beneficiary  $i$  was attributed to the MAPCP Demonstration practice. The indicator remains = 1 for all subsequent quarters. Because of the rolling entry of beneficiaries into the demonstration,  $\text{Assign}_{ijt}$  switches from 0 to 1 at different points in time for different beneficiaries. For example, for a beneficiary attributed to a MAPCP Demonstration

practice during the first demonstration quarter,  $Assign_{ijt} = 1$  for the first demonstration quarter and all quarters thereafter. For a beneficiary who was attributed during the second demonstration quarter,  $Assign_{ijt} = 1$  for the second demonstration quarter and all quarters thereafter.

$Q_{t=dq\_1}, Q_{t=dq\_2}, \dots, Q_{t=dq\_12}$ —indicators for the 1st through 12th demonstration quarters.

$Q_{t=dq\_1}$  represents the first month of the demonstration in all states. The demonstration quarter indicators are interacted with the indicator for attribution to a practice after the start of the MAPCP Demonstration,  $Assign_{ijt}$ , and with the indicator for being in a practice that engaged in a PCMH activity,  $Engage_{ij}$ .

$X_{ij}$ —a series of beneficiary- and practice-level covariates, as described below.

**Beneficiary-level variables:** age, Hierarchical Condition Category risk score (prospective, based on a beneficiary's pre-attribution claims), Charlson comorbidity score, and indicators for female, White, urban place of residence, original entitlement for Medicare due to disability, dual enrollment in Medicaid, end-stage renal disease, and residence in an institutionalized setting.

**Practice-level variables:** proportion of associated billing providers with primary care specialties and indicators for solo practitioners, whether the practice participated in a PCMH initiative prior to the demonstration, federally qualified health centers, critical access hospitals, and rural health clinics.

**County-level variables:** median household income (in increments of \$10,000) and population density in the beneficiary's most recent county of residence.

$\varepsilon_{ijt}$ —a residual term representing unobserved heterogeneity in the outcome unexplained by any of the other covariates.

The model also included state fixed effects to account for state differences in outcomes that do not vary over time.

The key coefficients of interest measure the following:

- $\alpha_1$ —the difference in the quarterly average outcome before the MAPCP Demonstration between practices that engaged in a PCMH activity and those that did not, controlling for other covariates.
- $\beta_{0,t}$ —the quarterly effect for quarter  $t$ . The quarterly effects track outcomes (e.g., total Medicare expenditures) for practices that did not engage in a PCMH activity and can accommodate arbitrary trends (e.g., linear, quadratic) in the outcome. They also provide a benchmark for PCMH activity impacts discussed below.
- $\gamma_1, \gamma_2, \dots, \gamma_s$ —measures the change for beneficiaries attributed to practices that engaged in a given PCMH activity during the first  $s$  quarters of the MAPCP Demonstration.

The  $\gamma_1, \gamma_2, \dots, \gamma_s$  coefficients are interpreted as follows. Consider first a beneficiary in a practice that did not engage in an activity, so that  $\text{Engage}_{ij} = 0$ . If  $t = b$  denotes a particular baseline quarter and  $t = dq\_1$  is the first demonstration quarter, the predicted change in average outcome (setting  $\varepsilon_{ijt} = 0$  in Equation A.1) is:

$$\Delta CG = (\alpha_0 + \beta_{0,dq\_1} + \delta X_{ij} + \lambda) - (\alpha_0 + \beta_{0,b} + \delta X_{ij}) = \lambda + \beta_{0,dq\_1} - \beta_{0,b}.$$

Consider also a beneficiary attributed to a practice that engaged in an activity in the first demonstration quarter ( $t = dq\_1$ ). For this beneficiary,  $I_{ij} = 1$  and  $Assign_{ij,dq\_1} = 1$  and the predicted change in average outcome from Equation A.1 is:

$$\Delta Engage = (\alpha_0 + \alpha_1 + \beta_{0,dq\_1} + \beta_1 + \delta X_{ij} + \lambda + \gamma_1) - (\alpha_0 + \alpha_1 + \beta_{0,b} + \beta_1 + \delta X_{ij}) = (\lambda + \beta_{0,dq\_1} - \beta_{0,b}) + \gamma_1.$$

Comparing the change or trend in predicted average outcome between the beneficiary attributed to the MAPCP Demonstration practice that engaged in an activity and the beneficiary attributed to a practice that did not engage in the activity, we see:

$$\Delta Engage - \Delta CG = (\lambda + \beta_{0,dq\_1} - \beta_{0,b}) + \gamma_1 - (\lambda + \beta_{0,dq\_1} - \beta_{0,b}) = \gamma_1.$$

Hence,  $\gamma_1$  represents the regression-adjusted between-group difference (i.e., practices that engaged in an activity versus that that did not) of the difference in outcome between the baseline quarter and the first quarter of the demonstration. This interpretation is independent of the choice of baseline quarter  $t = b$ .

The regression specification allowed us to provide impact estimates that can vary from quarter to quarter throughout the demonstration. We accomplish this by including indicators that represent each quarter before and after a person is attributed to a MAPCP Demonstration practice. These quarterly time indicators allowed for flexible control of outcome trends across both the pre-demonstration and demonstration periods. We then interacted each *demonstration* quarterly indicator with (1) the indicator representing whether the beneficiary was attributed to a practice that engaged in a given PCMH activity (i.e., the *Engage* variable) and (2) an indicator that the demonstration quarter was a quarter in which the beneficiary was attributed to a practice (i.e., the *Assign* variable). These interactions allowed us to estimate a separate D-in-D parameter

for each demonstration quarter, and thereby allowed the impact of the PCMH activity to grow or decline in potentially different ways throughout the demonstration period. We do not present each of the quarter-specific D-in-D estimates. Rather, we present the weighted average of the four quarter-specific D-in-D estimates for the third year of the demonstration to allow time for practices' mastery of the PCMH activity to mature. Weights were defined as the number of beneficiaries in practices that engaged in the PCMH activity in each quarter.