

ORIGINAL RESEARCH

Improving Delivery of Cardiovascular Disease Preventive Services in Small-to-Medium Primary Care Practices

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Background: The EvidenceNOW initiative provided smaller primary care practices with external support interventions to implement quality improvement strategies focused on cardiovascular disease prevention. This manuscript reports effectiveness of EvidenceNOW interventions in improving quality metrics.

Methods: Seven regional Cooperatives delivered external support interventions (practice facilitation, health information technology support to assist with audit and feedback, performance benchmarking, learning collaboratives, and establishing community linkages) to 1278 smaller primary care practices. Outcomes included proportion of eligible patients meeting Centers for Medicaid and Medicare Services-specified ABCS metrics, that is, Aspirin for those at risk of ischemic vascular disease; achieving target Blood pressure among hypertensives; prescribing statin for those with elevated Cholesterol, diabetes, or increased cardiovascular disease risk; and screening for Smoking and providing cessation counseling. An event study compared prepost changes in outcomes among intervention practices and a difference-in-differences design compared intervention practices to 688 external comparison practices.

Results: Mean baseline outcomes ranged from 61.5% (cholesterol) to 64.9% (aspirin). In the event study, outcomes improved significantly (aspirin: +3.39 percentage points, 95% CI, 0.61–6.17; blood pressure: +1.59, 95% CI, 0.12–3.06; cholesterol: +4.43, 95% CI, 0.33–8.53; smoking: +7.33, 95% CI, 4.70–9.96). Difference-in-differences estimates were similar in magnitude but statistically significant for smoking alone. Preintervention trends were significant for smoking, but parallel-trends tests were not significant.

Conclusions: EvidenceNOW Cooperatives improved cardiovascular prevention quality metrics among small and medium sized primary care practices across the US. While estimated improvements were small, they reflected average changes across a large and diverse sample of practices. (J Am Board Fam Med 2022;35:968–978.)

Keywords: Cardiovascular Diseases, Delivery of Health Care, Hyperlipidemia, Hypertension, Quality Improvement, Primary Health Care

Introduction

More people die from cardiovascular disease in the United States (US) than any other disease.¹ The 2019

American College of Cardiology and American Heart Association (ACC/AHA) Guideline on the Primary Prevention of Cardiovascular Disease emphasize

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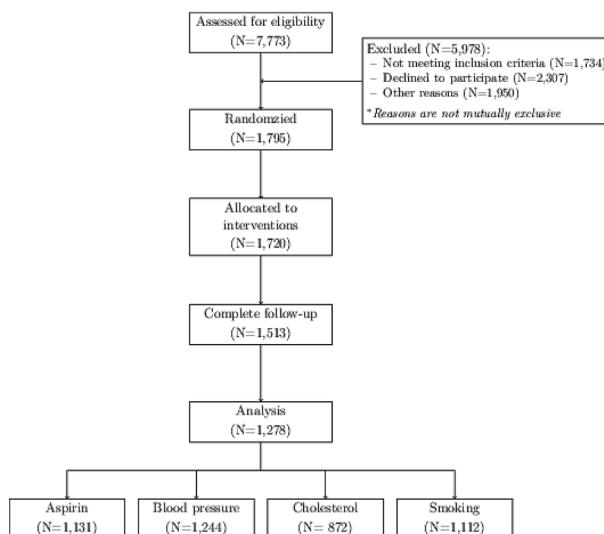
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Figure 1. EvidenceNOW consort diagram.

improving delivery of the ABCS of heart health, which included prescribing Aspirin for those at risk for ischemic vascular disease, achieving target Blood pressures for those with hypertension, prescribing statins to those with diabetes, high Cholesterol, or at risk for atherosclerotic cardiovascular disease, and screening and cessation counseling for Smoking.^{2,3} These strategies have been shown to reduce cardiovascular disease morbidity and mortality.^{3,4} Despite substantial clinical evidence, however, national ABCS rates remain suboptimal.⁵

To address this, the Centers for Medicare and Medicaid Services (CMS) and Centers for Disease Control and Prevention (CDC) launched the Million Hearts initiative in 2011.^{6–8} Its goal is to prevent 1 million heart attacks by 2022.⁶ Most Americans receive primary and secondary preventive care for cardiovascular disease in small to medium-sized primary care practices in their communities.⁹ Thus, improving ABCS rates among smaller practices is crucial to realizing the Million Hearts initiative.

Quality improvement strategies shown to increase ABCS adoption in health systems are available but are often not used widely as standard practice in primary care. For instance, the CDC’s Best Practices Guide for Cardiovascular Disease Prevention highlight that the use of team-based care, clinical decision support systems, and self-measured blood pressure monitoring is cost-effective in improving clinical

outcomes.¹⁰ However, primary care practices experience significant barriers to routine use of these strategies resulting in suboptimal ABCS rates and approaches to improve care delivery such as the Comprehensive Primary Care Initiative or Patient-Centered Medical Home have not consistently shown improvements in quality of care.^{11–14}

Recognizing this gap in ABCS delivery and limited quality improvement resources among smaller practices,¹⁵ the Agency for Health care Research and Quality (AHRQ) funded a national initiative called EvidenceNOW encouraging health systems and health professionals to focus on improving the ABCS and also practice capacity.^{16,17} EvidenceNOW funded 7 regional “cooperatives” (the term AHRQ used to reference grantees) spanning 12 US states to provide external support interventions at scale to primary care practices in their region with the goal of implementing quality improvement strategies targeting the ABCS. In this manuscript, we report the overall effectiveness of EvidenceNOW interventions on practice-level change in performance on cardiovascular disease (ABCS) clinical quality metrics.

Methods

EvidenceNOW Cooperatives enrolled over 1500 practices across 7 regions. Online Appendix Figure 1 shows the geographic distribution of EvidenceNOW Cooperatives. AHRQ also funded an external evaluation, Evaluating System Change and

Learning to Take Evidence to Scale (ESCALATES), led by our team (Cohen, PI).

Interventions

In its Request for Applications, AHRQ sought applications that proposed multi-component interventions providing quality improvement support to small and medium-sized primary care practices. It strongly encouraged practice facilitation as a central and unifying intervention. Thus, EvidenceNOW Cooperatives established infrastructure to deliver external support to practices recruited in their regions. They all implemented practice facilitation. In addition, each cooperative implemented a distinct package of interventions focused on improving the ABCS of heart health, including providing health information technology support to assist practices with audit and feedback, performance benchmarking, creating learning collaboratives, and establishing community linkages. While Cooperatives targeted interventions at improving ABCS outcomes, practices varied in the extent to which they implemented these interventions based on their motivations, priority, and resources. Each Cooperative evaluated implementation and effectiveness of its own intervention.^{18–24} We (ESCALATES) evaluated the effectiveness of the overall initiative.¹⁷

Study Designs

Because Cooperatives lacked internal practice controls, we used 2 quasi-experimental designs to evaluate the overall effectiveness of interventions: (1) an event study including only intervention practices and (2) a difference-in-differences approach comparing intervention practices with an external comparison group. The study period for both approaches ranged from the last quarter of 2015 (baseline) to the second quarter of 2018.

The event study assessed changes in ABCS relative to intervention start (the event) among all EvidenceNOW practices. The baseline period was the quarter just before the start of intervention for each practice cohort (fourth quarter of 2015 for the first cohort to the fourth quarter of 2016 for the fifth cohort). Across Cooperatives, interventions started in 5 cohorts between the first quarter of 2016 and the first quarter of 2017 and ended on a rolling basis over the next 12 months.

The difference-in-differences design evaluated change in outcomes for the years 2015

(preintervention), 2016 (during intervention) and 2017 (postintervention), comparing EvidenceNOW practices to an external comparison group of primary care practices provided by the DARTNet institute.²⁵ The baseline period for this analysis was the fourth quarter of 2015. Online Appendix Figure A2 depicts the outcome measurement time periods.

The difference-in-differences design is generally preferred over other types of pre-post designs (such as the event study) because it does not rely on the assumption that outcomes would not have changed in the absence of the intervention. However, the design requires outcome trends of comparison practices (ie, Dartnet) to accurately reflect those of intervention practices (ie, EvidenceNOW) in the absence of any intervention.^{26,27} Because of potential data quality issues for some measures in the Dartnet data, we compared findings across both designs to facilitate interpretation.

Data Sources and Practice Samples

We specified practice samples from 2 data sources: (1) EvidenceNOW (intervention practices), and (2) DARTNet (external comparison group).

Intervention Practices

Cooperatives initially assessed 7773 practices for eligibility and randomized 1795 for interventions (Figure 1). While eligibility criteria varied somewhat, most Cooperatives excluded larger practices (defined by AHRQ as ≥ 10 FTE clinicians) and those that did not have an electronic health record. However, 2 cooperatives that were experiencing challenges recruiting included a few practices with 11 to 15 FTE clinicians. Additional exclusion criteria were specific to Cooperatives' regional context (eg, using a specific electronic health record (EHR) system) and recruitment strategy (eg, from specific practice networks) and described in detail elsewhere.^{18–24} In addition, for our sensitivity analyses described below, we further excluded federally qualified health center (FQHC) practices from the EvidenceNOW sample for comparability with the external comparison group.

ABCS outcome metrics were collected from all practices. We excluded practices with unreliable outcome data, which included practices that (1) did not provide outcomes for at least 1 quarter before the intervention, (2) did not provide

outcomes following the intervention, and (3) had low denominator values during one or more study quarters, defined as fewer than 10 patients in the denominator for the aspirin measure and fewer than 30 patients in the denominator for other measures. Of the 1795 practices randomized to interventions, 1278 (71%) were retained in the final sample. Specific to each outcome, the final sample had between 872 (cholesterol) and 1244 (blood pressure) EvidenceNOW practices.

External Comparison Practices. Because EvidenceNOW Cooperatives' study designs did not include internal control practices, we assembled a group of practices external to EvidenceNOW to serve as a comparison group. These were derived from the DARTNet Institute, a real-time EHR data repository. The institute provides secure, deidentified datasets of clinical quality metrics from 12 distinct practice-based research networks that includes over 1000 primary care practices. We applied the same exclusion criteria to DartNet practices.²⁵ The final sample had between 377 (blood pressure) and 688 (smoking) DartNet practices.

As a sensitivity analysis, we defined a subsample of DARTNet practices located in states represented within EvidenceNOW because they might more accurately reflect regional outcome trends. For this sensitivity analysis (but not the main analysis), we excluded federally qualified health center (FQHC) practices from the EvidenceNOW subsample, because DARTNet did not include FQHC practices located in EvidenceNOW states. The EvidenceNOW subsample had between 580 (cholesterol) to 776 (aspirin) practices; the DARTNet subsample had between 75 (blood pressure) to 117 (smoking) practices.

Measures

The ESCALATES team, in collaboration with Cooperatives, harmonized ABCS measure definitions and practice characteristics. Details about data collection are described in previous studies.^{28,29}

Outcomes

We used the Centers for Medicaid and Medicare Services (CMS) specifications for the ABCS outcomes in use in 2015 (Table 1). Each outcome measured the proportion of eligible patients prescribed the recommended treatment in each practice. Cooperatives obtained practice-level performance on ABCS outcomes from practices'

electronic health records (EHRs) through quality reports, health information exchange reports, or, in some cases, chart audits, and shared with the ESCALATES team.

Covariates

Practice characteristics were obtained through surveys administered to participating practices by Cooperatives; these included: practice size (solo, 2 to 5, 6 to 10, 11 to 15); practice ownership (clinician-owned, hospital/health system-owned, FQHC, and other); practice location (rural, large town, suburban, urban); whether a practice participated in demonstration programs; whether a practice was in a medically underserved area; health insurance distribution (percent of patients with commercial insurance, uninsured, on Medicaid, on Medicare, dually eligible for Medicaid and Medicare, or on other insurance) and race/ethnicity distribution (percent of white, black, Hispanic patients) of practice patient panel. DARTNet data included practice ownership, race and ethnicity and practice characteristics.

Statistical Analysis

We used multivariable linear regression models for both designs. The event study included binary indicators for quarters relative to the last quarter before start of intervention, ranging from -4 to 9, with 0 indicating the quarter intervention began. These indicators measured change in the outcome relative to the last preintervention quarter. We, then adjusted for practice characteristics and included binary indicators for Cooperatives, intervention cohorts and the quarter of first data submission in the regression. After model estimation, we averaged coefficients for the fifth to eighth postintervention quarter, representing changes in the second year of the intervention.

The difference-in-differences approach included indicator variables for postintervention calendar quarters (first quarter of 2016 to second quarter of 2018), a binary indicator for the intervention group (EvidenceNOW compared with DARTNet), and interaction terms between time indicators and the intervention group indicator. Interaction terms measured changes in outcomes of EvidenceNOW practices compared with DARTNet practices. We adjusted for practice characteristics and included binary indicators for intervention cohorts and the quarter of first data submission in the regression.

Table 1. Specification of ABCS Clinical Quality Outcome Measures

Aspirin	Blood Pressure	Cholesterol	Smoking
Denominator			
Patients 18 years and older with at least one face to face visit who (i) had an active diagnosis of ischemic vascular disease at any time during the current measurement period; (ii) were discharged alive for acute myocardial infarction, coronary artery bypass graft or percutaneous coronary interventions in the 12 months before the measurement period	Patients 18 years and older and 85 years or younger with at least one face to face visit and active diagnosis of essential hypertension at any time before the first date of month 7 of the measurement period and who did not (i) have an active diagnosis of pregnancy at any time during the measurement period; or (ii) have evidence of end stage renal disease, dialysis, or renal transplant before or during the measurement period	Patients 21 and older with at least one face to face visit who have (i) an active diagnosis of clinical atherosclerotic cardiovascular disease during the current measurement period or any time period; (ii) LDL-C result \geq 190 mg/dL at any time during or before the measurement period; (iii) aged 40 to 75 years at the beginning of the measurement period with an active diagnosis of diabetes with the highest LDL-C result of 70 to 189 mg/dL during the current measurement period or two years before the beginning of the measurement period; and who (i) did not have adverse effect, allergy or intolerance to statin medication therapy; (ii) did not have an active diagnosis of pregnancy or breastfeeding; (iii) did not receive palliative care; (iv) did not have an active liver disease or hepatic disease of insufficiency; (v) did not have end stage renal disease; or (vi) did not have a most recent LDL-C results $<$ 70 mg/dL for patients with a diabetes diagnosis who are not currently receiving statin medication therapy	Patients 18 years and older as of the first day of the measurement period with at least two visits during the measurement period
Numerator			
Number of patients who have documentation of use of aspirin or another antithrombotic during the measurement period	Number of patients whose blood pressure at the most recent visit is adequately controlled (systolic blood pressure $<$ 140 mmHg and diastolic blood pressure $<$ 90 mm Hg) during the measurement period	Number of patients with a statin medication current on the medication list or prescribed a statin medication during the measurement period	Number of patients who were screened for tobacco use at least once within 24 months and who received tobacco cessation intervention if identified as a tobacco user.
Measurement period (EvidenceNOW practices)			
Data quarter and preceding three quarters	Data quarter and preceding three quarters	Data quarter and preceding three quarters	Data quarter and preceding three quarters

Notes: Measure specifications are based on CMS164v4 (aspirin prescription when appropriate), CMS165v4 (blood pressure control), CMS347v1 (cholesterol management) and CMS138v4 (smoking cessation support counseling).

We then averaged coefficients for the year 2017, which approximated the second intervention year. We used bootstrapping with 1000 repetitions to cluster standard errors at the Cooperative level (for the event-study) or at the state levels (for the EvidenceNOW-DARTNet comparison).

To test the assumption that outcomes would not have changed without intervention in the event study, we calculated average preintervention

outcome change based on estimates for the fourth to second preintervention period. We note that most practices did not submit data starting 4 quarters before intervention begin due to a staggered recruitment process. For the differences-in-differences analysis, we assessed differential trends between EvidenceNOW and DARTNet practices for the first 2 quarters of 2016. We selected these two quarters because we lacked a true preintervention

period for this analysis and because interventions were unlikely to have immediate effects on outcomes. When preintervention trends or parallel-trends test were significant, we estimated trend-adjusted models.^{30,31} Trend adjusted models assumed that trends before the intervention would have continued at the same rate during the intervention period absent treatment. All analyses were conducted using R version 3.5.1. The Institutional

Table 2. Characteristics of the EvidenceNOW and DARTNet Practice Sample

Practice and patient characteristic	EvidenceNOW Practices	DARTNet Practices
Practice size		
Solo	22.7	
2 to 5 clinicians	46.7	
6 to 10 clinicians	14.0	
11 to 15 clinicians	10.6	
Missing	5.9	
Practice ownership		
Clinician	42.1	46.0
Hospital/health system/ HMO	22.7	46.0
FQHCs	19.6	3.0
Other	11.4	4.9
Missing	4.2	0.0
Practice location		
Rural area	12.8	
Large town	10.8	
Suburban	6.3	
Core urban	59.5	
Missing	10.6	
Insurance status: Fraction of patients		
Uninsured	9.9	
Medicaid	23.0	
Medicare	22.9	
Dually eligible	7.1	
Commercially insured	34.5	
Other insurance	2.7	
Race/ethnicity: Fraction of patients classified as		
White	59.8	49.1
Black	15.6	6.0
Unknown race	7.8	0.0
Hispanic	19.1	6.7
Unknown ethnicity	9.3	0.0
Practice participated in demonstration program		
No	53.7	
Yes	19.7	
Missing	26.6	

Continued

Table 2. Continued

Practice and patient characteristic	EvidenceNOW Practices	DARTNet Practices
Practice has MUA HER		
No	44.5	
Yes	18.4	
Missing	37.1	

Notes: Numbers in the table are percentage values for practice characteristics and mean percentage values for patient characteristics. The sample includes all practices with at least one valid ABCS outcome measure during the study period (n = 1278 for EvidenceNOW practices; n = 613 for DARTNet practices). Practice location is based on the rural-urban commuting areas using 2010 Census data. Numbers for insurance status and race/ethnicity are average percentage values. They do not sum to 100 percent because practices were not required to report estimates that did so. Dual eligible insurance status includes patients receiving both Medicaid and Medicare. Demonstration programs include State Innovation Models Initiative, Comprehensive Primary Care Initiative, Transforming Clinical Practice Initiative—Support and Alignment Network, Community Health Worker training program, Blue Cross/Blue Shield patient-centered medical home program, Association of State and Territorial Health Officials’ Million Hearts State Learning Collaborative, Million Hearts: Cardiovascular Disease Risk Reduction Model, and any other program identified by the practice. HMO: Health Management Organization; FQHC: Federally Qualified Health Center; EHR: electronic health records; MUA: Meaningful Use. Sources: EvidenceNOW practice survey; DARTNet practice data.

Review Board of Oregon Health & Science University approved this study.

Results

Most EvidenceNOW practices (83.4%) had ≤10 clinicians (Table 2). While EvidenceNOW’s focus was on smaller practices, about 10% of the practices recruited were slightly larger (11 to 15 clinicians). Sixty percent of practices were in urban core areas. DARTNet practices were more than twice as likely to be health system-owned compared with EvidenceNOW practices.

Very few DARTNet practices (3%) across all states were FQHCs (none of the DARTNet practices in EvidenceNOW states were FQHCs). EvidenceNOW and DARTNet practices had a similar percentage of white patients. EvidenceNOW practices had a higher proportion of black and Hispanic patients compared with DARTNet practices. Mean baseline ABCS performance among EvidenceNOW practices were 64.9% (aspirin), 63.6% (blood pressure), 61.5% (cholesterol), and

62.0% (smoking) with wide variation across practices. Among DARTNet practices, mean baseline ABCS levels were 29.6% (aspirin), 64.7% (blood pressure), 39.4% (cholesterol), and 12.6% (smoking). Except for blood pressure, outcome levels for DARTNet practices at baseline were much lower than EvidenceNOW practices.

In the event study, all ABCS outcomes improved. (Table 3). Average outcome change 2 years after the intervention (between baseline and the fifth to eighth quarter) was +3.39 percentage points (95% CI: 0.61 to 6.17, $P < .05$) for aspirin, +1.59 percentage points (95% CI: 0.12 to 3.06, $P < .05$) for blood pressure, +4.43 percentage points (95% CI: 0.33 to 8.53, $P < .05$) for cholesterol and +7.33 (95% CI: 4.70 to 9.96, $P < .001$) for smoking. All outcomes improved gradually during the first 4 postintervention quarters, and then remained at the same level for aspirin, blood pressure and cholesterol, while further increasing for smoking (Figure 2). Preintervention trend estimates for the event

study were not statistically significant, except for a positive pretrend for the smoking outcome in the event study (pretrend estimate: 2.03, $P < .01$, Table 3). Adjusting for this pretrend resulted in a significant negative estimate for smoking (see Online Appendix Table B5).

In the difference-in-differences design, parallel-trends test was not statistically significant for any of the outcomes. As shown in Table 3, EvidenceNOW practices showed higher performance on all measures as compared with DARTNet controls but with varying levels of statistical significance (Aspirin +3.75 percentage points, $P = .0875$; Blood pressure +2.76 percentage points, $P = .0556$; Cholesterol +3.87 percentage points, $P = .2990$; and Smoking +8.32 percentage points, $P = .0027$). Outcomes for DARTNet practices between 2016 and 2017 did not show any clear trends (Online Appendix Figure A2) and aspirin and cholesterol outcomes for the first and second quarter of 2018 were much larger than for other quarters. Estimates from sensitivity analysis using the subsample of DARTNet

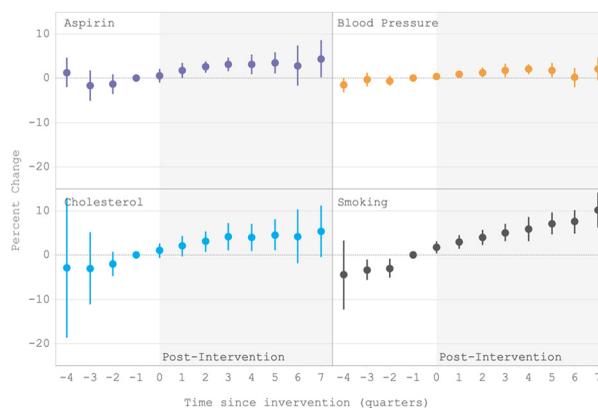
Table 3. Baseline ABCS Levels and Estimates of Effectiveness of EvidenceNOW

Approach	Aspirin	Blood Pressure	Cholesterol	Smoking
Event study				
Baseline level, % (SD)	64.9 (23.5)	63.6 (15.0)	61.5 (19.4)	62.0 (30.7)
Change estimate	3.39	1.59	4.43	7.33
95% CI	0.61, 6.17	0.12, 3.06	0.33, 8.53	4.70, 9.96
<i>P</i> value	0.0167	0.0337	0.0342	0.0000
Pre-intervention trend test estimate (<i>P</i> value)	0.58 (0.37)	0.41 (0.19)	1.46 (0.27)	2.03 (0.002)
Difference-in-differences, DARTNet comparison (all states)				
Baseline level, % (SD) (EvidenceNOW)	65.1 (23.2)	63.1 (15.2)	62.5 (19.2)	64.9 (30.2)
Baseline level, % (SD) (DARTNet)	29.6 (20.3)	64.7 (20.4)	39.4 (19.2)	12.6 (9.1)
Change estimate	3.75	2.76	3.87	8.32
95% CI	-0.56, 8.06	-0.06, 5.58	-3.44, 11.18	2.89, 13.75
<i>P</i> value	0.0875	0.0556	0.2990	0.0027
Parallel trend test estimate (<i>P</i> value)	0.65 (0.50)	0.49 (0.46)	1.49 (0.26)	1.49 (0.35)
Difference-in-differences, DARTNet comparison (EvidenceNOW states)				
Baseline level, % (SD) (EvidenceNOW)	64.9 (23.6)	62.9 (15.3)	62.0 (19.0)	61.4 (30.5)
Baseline level, % (SD) (DARTNet)	31.0 (19.6)	63.6 (16.9)	40.9 (21.4)	15.9 (10.7)
Change estimate	4.88	2.87	3.81	11.54
95% CI	-3.33, 13.09	0.07, 5.67	-6.46, 14.08	3.56, 19.52
<i>P</i> value	0.2444	0.0447	0.4680	0.0046
Parallel-trends test estimate (<i>P</i> value)	-0.54 (0.46)	-0.55 (0.74)	0.53 (0.72)	2.67 (0.28)

Abbreviations: SD, standard deviation; CI, confidence interval.

Notes: For the event study, baseline levels correspond to the last quarter before intervention begin (fourth quarter of 2015 for the first cohort to fourth quarter of 2016 for the fifth cohort). Estimates of the effect of interventions correspond to average estimates of the fifth to eighth post-intervention quarters. Pre-intervention trend estimates are based on the fourth to second pre-intervention period. For the difference-in-difference analysis, baseline levels correspond to the fourth quarter of 2015. Estimates of the effect of the intervention correspond to average estimates of the interaction term between an indicator for EvidenceNOW practices and 2017 quarters. Parallel-trends tests are based on the first and second quarter of 2016.

Figure 2. Event study estimates.



Notes: The figure shows event study estimates and 95% confidence intervals. The last preintervention period is the reference period. Source: EvidenceNOW electronic health records.

practices from EvidenceNOW regions were similar in magnitude to the full sample, with 2 coefficients (blood pressure and smoking) reaching significance (Table 3).

Discussion

EvidenceNOW was one of the largest primary care quality improvement initiatives focused on improving cardiovascular disease preventive care by providing external support interventions to smaller practices. Overall effectiveness of these interventions in improving ABCS outcomes is best evaluated from trials that incorporate a robust comparison group of practices, either through randomization or through external comparisons. EvidenceNOW projects were pragmatic trials with varying designs; thus, in the absence of control practices, quasi-experimental study designs can help in making causal inference.³² We employed 2 such designs to evaluate effectiveness of interventions and the results were largely complementary. We found that EvidenceNOW interventions were associated with small improvements in the ABCS quality metrics 2 years after the intervention (event study). When comparing with an external group of practices (difference in differences), EvidenceNOW practices demonstrated improvements for all quality metrics, but statistically significant improvements were observed only for the smoking screening/cessation counseling metric.

Overall, there was consistency of findings across the 2 designs except for the smoking outcome

metric. The difference in differences design showed an almost 8 percentage point improvement in smoking among EvidenceNOW practices compared with Dartnet comparison practices. Importantly, the parallel trends test was nonsignificant, suggesting that our estimate of the smoking improvement might be appropriate and valid. Thus, observed estimates of smoking outcome improvement were likely associated with intervention effects. While the event study also showed a 7.3 percentage point improvement, we observed a positive pretrend, possibly suggesting a secular effect. We did not observe such a trend in the Dartnet comparison practices and other studies have also not demonstrated such improvements in smoking and other outcomes over time.^{33–35} It is possible that practices motivated to improve smoking outcomes may have self-selected into EvidenceNOW or implemented changes in anticipation of receiving the intervention. If that were the case, observed improvements may not be completely attributable to EvidenceNOW interventions.

Supporting practices by providing facilitation, expert consultation, and health information technology in implementing quality improvements has been shown to improve a range of practice outcomes.^{36–40} However, most of these findings come from small practice samples enrolled in controlled research studies.^{19,20,22} This study is one of the first to assess effectiveness in improving quality metrics at a large scale when diverse primary care practices were provided with external support through primary care extension infrastructure. We observed

small improvements in all ABCS outcomes, with the smoking metric demonstrating statistical significance for both research designs. While observed changes were small, it is important to note that benefits in cardiovascular disease outcomes may be observed, for instance, even with minor reductions in blood pressure or just by appropriately prescribing statins to those at increased risk.¹⁻³

The Affordable Care Act mandated that Health and Human Services establish a primary care extension program to provide practices with external support. However, the program was never funded.^{41,42} Our study suggests that such an extension program could help practices improve ABCS clinical quality metrics. While improvements in the outcome metrics were small, they were observed across a large and diverse sample of practices suggesting that external support interventions provided to practices may have population-level benefits perhaps even for other chronic conditions such as diabetes and mental health. If such benefits are to be adopted more widely and sustained, more research is needed identifying strategies to mitigate the influence of practice-level barriers to implementing quality improvements, such as competing demands and a challenging reimbursement environment for primary care.

Using two statistical methods including the inclusion of an external comparison group of practices is a strength of this evaluation of pragmatic EvidenceNOW interventions. However, our study also had several limitations. First, practices had different capabilities in extracting data on ABCS quality metrics from EHRs, which might have affected data quality. We minimized this concern by working collaboratively with cooperatives to ensure data quality and by excluding practices with unreliable data. Second, effect estimates might be affected by practices' first data submission, either relative to the time since the intervention or relative to the baseline quarter. We addressed this concern by including indicators for intervention cohorts and the first quarter of data submission in regressions. Third, practices submitted baseline data at different points before intervention start. Therefore, preintervention trends may not have been precisely estimated. Fourth, the DARTNet sample was relatively small limiting power of our difference-in-differences analysis. Unfortunately, we did not have access to other suitable external data sources and had to

exclude some practices due to data quality concerns. Fourth, there may be potential for self-selection bias as practices that chose to enroll may be more likely to be motivated to make changes and engage in facilitation. The relatively high mean baseline outcome levels may, in part, be because of this reason. However, we also observed wide variation in baseline ABCS rates across practices demonstrating that EvidenceNOW Cooperatives also reached practices with lower performance on these metrics. Fifth, data on other confounders (eg, age, race/ethnicity) were not available and therefore not included in our analysis. Finally, DARTNet practices showed large changes in outcomes in 2018 that likely reflect data quality or coding issues. Although we were unable to identify the underlying reason for those changes, our analysis is based on change in outcomes using 2017 postintervention data and thus, these issues did not affect our findings.

It is important to note that external support strategies implemented in EvidenceNOW were based on the best clinical evidence available at the time of the initiative. Therefore, changes in guidelines (such as for aspirin use in 2021) would not be reflected in this work.

Notwithstanding these limitations, our study provides valuable lessons for future studies seeking to evaluate effectiveness of external support interventions in primary care. First, they should construct a valid comparison group of practices that follows the same data collection protocols as intervention practices. Second, they should include a sufficient number of preintervention data points to reliably attribute outcome change to interventions. Finally, they should consider using experimental approaches in allocating practices to interventions to minimize self-selection bias (eg, cluster-randomized trial or randomized stepped-wedge trials).

Conclusion

Our findings suggest that providing external support interventions in implementing quality improvement strategies may improve ABCS quality metrics among smaller primary care practices. While estimated improvements were small, they reflected average changes across a large and diverse sample of practices. Future research examining number of cardiovascular events

prevented as a result of these complex, multi-component interventions is needed to justify investments in such large-scale primary care quality improvement programs.

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To see this article online, please go to: <http://jabfm.org/content/35/5/968.full>.

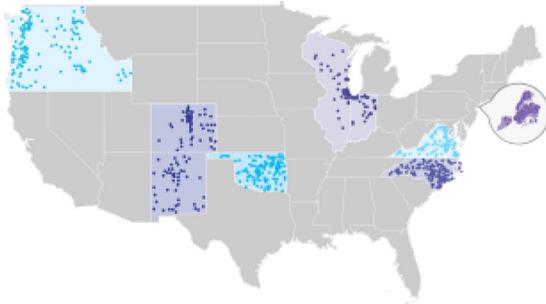
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Appendix

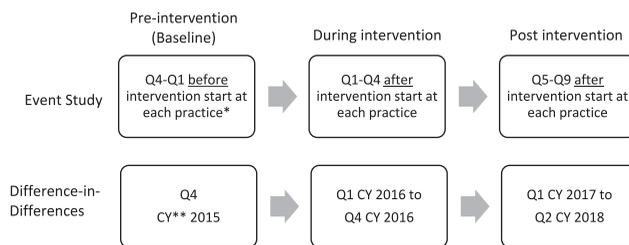
A Appendix Figures



Appendix Figure A-1: EvidenceNOW cooperatives and practices

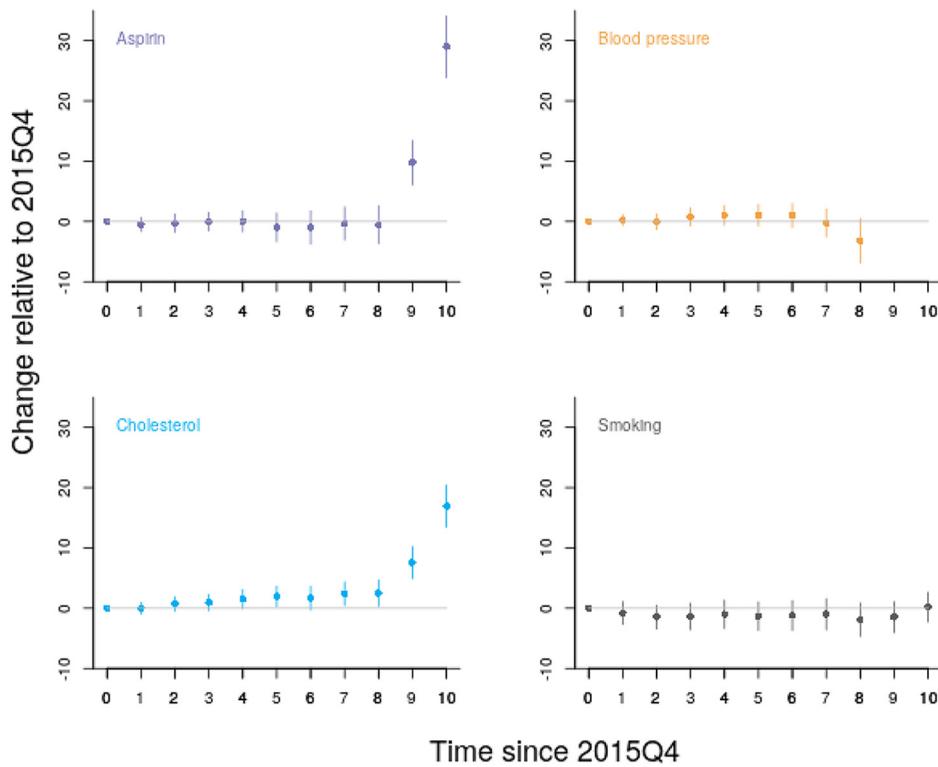
Notes: The figures displays EvidenceNOW cooperatives as shaded areas and practices as colored dots. Blue and purple colors are used to differentiate between adjacent cooperatives.

Appendix Figure A-2: Outcome measurement time periods



*Practices were enrolled in cohorts and began interventions on a rolling basis. The pre-intervention period by practice cohort ranged from the 4th quarter of 2015 to the 4th quarter of the 2016

** Calendar Year



Appendix Figure A-3: Time trends for DARTNet practices

Notes: The figure displays estimates and 95% confidence intervals of calendar time fixed effects of DartNet practices from the difference-in-differences analysis. For blood pressure, estimates for the first and second quarter of 2018 are missing because DARTNet data did not include these time periods. Source: DARTNet electronic health records.

B Appendix Tables

This section shows full regression results for the following regressions:

- Appendix Table B-1: Event study, aspirin
- Appendix Table B-2: Event study, blood pressure
- Appendix Table B-3: Event study, cholesterol
- Appendix Table B-4: Event study, smoking
- Appendix Table B-5: Event study, smoking (with pre-intervention trend adjustment)
- Appendix Table B-6: Difference-in-differences, all states, aspirin
- Appendix Table B-7: Difference-in-differences, all states, blood pressure
- Appendix Table B-8: Difference-in-differences, all states, cholesterol
- Appendix Table B-9: Difference-in-differences, all states, smoking
- Appendix Table B-10: Difference-in-differences, EvidenceNOW states, aspirin
- Appendix Table B-11: Difference-in-differences, EvidenceNOW states, blood pressure
- Appendix Table B-12: Difference-in-differences, EvidenceNOW states, cholesterol
- Appendix Table B-13: Difference-in-differences, EvidenceNOW states, smoking

Appendix Table B-1: Regression results: event study, aspirin

	Estimate	Std. Err.	P value
Intercept	85.85***	21.53	0.0001
Time before intervention begin: 4	1.33	1.74	0.4455
Time before intervention begin: 3	-1.66	1.76	0.3460
Time before intervention begin: 2	-1.36	1.15	0.2340
Time since intervention begin: 0	0.59	0.76	0.4356
Time since intervention begin: 1	1.76*	0.89	0.0478
Time since intervention begin: 2	2.57***	0.66	0.0001
Time since intervention begin: 3	3.16***	0.77	0.0000
Time since intervention begin: 4	3.10**	1.13	0.0060
Time since intervention begin: 5	3.51**	1.19	0.0032
Time since intervention begin: 6	2.88	2.33	0.2174
Time since intervention begin: 7	4.41*	2.16	0.0410
Time since intervention begin: 8	4.28*	1.99	0.0312
Time since intervention begin: 9	1.65	2.06	0.4235
Time since intervention begin: 4 to 7 quarters	3.39*	1.42	0.0167
Practice size: 2-5 clinicians	-1.58	2.17	0.4683
Practice size: 6-10 clinicians	2.61	1.69	0.1219
Practice size: 11+ clinicians	0.35	2.48	0.8875
Practice size: Missing	10.44**	3.83	0.0065
Practice ownership: FQHC	-1.62	2.85	0.5697
Practice ownership: Hospital/Health-System/HMO	5.26*	2.30	0.0219
Practice ownership: Other	-0.05	3.56	0.9886
Practice location: Large Town	-4.72	3.14	0.1332
Practice location: Suburban	-2.02	2.76	0.4656
Practice location: Urban Core	-0.17	3.05	0.9559
Percent of patients commercially insured	-0.08	0.13	0.5478
Percent of patients on Medicaid	-0.07	0.10	0.5176
Percent of patients on Medicare	-0.08	0.12	0.5060
Percent of dually eligible patients	-0.03	0.11	0.7693
Percent of patients with other insurance	-0.01	0.13	0.9409
Percent of white patients	0.00	0.04	0.9743
Percent of black / African-American patients	0.01	0.05	0.8974
Percent of Hispanic patients	-0.11*	0.04	0.0113
Percent of patients with unknown ethnicity	-0.14	0.09	0.1021
Practice participated in demonstration: Missing	-4.33	3.98	0.2760
Practice participated in demonstration: Yes	-0.44	2.59	0.8661
Practice is located in MUA: Missing	1.60	8.21	0.8458
Practice is located in MUA: Yes	4.52	3.32	0.1738
Intervention cohort: 1	-8.03	13.27	0.5449
Intervention cohort: 2	-11.75	13.12	0.3704
Intervention cohort: 3	1.17	13.17	0.9294
Intervention cohort: 4	11.05	14.37	0.4420
Quarter of first data submission: 1	5.57	4.01	0.1651
Quarter of first data submission: 2	-10.22*	4.09	0.0125
Quarter of first data submission: 3	-14.58	8.05	0.0702
F-Test	54.52		0.0000
R-squared	0.338		

Source: EvidenceNOW practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-2: Regression results: event study, blood pressure

	Estimate	Std. Err.	P value
Intercept	71.59***	11.23	0.0000
Time before intervention begin: 4	-1.52	0.83	0.0664
Time before intervention begin: 3	-0.23	0.77	0.7686
Time before intervention begin: 2	-0.60	0.56	0.2870
Time since intervention begin: 0	0.35	0.35	0.3126
Time since intervention begin: 1	0.98*	0.41	0.0169
Time since intervention begin: 2	1.35*	0.58	0.0190
Time since intervention begin: 3	1.77*	0.77	0.0217
Time since intervention begin: 4	2.07***	0.55	0.0001
Time since intervention begin: 5	1.79*	0.83	0.0309
Time since intervention begin: 6	0.20	1.11	0.8569
Time since intervention begin: 7	2.08	1.33	0.1199
Time since intervention begin: 8	1.43	2.15	0.5041
Time since intervention begin: 9	1.41	1.40	0.3145
Time since intervention begin: 4 to 7 quarters	1.59*	0.75	0.0337
Practice size: 2-5 clinicians	-0.66	1.11	0.5515
Practice size: 6-10 clinicians	1.10	1.97	0.5762
Practice size: 11+ clinicians	0.96	1.51	0.5264
Practice size: Missing	-5.81**	2.11	0.0060
Practice ownership: FQHC	0.78	1.16	0.5006
Practice ownership: Hospital/Health-System/HMO	-3.63	2.07	0.0797
Practice ownership: Other	-6.03	4.21	0.1522
Practice location: Large Town	0.43	1.00	0.6690
Practice location: Suburban	0.92	1.28	0.4724
Practice location: Urban Core	3.32*	1.56	0.0339
Percent of patients commercially insured	-0.05	0.09	0.5503
Percent of patients on Medicaid	-0.10	0.07	0.1853
Percent of patients on Medicare	0.00	0.06	0.9506
Percent of dually eligible patients	0.03	0.10	0.7451
Percent of patients with other insurance	-0.04	0.08	0.5832
Percent of white patients	0.00	0.03	0.8701
Percent of black / African-American patients	-0.13***	0.03	0.0000
Percent of Hispanic patients	-0.03	0.03	0.3677
Percent of patients with unknown ethnicity	0.03	0.02	0.2698
Practice participated in demonstration: Missing	-3.50*	1.37	0.0104
Practice participated in demonstration: Yes	-1.49	1.65	0.3655
Practice is located in MUA: Missing	4.96***	1.46	0.0007
Practice is located in MUA: Yes	-1.53*	0.75	0.0422
Intervention cohort: 1	-6.02	4.45	0.1768
Intervention cohort: 2	-9.04	5.46	0.0978
Intervention cohort: 3	-8.16	5.99	0.1734
Intervention cohort: 4	-7.23*	3.18	0.0229
Quarter of first data submission: 1	-0.18	4.04	0.9641
Quarter of first data submission: 2	6.11	5.37	0.2554
Quarter of first data submission: 3	9.88	6.35	0.1197
F-Test	19.95		0.0000
R-squared	0.147		

Source: EvidenceNOW practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-3: Regression results: event study, cholesterol

	Estimate	Std. Err.	P value
Intercept	93.65***	18.92	0.0000
Time before intervention begin: 4	-2.85	8.09	0.7244
Time before intervention begin: 3	-2.94	4.16	0.4794
Time before intervention begin: 2	-1.96	1.38	0.1574
Time since intervention begin: 0	1.02	0.82	0.2144
Time since intervention begin: 1	2.04	1.14	0.0731
Time since intervention begin: 2	3.07*	1.20	0.0106
Time since intervention begin: 3	4.16**	1.56	0.0076
Time since intervention begin: 4	3.94*	1.58	0.0125
Time since intervention begin: 5	4.56*	1.81	0.0115
Time since intervention begin: 6	4.27	3.10	0.1686
Time since intervention begin: 7	5.41	2.99	0.0701
Time since intervention begin: 8	5.63	3.15	0.0737
Time since intervention begin: 9	4.82*	2.09	0.0211
Time since intervention begin: 4 to 7 quarters	4.43*	2.09	0.0342
Practice size: 2-5 clinicians	-2.05	1.72	0.2331
Practice size: 6-10 clinicians	-1.90	4.14	0.6470
Practice size: 11+ clinicians	-2.60	1.93	0.1770
Practice size: Missing	3.57	6.83	0.6014
Practice ownership: FQHC	-0.76	1.99	0.7022
Practice ownership: Hospital/Health-System/HMO	-1.65	3.91	0.6726
Practice ownership: Other	1.52	3.18	0.6343
Practice location: Large Town	-6.44	7.25	0.3744
Practice location: Suburban	1.61	6.98	0.8174
Practice location: Urban Core	0.72	5.34	0.8928
Percent of patients commercially insured	-0.07	0.08	0.3808
Percent of patients on Medicaid	-0.10	0.09	0.2820
Percent of patients on Medicare	-0.06	0.07	0.4435
Percent of dually eligible patients	0.04	0.10	0.6985
Percent of patients with other insurance	-0.14	0.16	0.3850
Percent of white patients	-0.07*	0.03	0.0318
Percent of black / African-American patients	-0.03	0.07	0.7012
Percent of Hispanic patients	-0.11*	0.05	0.0202
Percent of patients with unknown ethnicity	-0.08	0.08	0.3180
Practice participated in demonstration: Missing	4.56	3.34	0.1721
Practice participated in demonstration: Yes	2.96	1.98	0.1352
Practice is located in MUA: Missing	1.82	7.84	0.8166
Practice is located in MUA: Yes	1.17	2.70	0.6662
Intervention cohort: 1	-10.05	9.56	0.2929
Intervention cohort: 2	-11.79	9.10	0.1954
Intervention cohort: 3	-4.32	10.76	0.6883
Intervention cohort: 4	-10.56	13.54	0.4353
Quarter of first data submission: 1	-0.15	3.00	0.9591
Quarter of first data submission: 2	-6.07	6.84	0.3748
Quarter of first data submission: 3	4.64	13.47	0.7306
F-Test	26.82		0.0000
R-squared	0.253		

Source: EvidenceNOW practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-4: Regression results: event study, smoking

	Estimate	Std. Err.	P value
Intercept	61.05***	14.05	0.0000
Time before intervention begin: 4	-4.47	3.99	0.2630
Time before intervention begin: 3	-3.29**	1.21	0.0067
Time before intervention begin: 2	-2.97**	1.12	0.0084
Time since intervention begin: 0	1.80*	0.73	0.0143
Time since intervention begin: 1	3.02***	0.78	0.0001
Time since intervention begin: 2	3.96***	0.88	0.0000
Time since intervention begin: 3	5.07***	1.02	0.0000
Time since intervention begin: 4	5.93***	1.38	0.0000
Time since intervention begin: 5	7.13***	1.28	0.0000
Time since intervention begin: 6	7.54***	1.39	0.0000
Time since intervention begin: 7	10.24***	2.00	0.0000
Time since intervention begin: 8	5.75	4.07	0.1578
Time since intervention begin: 9	-1.50	1.73	0.3849
Time since intervention begin: 4 to 7 quarters	7.33***	1.34	0.0000
Practice size: 2-5 clinicians	-3.43	3.44	0.3183
Practice size: 6-10 clinicians	-3.75	2.96	0.2043
Practice size: 11+ clinicians	2.35	3.73	0.5280
Practice size: Missing	-2.55	2.90	0.3791
Practice ownership: FQHC	8.26	4.98	0.0973
Practice ownership: Hospital/Health-System/HMO	8.42**	3.24	0.0094
Practice ownership: Other	0.50	4.49	0.9114
Practice location: Large Town	9.64*	3.93	0.0142
Practice location: Suburban	1.72	2.55	0.4992
Practice location: Urban Core	9.58**	3.30	0.0037
Percent of patients commercially insured	0.07	0.07	0.3422
Percent of patients on Medicaid	0.09	0.14	0.4921
Percent of patients on Medicare	0.06	0.12	0.5832
Percent of dually eligible patients	0.02	0.10	0.8296
Percent of patients with other insurance	0.18	0.14	0.2051
Percent of white patients	-0.08	0.07	0.2523
Percent of black / African-American patients	-0.05	0.09	0.5305
Percent of Hispanic patients	-0.02	0.04	0.5453
Percent of patients with unknown ethnicity	-0.02	0.07	0.7782
Practice participated in demonstration: Missing	7.98*	3.93	0.0421
Practice participated in demonstration: Yes	0.10	2.36	0.9678
Practice is located in MUA: Missing	2.98	7.27	0.6817
Practice is located in MUA: Yes	2.14	2.85	0.4526
Intervention cohort: 1	-3.21	12.71	0.8005
Intervention cohort: 2	-0.92	11.97	0.9386
Intervention cohort: 3	3.60	12.73	0.7773
Intervention cohort: 4	-13.03	17.96	0.4681
Quarter of first data submission: 1	5.11	4.00	0.2020
Quarter of first data submission: 2	-1.15	12.52	0.9268
Quarter of first data submission: 3	16.55	13.68	0.2266
F-Test	83.36		0.0000
R-squared	0.444		

Source: EvidenceNOW practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-5: Regression results: event study, smoking (with pre-intervention trend adjustment)

	Estimate	Std. Err.	P value
Intercept	61.05***	14.05	0.0000
Time before intervention begin: 4	1.63	3.99	0.6819
Time before intervention begin: 3	0.77	1.21	0.5233
Time before intervention begin: 2	-0.93	1.12	0.4071
Time since intervention begin: 0	-0.24	0.73	0.7465
Time since intervention begin: 1	-1.05	0.78	0.1777
Time since intervention begin: 2	-2.14*	0.88	0.0150
Time since intervention begin: 3	-3.06**	1.02	0.0027
Time since intervention begin: 4	-4.23**	1.38	0.0022
Time since intervention begin: 5	-5.07***	1.28	0.0001
Time since intervention begin: 6	-6.69***	1.39	0.0000
Time since intervention begin: 7	-6.03**	2.00	0.0026
Time since intervention begin: 8	-12.56**	4.07	0.0020
Time since intervention begin: 9	-21.84***	1.73	0.0000
Time since intervention begin: 4 to 7 quarters	-5.29***	1.34	0.0001
Practice size: 2-5 clinicians	-3.43	3.44	0.3183
Practice size: 6-10 clinicians	-3.75	2.96	0.2043
Practice size: 11+ clinicians	2.35	3.73	0.5280
Practice size: Missing	-2.55	2.90	0.3791
Practice ownership: FQHC	8.26	4.98	0.0973
Practice ownership: Hospital/Health-System/HMO	8.42**	3.24	0.0094
Practice ownership: Other	0.50	4.49	0.9114
Practice location: Large Town	9.64*	3.93	0.0142
Practice location: Suburban	1.72	2.55	0.4992
Practice location: Urban Core	9.58**	3.30	0.0037
Percent of patients commercially insured	0.07	0.07	0.3422
Percent of patients on Medicaid	0.09	0.14	0.4921
Percent of patients on Medicare	0.06	0.12	0.5832
Percent of dually eligible patients	0.02	0.10	0.8296
Percent of patients with other insurance	0.18	0.14	0.2051
Percent of white patients	-0.08	0.07	0.2523
Percent of black / African-American patients	-0.05	0.09	0.5305
Percent of Hispanic patients	-0.02	0.04	0.5453
Percent of patients with unknown ethnicity	-0.02	0.07	0.7782
Practice participated in demonstration: Missing	7.98*	3.93	0.0421
Practice participated in demonstration: Yes	0.10	2.36	0.9678
Practice is located in MUA: Missing	2.98	7.27	0.6817
Practice is located in MUA: Yes	2.14	2.85	0.4526
Intervention cohort: 1	-3.21	12.71	0.8005
Intervention cohort: 2	-0.92	11.97	0.9386
Intervention cohort: 3	3.60	12.73	0.7773
Intervention cohort: 4	-13.03	17.96	0.4681
Quarter of first data submission: 1	5.11	4.00	0.2020
Quarter of first data submission: 2	-1.15	12.52	0.9268
Quarter of first data submission: 3	16.55	13.68	0.2266
F-Test	88.63		0.0000
R-squared	0.459		

Source: EvidenceNOW practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-6: Regression results: difference-in-differences, all states, aspirin

	Estimate	Std. Err.	P value
Intercept	47.44***	3.86	0.0000
2016 Q1	-0.49	0.59	0.4113
2016 Q2	-0.29	0.77	0.7102
2016 Q3	-0.02	0.79	0.9814
2016 Q4	0.03	0.89	0.9695
2017 Q1	-0.97	1.21	0.4240
2017 Q2	-1.01	1.41	0.4760
2017 Q3	-0.33	1.39	0.8111
2017 Q4	-0.53	1.60	0.7431
2018 Q1	9.74***	1.88	0.0000
2018 Q2	28.99***	2.61	0.0000
EN practice	55.49***	10.68	0.0000
EN practice x 2016Q1	0.52	1.30	0.6871
EN practice x 2016Q2	1.57	1.55	0.3098
EN practice x 2016Q3	1.08	1.74	0.5325
EN practice x 2016Q4	2.34	1.66	0.1567
EN practice x 2017Q1	2.62	1.90	0.1667
EN practice x 2017Q2	3.84	2.02	0.0571
EN practice x 2017Q3	4.41	2.39	0.0658
EN practice x 2017Q4	4.23	2.91	0.1460
EN practice x 2018Q1	-7.95*	3.12	0.0108
EN practice x 2018Q2	-33.27***	5.68	0.0000
EN practice x 2017	3.75	2.20	0.0875
Practice ownership: FQHC	-0.52	3.42	0.8785
Practice ownership: Hospital/Health-System/HMO	0.66	2.07	0.7488
Practice ownership: Other	-0.26	5.77	0.9645
Percent of white patients	-0.25***	0.04	0.0000
Percent of black / African-American patients	-0.23**	0.09	0.0081
Percent of Hispanic patients	-0.11	0.06	0.0731
Intervention cohort: 1	-23.39	12.88	0.0694
Intervention cohort: 2	-25.63	13.13	0.0509
Intervention cohort: 3	-20.10	12.22	0.1000
Intervention cohort: 4	-12.04	12.68	0.3425
Quarter of first data submission: 1	1.63	5.97	0.7853
Quarter of first data submission: 2	-2.26	4.24	0.5938
Quarter of first data submission: 3	-1.77	6.80	0.7943
Quarter of first data submission: 4	-7.85	6.36	0.2171
F-Test	274.65		0.0000
R-squared	0.484		

Source: EvidenceNOW and DartNet practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-7: Regression results: difference-in-differences, all states, blood pressure

	Estimate	Std. Err.	P value
Intercept	67.86***	1.47	0.0000
2016 Q1	0.23	0.45	0.6098
2016 Q2	-0.04	0.65	0.9519
2016 Q3	0.76	0.75	0.3166
2016 Q4	1.02	0.82	0.2135
2017 Q1	1.03	0.90	0.2520
2017 Q2	0.99	1.01	0.3273
2017 Q3	-0.24	1.18	0.8390
2017 Q4	-3.19	1.88	0.0897
2018 Q1			
2018 Q2			
EN practice	-1.27	4.13	0.7585
EN practice x 2016Q1	0.06	0.89	0.9442
EN practice x 2016Q2	1.85	1.20	0.1223
EN practice x 2016Q3	1.76	1.06	0.0971
EN practice x 2016Q4	0.72	1.16	0.5313
EN practice x 2017Q1	0.70	1.17	0.5512
EN practice x 2017Q2	1.09	1.37	0.4248
EN practice x 2017Q3	3.35*	1.60	0.0364
EN practice x 2017Q4	6.18**	2.13	0.0037
EN practice x 2018Q1			
EN practice x 2018Q2			
EN practice x 2017	2.76	1.44	0.0556
Practice ownership: FQHC	-6.09	4.13	0.1406
Practice ownership: Hospital/Health-System/HMO	-3.13	2.34	0.1815
Practice ownership: Other	-6.48*	3.14	0.0388
Percent of white patients	-0.03	0.03	0.2166
Percent of black / African-American patients	-0.11*	0.04	0.0143
Percent of Hispanic patients	0.02	0.03	0.4498
Intervention cohort: 1	2.23	4.12	0.5879
Intervention cohort: 2	-0.27	4.90	0.9561
Intervention cohort: 3	1.30	4.64	0.7790
Intervention cohort: 4	2.47	5.02	0.6225
Quarter of first data submission: 1	-0.49	3.05	0.8730
Quarter of first data submission: 2	0.58	3.86	0.8805
Quarter of first data submission: 3	3.05	7.22	0.6730
Quarter of first data submission: 4	2.36	3.62	0.5147
F-Test	13.43		0.0000
R-squared	0.047		

Source: EvidenceNOW and DartNet practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-8: Regression results: difference-in-differences, all states, cholesterol

	Estimate	Std. Err.	P value
Intercept	57.51***	3.09	0.0000
2016 Q1	-0.01	0.49	0.9919
2016 Q2	0.71	0.60	0.2357
2016 Q3	0.93	0.68	0.1740
2016 Q4	1.52	0.81	0.0597
2017 Q1	1.96*	0.86	0.0220
2017 Q2	1.66	1.01	0.0994
2017 Q3	2.39*	0.99	0.0158
2017 Q4	2.51*	1.11	0.0236
2018 Q1	7.57***	1.35	0.0000
2018 Q2	16.93***	1.78	0.0000
EN practice	51.72***	13.20	0.0001
EN practice x 2016Q1	1.88	1.41	0.1805
EN practice x 2016Q2	2.17	2.62	0.4064
EN practice x 2016Q3	3.25	2.87	0.2571
EN practice x 2016Q4	2.97	3.23	0.3587
EN practice x 2017Q1	3.68	3.34	0.2705
EN practice x 2017Q2	4.17	3.61	0.2482
EN practice x 2017Q3	3.96	4.01	0.3241
EN practice x 2017Q4	3.64	4.14	0.3791
EN practice x 2018Q1	-1.73	4.54	0.7035
EN practice x 2018Q2	-9.65*	4.09	0.0182
EN practice x 2017	3.87	3.73	0.2990
Practice ownership: FQHC	-0.85	1.90	0.6552
Practice ownership: Hospital/Health-System/HMO	-5.00	2.56	0.0507
Practice ownership: Other	-0.03	2.63	0.9910
Percent of white patients	-0.20***	0.04	0.0000
Percent of black / African-American patients	-0.16**	0.05	0.0016
Percent of Hispanic patients	-0.11**	0.04	0.0050
Intervention cohort: 1	-36.32**	13.50	0.0071
Intervention cohort: 2	-37.44**	13.11	0.0043
Intervention cohort: 3	-31.30*	12.86	0.0149
Intervention cohort: 4	-36.45**	13.30	0.0062
Quarter of first data submission: 1	-3.40	4.35	0.4356
Quarter of first data submission: 2	-4.09	4.75	0.3888
Quarter of first data submission: 3	8.21	8.75	0.3477
Quarter of first data submission: 4	-17.89***	4.37	0.0000
F-Test	178.14		0.0000
R-squared	0.409		

Source: EvidenceNOW and DartNet practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-9: Regression results: difference-in-differences, all states, smoking

	Estimate	Std. Err.	P value
Intercept	11.02***	2.28	0.0000
2016 Q1	-0.80	0.97	0.4108
2016 Q2	-1.49	1.01	0.1392
2016 Q3	-1.38	1.12	0.2187
2016 Q4	-1.01	1.20	0.4011
2017 Q1	-1.32	1.20	0.2719
2017 Q2	-1.20	1.26	0.3410
2017 Q3	-1.01	1.31	0.4416
2017 Q4	-1.91	1.41	0.1744
2018 Q1	-1.50	1.31	0.2531
2018 Q2	0.19	1.25	0.8825
EN practice	64.24***	10.66	0.0000
EN practice x 2016Q1	0.87	2.17	0.6873
EN practice x 2016Q2	4.20	2.26	0.0636
EN practice x 2016Q3	5.70*	2.54	0.0246
EN practice x 2016Q4	6.99**	2.30	0.0024
EN practice x 2017Q1	7.84**	2.61	0.0026
EN practice x 2017Q2	7.53**	2.88	0.0090
EN practice x 2017Q3	7.76**	2.85	0.0064
EN practice x 2017Q4	10.32***	3.06	0.0007
EN practice x 2018Q1	5.59	3.93	0.1558
EN practice x 2018Q2	-7.51	10.54	0.4760
EN practice x 2017	8.32**	2.77	0.0027
Practice ownership: FQHC	5.49	5.86	0.3485
Practice ownership: Hospital/Health-System/HMO	4.49**	1.58	0.0045
Practice ownership: Other	-6.27	4.56	0.1690
Percent of white patients	-0.01	0.03	0.8083
Percent of black / African-American patients	-0.13	0.08	0.0881
Percent of Hispanic patients	-0.01	0.04	0.7602
Intervention cohort: 1	-19.65	15.12	0.1939
Intervention cohort: 2	-13.14	13.65	0.3357
Intervention cohort: 3	-16.20	13.66	0.2356
Intervention cohort: 4	-29.27*	12.44	0.0187
Quarter of first data submission: 1	6.58	4.72	0.1637
Quarter of first data submission: 2	8.62	8.18	0.2918
Quarter of first data submission: 3	29.19**	10.04	0.0036
Quarter of first data submission: 4	1.85	2.48	0.4563
F-Test	743.47		0.0000
R-squared	0.689		

Source: EvidenceNOW and DartNet practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-10: Regression results: difference-in-differences, EvidenceNOW states, aspirin

	Estimate	Std. Err.	P value
Intercept	41.47**	13.19	0.0017
2016 Q1	0.20	0.60	0.7408
2016 Q2	-0.02	1.11	0.9852
2016 Q3	0.82	1.18	0.4897
2016 Q4	-1.15	1.70	0.4987
2017 Q1	-1.11	2.01	0.5818
2017 Q2	-3.20	3.78	0.3974
2017 Q3	-2.70	3.65	0.4605
2017 Q4	-2.00	4.25	0.6383
2018 Q1	6.64	5.92	0.2625
2018 Q2	22.54**	8.58	0.0087
EN practice	40.72***	11.32	0.0003
EN practice x 2016Q1	-1.15	0.97	0.2373
EN practice x 2016Q2	0.13	1.46	0.9312
EN practice x 2016Q3	-0.21	1.85	0.9090
EN practice x 2016Q4	3.16	2.22	0.1553
EN practice x 2017Q1	2.01	2.60	0.4390
EN practice x 2017Q2	5.90	4.25	0.1655
EN practice x 2017Q3	6.61	4.68	0.1580
EN practice x 2017Q4	5.17	6.01	0.3895
EN practice x 2018Q1	-5.21	7.13	0.4650
EN practice x 2018Q2	-26.45***	7.71	0.0006
EN practice x 2017	4.88	4.19	0.2444
Practice ownership: Hospital/Health-System/HMO	3.65	3.50	0.2964
Practice ownership: Other	-5.98	5.55	0.2817
Percent of white patients	-0.12	0.10	0.2073
Percent of black / African-American patients	-0.05	0.09	0.5501
Percent of Hispanic patients	0.02	0.09	0.8377
Intervention cohort: 1	-12.34	12.81	0.3355
Intervention cohort: 2	-19.78	12.21	0.1052
Intervention cohort: 3	-13.55	12.70	0.2864
Intervention cohort: 4	-5.11	14.23	0.7194
Quarter of first data submission: 1	13.16**	4.49	0.0034
Quarter of first data submission: 2	4.70	6.53	0.4718
Quarter of first data submission: 3	0.32	8.34	0.9693
Quarter of first data submission: 4	-5.62	9.61	0.5584
F-Test	45.66		0.0000
R-squared	0.241		

Source: EvidenceNOW and DartNet practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-11: Regression results: difference-in-differences, EvidenceNOW states, blood pressure

	Estimate	Std. Err.	P value
Intercept	65.94***	3.85	0.0000
2016 Q1	1.22	1.83	0.5074
2016 Q2	1.54	2.10	0.4628
2016 Q3	2.26	2.02	0.2639
2016 Q4	0.97	2.31	0.6742
2017 Q1	1.47	1.94	0.4481
2017 Q2	1.78	1.80	0.3237
2017 Q3	-1.43	1.66	0.3871
2017 Q4	-2.95	2.95	0.3164
2018 Q1			
2018 Q2			
EN practice	-4.75	4.97	0.3399
EN practice x 2016Q1	-1.11	2.13	0.6011
EN practice x 2016Q2	0.00	2.52	0.9987
EN practice x 2016Q3	0.27	2.21	0.9034
EN practice x 2016Q4	1.14	2.52	0.6508
EN practice x 2017Q1	0.76	2.05	0.7103
EN practice x 2017Q2	0.78	1.82	0.6677
EN practice x 2017Q3	4.41*	2.22	0.0474
EN practice x 2017Q4	5.82	3.19	0.0678
EN practice x 2018Q1			
EN practice x 2018Q2			
EN practice x 2017	2.87*	1.43	0.0447
Practice ownership: Hospital/Health-System/HMO	-5.24	2.78	0.0595
Practice ownership: Other	-8.06*	3.89	0.0382
Percent of white patients	-0.01	0.05	0.8539
Percent of black / African-American patients	-0.07	0.06	0.2523
Percent of Hispanic patients	0.02	0.05	0.7460
Intervention cohort: 1	6.65	5.77	0.2489
Intervention cohort: 2	4.09	6.16	0.5069
Intervention cohort: 3	4.73	6.22	0.4466
Intervention cohort: 4	5.46	5.82	0.3486
Quarter of first data submission: 1	-2.30	4.69	0.6236
Quarter of first data submission: 2	3.15	6.46	0.6265
Quarter of first data submission: 3	0.21	6.73	0.9745
Quarter of first data submission: 4	6.86*	3.19	0.0315
F-Test	11.81		0.0000
R-squared	0.071		

Source: EvidenceNOW and DartNet practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-12: Regression results: difference-in-differences, EvidenceNOW states, cholesterol

	Estimate	Std. Err.	P value
Intercept	55.54***	8.66	0.0000
2016 Q1	0.50	0.70	0.4764
2016 Q2	1.21	1.00	0.2262
2016 Q3	1.53	1.22	0.2092
2016 Q4	0.57	1.63	0.7275
2017 Q1	1.78	1.85	0.3340
2017 Q2	0.51	2.83	0.8563
2017 Q3	1.46	2.77	0.5993
2017 Q4	0.84	2.93	0.7755
2018 Q1	4.98	4.02	0.2161
2018 Q2	12.68*	5.49	0.0209
EN practice	43.59***	9.61	0.0000
EN practice x 2016Q1	0.60	1.47	0.6839
EN practice x 2016Q2	0.92	2.98	0.7586
EN practice x 2016Q3	1.78	3.50	0.6105
EN practice x 2016Q4	3.05	3.69	0.4077
EN practice x 2017Q1	2.99	3.90	0.4427
EN practice x 2017Q2	4.34	5.38	0.4199
EN practice x 2017Q3	3.74	5.69	0.5105
EN practice x 2017Q4	4.26	6.33	0.5012
EN practice x 2018Q1	0.29	7.54	0.9694
EN practice x 2018Q2	-5.65	8.62	0.5124
EN practice x 2017	3.81	5.24	0.4680
Practice ownership: Hospital/Health-System/HMO	-5.39	4.30	0.2108
Practice ownership: Other	-2.27	4.09	0.5783
Percent of white patients	-0.10*	0.04	0.0149
Percent of black / African-American patients	-0.04	0.12	0.7245
Percent of Hispanic patients	-0.04	0.11	0.7150
Intervention cohort: 1	-32.82**	10.71	0.0022
Intervention cohort: 2	-35.32***	10.04	0.0004
Intervention cohort: 3	-30.40**	9.62	0.0016
Intervention cohort: 4	-37.37***	6.89	0.0000
Quarter of first data submission: 1	6.25	4.75	0.1888
Quarter of first data submission: 2	0.84	10.11	0.9334
Quarter of first data submission: 3	14.19	12.26	0.2469
Quarter of first data submission: 4	-18.15*	7.60	0.0169
F-Test	31.65		0.0000
R-squared	0.210		

Source: EvidenceNOW and DartNet practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001

Appendix Table B-13: Regression results: difference-in-differences, EvidenceNOW states, smoking

	Estimate	Std. Err.	P value
Intercept	11.09	6.95	0.1106
2016 Q1	-2.45	1.67	0.1424
2016 Q2	-2.85	2.02	0.1587
2016 Q3	-3.38	2.03	0.0967
2016 Q4	-2.23	2.75	0.4157
2017 Q1	-2.78	2.47	0.2613
2017 Q2	-3.56	2.45	0.1465
2017 Q3	-3.67	2.60	0.1578
2017 Q4	-5.03	2.66	0.0588
2018 Q1	-4.67	2.42	0.0541
2018 Q2	-3.44	2.31	0.1361
EN practice	53.49***	11.28	0.0000
EN practice x 2016Q1	2.77	3.12	0.3738
EN practice x 2016Q2	5.14	3.78	0.1733
EN practice x 2016Q3	7.28	3.86	0.0592
EN practice x 2016Q4	8.49*	4.07	0.0371
EN practice x 2017Q1	9.83*	4.11	0.0169
EN practice x 2017Q2	10.72**	4.10	0.0090
EN practice x 2017Q3	11.28**	4.23	0.0077
EN practice x 2017Q4	14.69***	4.05	0.0003
EN practice x 2018Q1	10.28*	4.88	0.0351
EN practice x 2018Q2	-0.85	10.16	0.9330
EN practice x 2017	11.54**	4.07	0.0046
Practice ownership: Hospital/Health-System/HMO	11.08***	3.18	0.0005
Practice ownership: Other	-6.21	6.23	0.3184
Percent of white patients	-0.03	0.09	0.7011
Percent of black / African-American patients	-0.03	0.09	0.7293
Percent of Hispanic patients	-0.05	0.10	0.6161
Intervention cohort: 1	-7.71	14.47	0.5944
Intervention cohort: 2	-5.26	13.75	0.7020
Intervention cohort: 3	-11.15	13.88	0.4217
Intervention cohort: 4	-24.56	12.99	0.0588
Quarter of first data submission: 1	13.91***	4.21	0.0009
Quarter of first data submission: 2	16.94	13.74	0.2179
Quarter of first data submission: 3	32.48***	7.42	0.0000
Quarter of first data submission: 4	4.50	3.56	0.2059
F-Test	127.86		0.0000
R-squared	0.460		

Source: EvidenceNOW and DartNet practice data.

Notes: *: p<0.05; **: p<0.01; ***: p<0.001