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Association Of A Regional Health Improvement Collaborative With Ambulatory Care–Sensitive Hospitalizations

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Abstract

Although regional health improvement collaboratives have been adopted nationwide to improve primary care quality, their effects on avoidable hospitalizations and costs remain unclear. We quantified the association of the Better Health Partnership, a primary care–led regional health improvement collaborative operating in Cuyahoga County, Ohio (Cleveland and surrounding suburbs), with hospitalization rates for ambulatory care–sensitive conditions. The partnership uses a positive deviance approach to identify, disseminate publicly, and accelerate adoption of best practices for care of patients with diabetes, heart failure, and hypertension. Using a difference-in-differences approach, we compared rates of hospitalizations for ambulatory care–sensitive conditions in six Ohio counties before (2003–08) and after (2009–14) the establishment of the partnership. Age- and sex-adjusted hospitalization rates for targeted ambulatory care–sensitive conditions in Cuyahoga County declined significantly more than the rates in the comparator counties in 2009–11 (106 fewer hospitalizations per 100,000 adult residents) and 2012–14 (91 fewer hospitalizations). We estimated that 5,746 hospitalizations for ambulatory care–sensitive conditions were averted in 2009–14, leading to cost savings of nearly \$40 million.

Ten years ago Don Berwick and coauthors introduced the concept of a primary care–centered Triple Aim for the US health care system that highlights improved quality of care, improved health of populations, and reduced per capita costs of health care.¹ Essential conditions described as needed to achieve the Triple Aim included an identified population, the universal commitment of a diverse membership, and the existence of an organization (an “integrator”) that accepts responsibility for all three aims for the designated population.

The passage of the Affordable Care Act in 2010 was accompanied by related developments in health care financing and delivery, motivated in part by the belief that improvements in primary care quality can improve health and reduce the incidence and cost of preventable hospitalizations.² These developments include efforts to encourage the implementation of patient-centered medical homes³ and the creation of alternative financing mechanisms, such as incentives associated with accountable care organizations and multipayer comprehensive primary care initiatives.^{4,5}

Regional health improvement collaboratives also arose during the past decade as a potentially transformational approach to increasing the value of primary care.^{6–8} Regional primary care–based collaboratives, including those supported by the Robert Wood Johnson Foundation’s Aligning Forces for Quality initiative,^{7–9} were called upon to act as the integrator in efforts to achieve the Triple Aim. The initiative further required that programs specify a geographic health care market for improvement activities, including public reports of provider performance and formal quality improvement programs on program-identified chronic and costly conditions.⁹ Over thirty regional health improvement collaboratives exist now nationwide, influencing the health care of over 40 percent of the US population.⁶ While these initiatives vary widely in their organizational design, conditions targeted for improvement, use of electronic health records (EHRs) for measurement and quality improvement, and levels of engagement of different stakeholders, the collaboratives have a common commitment to identifying and diffusing innovative ideas for quality improvement by leveraging data generated at the local level. In this way, they embody the premise that all health care is local.⁸

Better Health Partnership (BHP) is a primary care–led health improvement collaborative that was established in 2007 in Cuyahoga County, Ohio’s most populous county (containing Cleveland and the surrounding suburbs).¹⁰ With BHP serving as the integrator organization, a voluntary clinical advisory committee vetted nationally endorsed clinical quality measures and procedures for data collection, data submission, and twice-yearly public reporting to the community. BHP’s multifaceted approach to disseminating observed best practices in the care of adults with chronic conditions includes regionwide semiannual learning collaborative summits and practice coaching, with a focus on workflow redesign, the meaningful use of EHRs, and recognition as patient-centered medical homes.^{11–13}

While we and others have reported the results of regional primary care collaboratives designed to improve the quality of care,^{13–15} much less is known about their effectiveness in reducing avoidable hospitalizations and costs. In this case study we capitalized on the availability of a database of information about all discharges from nonfederal hospitals in Ohio to evaluate the association of BHP with county-level hospitalization rates and costs for

ambulatory care–sensitive conditions, a widely accepted and used metric for primary care quality.^{16–20}

Study Data And Methods

STUDY DESIGN AND POPULATION

We used a difference-in-differences analysis to examine changes in age- and sex-adjusted hospitalization rates for ambulatory care–sensitive conditions and related costs for all residents ages twenty and older in Ohio’s six largest counties before (2003–08) and after (2009–14) the initiation of BHP in Cuyahoga County.

PROGRAM AND RELATED INTERVENTIONS

Founded in 2007 as an Aligning Forces for Quality initiative site, BHP designated its health care market as Cuyahoga County, Ohio. BHP’s members include general internists, family physicians, geriatricians, medicine-pediatrics specialists, and advanced practice nurses. These primary care providers provide medical care for an estimated three-fourths of the adult residents with chronic medical conditions in the county.¹³ BHP’s organizational clinical members include academic medical centers, the county-supported public health care system, the Cleveland Veterans Affairs Medical Center, and all free clinics and federally qualified health centers in the county. All membership is voluntary and considered a long-term commitment. BHP assesses members’ performance across nationally endorsed quality measures for diabetes (introduced during 2007 and including vaccination for pneumococcal pneumonia), congestive heart failure (2008), and hypertension (2009).²¹ As part of its quality improvement initiatives, BHP also collects data on each patient’s social determinants of health, including insurance type, race/ethnicity, language preference, and neighborhood household income and educational attainment. These efforts have been described elsewhere.^{13,14}

BHP leverages the clinical and social determinants data it gathers to engage in three types of quality improvement activities designed to disseminate innovative approaches to improving primary care quality.¹³ First, twice-yearly public reports enable members to compare their achievement on quality measures with that of others in the region.²² Second, BHP identifies best practices using a positive deviance approach,^{11,12} identifying protocols from high-performing outlier clinics and health care organizations and disseminating them in twice-yearly learning collaborative summits. Finally, BHP uses the protocols from these positive deviance analyses to guide practice coaches in their support of quality improvement.^{13,15} Coaching includes workflow redesign, care coordination and tailored communication across different subpopulations, the meaningful use of EHRs, quality improvement projects, and helping practices gain recognition as patient-centered medical homes. The theme of disseminating ideas on how to deliver high-quality primary care runs throughout these three quality improvement activities.

DATA SOURCES

We used a population-based database of all hospitalizations and associated charges for all nonfederal acute care hospitals in Ohio in the period 2003–14.²³ Data pertaining to the use

of hospital observation units were available for 2006–14. Each data point in the database represents a single inpatient or hospital observation episode.²³ The database includes geographic identifiers that enable sample restriction to hospitalizations for residents living in specific counties, regardless of the site of hospitalization. Data on diagnoses and procedures from each inpatient episode are recorded using *International Classification of Diseases*, Ninth Revision, Clinical Modification (ICD-9-CM), codes. Supply-side data were obtained from the Area Health Resources Files,²⁴ and county-level demographic, income, poverty, and education data were abstracted from US census data.

DATA MEASURES

Our outcomes of interest were the Agency for Healthcare Research and Quality's Ambulatory Care–Sensitive Conditions Prevention Quality Indicators for heart failure (number 8); hypertension (number 7); diabetes (a composite of numbers 1, 3, 14, and 16); and bacterial pneumonia (number 11), which BHP included as a quality-of-care measure for diabetes.²⁵ These specific Prevention Quality Indicators were chosen because they are accepted measures of primary care quality for the conditions that BHP targeted. We determined age- and sex- adjusted hospitalization rates for each indicator per 100,000 adult residents in each of Ohio's six most populous counties throughout the study period.²⁶ For ease of data visualization in our exhibits, hospitalization rates for ambulatory care–sensitive conditions in the five comparator counties (Franklin, Hamilton, Montgomery, Lucas, and Summit—the next most populous counties in Ohio after Cuyahoga) were merged using a weighted average to generate a single “comparator county” rate throughout the study period.

In secondary analyses, age- and sex-adjusted inpatient hospitalization rates for all conditions that are not ambulatory care–sensitive for residents in the same counties were calculated for the same study period, and age- and sex-adjusted hospital observation rates for residents in the same counties were determined for 2006–14 (data were not available for 2003–05). We defined the start of the post period as January 1, 2009, because BHP began publicly reporting on care and outcomes and offering practice coaching during 2008.¹³

COSTS

We used Medicare cost-to-charge ratios to estimate mean cost per hospitalization. All costs were inflated to 2014 dollars using the Bureau of Labor Statistics Consumer Price Index calculator.²⁷ Yearly averted hospitalizations were estimated for 2009–11 and 2012–14 by multiplying the mean difference in hospitalization rate for Cuyahoga County from 2009–11 and 2012–14, respectively, by the estimated year-specific adult population of the county. We divided the post period into two three-year segments to account for the possible differential adoption of Affordable Care Act–related interventions that would confound BHP's association with hospitalizations in the later period.²⁸ Cost savings in each post-period year were estimated by multiplying estimates of year-specific averted hospitalizations in Cuyahoga County by year-specific mean cost per hospitalization in the county.

STATISTICAL ANALYSES

Our main analysis used a quasi-experimental difference-in-differences approach. The first difference is that in yearly hospital discharge rates for heart failure, hypertension, diabetes,

and bacterial pneumonia between adult Cuyahoga County residents and adult residents of five comparator counties. The second difference is that between the years in the pre-BHP period (2003–08) and the years in each of the post-BHP periods (2009–11 and 2012–14). While we also considered using an interrupted time series analysis, we selected the difference-in-differences approach because we had an existing control group and there was no evidence of differential pre-period trends.

We employed standard linear regression models (ordinary least squares) for estimation, controlling for year and county fixed effects, and binary interaction terms for Cuyahoga County in each of the post-BHP periods. The interaction terms were the covariates of interest. We used the population size of each county, based on Census Bureau estimates, as a county-specific analytic weight to address anticipated heteroskedasticity in county-level hospital rates. The threshold for significance was set at an alpha level of 0.05.

All analyses were performed using Stata, version 13.1. Conventional standard errors are reported throughout this article. Our model produced an unbiased estimate of the effect of BHP under the assumption that any difference in average hospitalization rates for ambulatory care-sensitive conditions that we observed in the pre period (2003–08) would have continued during the postperiod (2009–14) in the absence of BHP. This assumption would be undermined if we found evidence of differential trends in the rates in Cuyahoga County versus the comparator counties during the pre-BHP period. To address this concern, we tested for differences in the fitted linear trends in the rates for Cuyahoga County relative to our comparison counties over the pre-BHP period.

Four secondary analyses were undertaken to examine alternative explanations for our findings in the primary analysis. First, we estimated an identical difference-in-differences model using as the outcome the rate of hospitalizations that were not for ambulatory care-sensitive conditions, to determine whether our findings were specific to ambulatory care-sensitive conditions or reflected broader differential trends in hospitalizations across Ohio's counties.

Second, prior studies have suggested that reductions in hospitalization rates might be a result of increases in hospital observation rates.²⁹ To examine this potential explanation, we conducted a difference-in-differences analysis using hospital observation rates as the dependent variable.

Third, as described by John Wennberg, hospital utilization may be driven in part by higher levels or increases in the supply of medical resources.³⁰ To examine this hypothesis, we used data from the Area Health Resources Files to quantify county-level rates of hospital bed supply (the per capita number of nonfederal, short-stay hospital beds) and tested for a differential change across counties.²⁴

Fourth, data from the Area Health Resources Files were used to assess the potential confounding effects of the Great Recession (2007–09) by measuring whether rates of uninsurance or unemployment changed differentially in Cuyahoga County during the post period, relative to the five comparator counties.

LIMITATIONS

There are several limitations to consider in interpreting this study. First, the unit of analysis was county-level hospitalizations of residents rather than hospitalizations or rehospitalizations of individual residents. We therefore were not able to address policy-relevant concerns relating to financial disincentives associated with thirty-day readmissions.

Second, as with all difference-in-differences models, it is possible that the events in the comparator counties (in this case, hospitalization rates for ambulatory care-sensitive conditions in the five other counties) are not accurate representations of how events would have evolved elsewhere in the absence of the intervention (in this case, in Cuyahoga County in the absence of BHP). However, we controlled for county- and year-specific fixed effects and ruled out the most important and likely confounders related to hospitalization rates. Furthermore, we reestimated our models following the sequential removal of two counties with regional improvement collaboratives that had varying types and levels of stakeholder engagement, use of EHRs, and rollout of public reporting. Our results were not meaningfully different in these structural sensitivity analyses (see the online appendix).³¹

Third, our inferences were based on BHP's quality improvement initiatives in a specific urban location with relatively high numbers of aging and minority residents (Cuyahoga County) and therefore might not be generalizable to other regions.

Finally, the post-BHP period (2009–2014) coincides with other important health system changes^{28,32–34} and the expansion of Medicaid in Ohio. To the extent that some of these changes were effective and differentially present in BHP's early programmatic interventions in Cuyahoga County, they may explain some of the effect of BHP on reductions in hospitalization rates for ambulatory care-sensitive conditions.

Study Results

BASELINE STATISTICS: 2003–08

In the baseline period, residents of Cuyahoga County were more likely to be older and to be black than were residents of the comparison counties (exhibit 1). Cuyahoga County also had more hospital beds per 100,000 residents. Rates of unemployment and uninsurance in Cuyahoga County were similar to those in the comparator counties.

The rate of hospitalizations for ambulatory care-sensitive conditions during the baseline period was, on average, 15.9 percent greater for Cuyahoga County than for the other counties, with differences significant for all measured conditions except bacterial pneumonia (exhibit 1). Average costs per hospital admission were significantly higher in the comparison counties for all ambulatory care-sensitive conditions combined and all individual conditions except hypertension. Observation rates for 2006–08 were lower than hospitalization rates and did not differ significantly across counties.

MAIN FINDINGS

In the pre-BHP period, hospitalization rates for ambulatory care-sensitive conditions were declining in both Cuyahoga and the comparator counties, but at very similar trajectories

(exhibit 2). The estimated difference in slopes in this period was nonsignificant ($p = 0.97$). The introduction of BHP coincided with a noticeably larger decline in Cuyahoga's rates relative to those of the comparison counties.

From 2009 to 2011, hospitalization rates for ambulatory care-sensitive conditions decreased by 106 more hospitalizations per 100,000 adults in Cuyahoga County than they did in the comparator counties (exhibit 3). From 2012 to 2014, there were 91 fewer hospitalizations for ambulatory care-sensitive conditions per 100,000 residents in Cuyahoga County than in the comparator counties. Only reductions in hospitalizations for bacterial pneumonia were nonsignificant in the later post period, while reductions in Cuyahoga County's hospitalizations for hypertension and diabetes were significant in both post periods, and reductions in heart failure were significant in the later post period. Among the four Prevention Quality Indicators that make up the diabetes-related hospitalization rates for ambulatory care-sensitive conditions, Cuyahoga County experienced significantly greater reductions for uncontrolled diabetes (number 14) ($p < 0.005$ in both post periods) and for lower extremity amputations (number 16) in the later post period ($p = 0.04$).

We estimate that 5,764 hospitalizations for ambulatory care-sensitive conditions were averted in the period 2009–14 in Cuyahoga County (exhibit 4). The average cost per hospitalization was \$6,856 in 2009–11 and \$6,958 in 2012–14. Combined, these average costs and averted hospitalizations yield an estimated cost savings of \$39.7 million. Estimated savings from averted hospitalizations were greatest for congestive heart failure (\$20.2 million), followed by diabetes-related conditions (\$9.2 million), pneumonia (\$8.7 million), and hypertension (\$4.4 million).

SECONDARY ANALYSES

Despite increasing rates of hospital observations in all counties, especially in the period 2012–14, we found no significant estimated difference-in-differences for these rates in either the first or the second post period (the results in this paragraph are presented in the appendix).³¹ We found no evidence of differential changes in hospitalization rates for conditions that were not ambulatory care-sensitive. Hospital beds per capita increased significantly more in Cuyahoga County than in the five comparison counties during the postintervention years ($p < 0.01$). Among the potential effects of the Great Recession, Cuyahoga experienced a relative decrease in the unemployment rate ($p = 0.013$) and a nonsignificant relative increase in uninsurance rates.

Discussion

This article adds to the growing literature that documents the association of primary care-driven regional health improvement collaboratives with population-based rates of hospitalizations for targeted ambulatory care-sensitive conditions. We estimate that almost 6,000 potentially preventable hospitalizations were averted by quality improvement initiatives that focused on disseminating locally identified best practices in Cuyahoga County over a six-year period. We also estimate that the accompanying cost savings for hospital care were almost \$40 million over the same time period. Estimated savings from averted hospitalizations were greatest for congestive heart failure (\$20.2 million), followed

by diabetes-related conditions (\$9.2 million), pneumonia (\$8.7 million), and hypertension (\$4.4 million).

As we have previously reported,¹³ regionwide performance on BHP's quality-of-care measures improved soon after the founding of the Better Health Partnership.¹⁰ As an example, the earliest BHP efforts focused on improvements in diabetes care, including receipt of the 23-valent pneumococcal vaccine, and were associated with significant reductions in hospitalizations for bacterial pneumonia. Among patients with diabetes, the rate of pneumococcal vaccination increased from 64 percent in 2007 to 73 percent in 2009 and 81 percent in 2014,¹⁰ exceeding national changes among adults ages sixty-five and older during the same period (57.7 percent, 60.6 percent, and 61.3 percent, respectively).³⁵ Similarly, in 2009, BHP reported best practices for blood pressure control that were first observed among member clinics of a large health maintenance organization,³⁶ with local rates of good blood pressure control (defined as blood pressure <140/90 mmHg) improving in contrast to a national decrease. Specifically, good blood pressure control was achieved in 68 percent of BHP patients in 2009 and in 74 percent in 2014,³⁷ while national rates fell from 71.4 percent among adults in 2009–10³⁸ to 66.5 percent in 2014.³⁹ Additionally, BHP expanded its membership throughout the study period, adding new practices and health care systems overtime. This expansion may partially explain the persistence of the differential decrease in the hospitalization rate for ambulatory care–sensitive conditions in Cuyahoga County relative to the comparator counties during the later post period.

These population-level improvements were associated with the establishment of a strong primary care provider integrator organization that was committed to and catalyzed primary care transformation and the public reporting of health care quality metrics in a relatively small well-defined geographic area.^{8,40} Whereas most regional health improvement collaboratives operating in larger markets rely principally on health insurance claims data to determine quality of care,^{13,41–47} BHP's commitment to adopting EHR data for measuring achievement and improvement led to its exclusive use of EHR data by the end of 2010.¹⁰ The use of EHR data promoted timely and trusted identification and dissemination of best practices. Public recognition of high-performing clinics across diverse patient subgroups fostered members' further engagement, involvement by BHP peers, and the establishment of the BHP coaching program.

The present findings are supported by the recent results of Brent Fulton and colleagues, who addressed a similar question by studying a countywide, physician-led learning collaborative in San Diego County, California.⁴⁸ The authors found that initiating the collaborative was associated with a significant reduction in hospitalization rates for heart attacks and an impressive but lesser decline in hospitalization rates for strokes. Thus, although BHP used a framework and funding mechanism similar to those of the regional health improvement collaboratives studied by Yunfeng Shi and colleagues⁴⁰ and Dennis Scanlon and colleagues,⁸ meaningful differences in leadership, clinical focus, scope of stakeholder engagement, and sources of data may account for the differences between the present study and others. While it is unclear which specific aspects of BHP led to the present findings, states might be encouraged to support innovations that improve population health through mechanisms such

as 1115 waivers and other tests of state innovation models that focus on primary care provider-led collaboration within health care markets.

Conclusion

Our study found that a primary care-focused regional quality improvement initiative in Cuyahoga County, Ohio, was associated with a significant improvement in population health. In the current climate of payment and health care delivery transformation, identifying opportunities to improve population health through low-cost initiatives that specifically aim to redesign the dissemination of best practices within a geographic region is increasingly important and valuable for stakeholders across the US health care system. Our findings support the premise that primary care-focused quality improvement initiatives that emphasize disseminating best practices within a region can avert preventable hospitalizations for ambulatory care-sensitive conditions and may lead to substantial cost savings for the health care system. ■

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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NOTES

1. Berwick DM, Nolan TW, Whittington J. The Triple Aim: care, health, and cost. *Health Aff (Millwood)*. 2008; 27(3):759–69. [PubMed: 18474969]
2. Dale SB, Ghosh A, Peikes DN, Day TJ, Yoon FB, Taylor EF, et al. Two-year costs and quality in the Comprehensive Primary Care Initiative. *N Engl J Med*. 2016;374(24):2345–56. [PubMed: 27074035]
3. Jackson GL, Powers BJ, Chatterjee R, Bettger JP, Kemper AR, Hasselblad V, et al. Improving patient care. The patient centered medical home. A systematic review. *Ann Intern Med*. 2013;158(3):169–78. [PubMed: 24779044]
4. Fisher ES, McClellan MB, Bertko J, Lieberman SM, Lee JJ, Lewis JL, et al. Fostering accountable health care: moving forward in Medicare. *Health Aff (Millwood)*. 2009;28(2): w219–31. [PubMed: 19174383]
5. CMS.gov. Comprehensive Primary Care initiative [Internet]. Baltimore (MD): Centers for Medicare and Medicaid Services; [last updated 2017 Oct 24; cited 2017 Dec 1]. Available from: <https://innovation.cms.gov/initiatives/comprehensive-primary-care-initiative/>
6. Network for Regional Healthcare Improvement. Regional health improvement collaboratives (RHICs): what they are and why we need them? [Internet]. Portland (ME): NRHI; [cited 2017 Dec 1]. Available from: <http://www.nrhi.org/uploads/what-is-a-rhic.pdf>

7. Cebul RD, Dade SE, Letourneau LM, Glaseroff A. Regional health improvement collaboratives needed now more than ever: program directors' perspectives. *Am J Manag Care*. 2012;18(6, Suppl):s112–4. [PubMed: 23286705]
8. Scanlon DP, Beich J, Leitzell B, Shaw BW, Alexander JA, Christianson JB, et al. The Aligning Forces for Quality initiative: background and evolution from 2005 to 2015. *Am J Manag Care*. 2016;22(12, Suppl):s346–59. [PubMed: 27567508]
9. Aligning Forces for Quality [home page on the Internet]. Princeton (NJ): Aligning Forces for Quality; c 2015 [cited 2017 Dec 1]. Available from: <http://forces4quality.org/>
10. Better Health Greater Cleveland. Keeping the promise of electronic health records: executive summary, 6th report [Internet]. Cleveland (OH): Better Health Partnership; 2011 [cited 2017 Dec 1]. Available from: http://betterhealthmembers.org/pdfs/exec_summary/Executive_Summary_Winter_2011.pdf
11. Rose AJ, Mccullough MB. A practical guide to using the positive deviance method in health services research. *Health Serv Res*. 2017;52(3): 1207–22. [PubMed: 27349472]
12. Cebul RD, Love T, Einstadter D. Reducing disparities in diabetes care: using a positive deviance approach in a regional health improvement collaborative. Abstract presented at: 2016 AcademyHealth Annual Research Meeting; 2016 Jun 26–28; Boston, MA.
13. Cebul RD, Love TE, Jain AK, Hebert CJ. Electronic health records and quality of diabetes care. *N Engl J Med*. 2011;365(9):825–33. [PubMed: 21879900]
14. Cebul RD, Love TE, Einstadter D, Petrulis AS, Corlett JR. MetroHealth Care Plus: effects of a prepared safety net on quality of care in a Medicaid expansion population. *Health Aff (Millwood)*. 2015;34(7):1121–30. [PubMed: 26153306]
15. Lamb GC, Smith MA, Weeks WB, Queram C. Publicly reported quality-of-care measures influenced Wisconsin physician groups to improve performance. *Health Aff (Millwood)*. 2013;32(3):536–43. [PubMed: 23459733]
16. Ansari Z, Barbetti T, Carson NJ, Auckland MJ, Cicuttini F. The Victorian ambulatory care sensitive conditions study: rural and urban perspectives. *Soz Praventivmed*. 2003;48(1):33–43. [PubMed: 12756887]
17. Billings J, Zeitel L, Lukomnik J, Carey TS, Blank AE, Newman L. Impact of socioeconomic status on hospital use in New York City. *Health Aff (Millwood)*. 1993;12(1):162–73.
18. Bindman AB, Chattopadhyay A, Osmond DH, Huen W, Bacchetti P. The impact of Medicaid managed care on hospitalizations for ambulatory care sensitive conditions. *Health Serv Res*. 2005;40(1):19–38. [PubMed: 15663700]
19. Bindman AB, Grumbach K, Osmond D, Komaromy M, Vranizan K, Lurie N, et al. Preventable hospitalizations and access to health care. *JAMA*. 1995;274(4):305–11. [PubMed: 7609259]
20. Saha S, Solotaroff R, Oster A, Bindman AB. Are preventable hospitalizations sensitive to changes in access to primary care? The case of the Oregon Health Plan. *Med Care*. 2007;45(8):712–9. [PubMed: 17667304]
21. Better Health Partnership. Patients as partners in care [Internet]. Cleveland (OH): BHP; [cited 2017 Dec 20]. Available from: http://www.betterhealthpartnership.org/individuals_landing.asp
22. Better Health Partnership. Data center [Internet]. Cleveland (OH): BHP; [cited 2017 Dec 1]. Available from: http://www.betterhealthpartnership.org/data_center/
23. Ohio Hospital Association. Statewide Inpatient and Outpatient Databases, 2003–14 [Internet]. Columbus (OH): The Association; [cited 2017 Dec 20]. Available for download (membership required) from: <https://ohiohospitals.org/Data-Center.aspx>
24. Health Resources and Services Administration. Area Health Resources Files [Internet]. Rockville (MD): HRSA; [cited 2017 Dec 1]. Available from: <https://datawarehouse.hrsa.gov/topics/ahrf.aspx>
25. Centers for Disease Control and Prevention. Pneumococcal vaccination: summary of who and when to vaccinate [Internet]. Atlanta (GA): CDC; [last updated 2016 Nov 22; cited 2017 Dec 1]. Available from: <https://www.cdc.gov/vaccines/vpd/pneumo/hcp/who-when-to-vaccinate.html>
26. Agency for Healthcare Research and Quality. Prevention Quality Indicators technical specifications, version 5.0 [Internet]. Rockville (MD): AHRQ; 2015 3 [cited 2017 Dec 20]. Available from: http://qualityindicators.ahrq.gov/Archive/PQI_TechSpec_ICD9_v50.aspx

27. Bureau of Labor Statistics. Consumer Price Index [Internet]. Washington (DC): The Bureau; [cited 2017 Dec 1]. Available from: <http://www.bls.gov/Cpi/>.
28. Obama B United States health care reform: progress to date and next steps. JAMA. 2016;316(5): 525–32. [PubMed: 27400401]
29. Zuckerman RB, Sheingold SH, Orav EJ, Ruhter J, Epstein AM. Readmissions, observation, and the Hospital Readmissions Reduction Program. N Engl J Med. 2016;374(16):1543–51. [PubMed: 26910198]
30. Wennberg JE. On the appropriateness of small-area analysis for cost containment. Health Aff (Millwood). 1996;15(4):164–7. [PubMed: 8991271]
31. To access the appendix, click on the Details tab of the article online.
32. Dawes AJ, Sacks GD, Russell MM, Lin AY, Maggard-Gibbons M, Winograd D, et al. Preventable readmissions to surgical services: lessons learned and targets for improvement. J Am Coll Surg. 2014; 219(3):382–9. [PubMed: 24891209]
33. McAfee T, Babb S, McNabb S, Fiore MC. Helping smokers quit—opportunities created by the Affordable Care Act. N Engl J Med. 2015; 372(1):5–7. [PubMed: 25409263]
34. Wagner Z, Wu Y, Sood N. The Affordable Care Act may increase the number of people getting tested for HIV by nearly 500,000 by 2017. Health Aff (Millwood). 2014;33(3): 378–85. [PubMed: 24590934]
35. Centers for Disease Control and Prevention. Report on self-reported pneumococcal vaccination coverage trends 1989–2008 [Internet]. Atlanta (GA): CDC; 2009 Table, Self-reported pneumococcal vaccination coverage trends 1989–2008 among adults by age group, risk group, race/ethnicity, health-care worker status, and pregnancy status, United States, National Health Interview Survey (NHIS); [cited 2017 Dec 20]. Available from: https://www.cdc.gov/flu/pdf/professionals/nhis89_08ppvaxtrendtab.pdf
36. Jaffe MG, Lee GA, Young JD, Sidney S, Go AS. Improved blood pressure control associated with a large-scale hypertension program. JAMA. 2013; 310(7):699–705. [PubMed: 23989679]
37. Better Health Partnership. Trends in high blood pressure standards [Internet]. Cleveland (OH): BHP; [cited 2017 Dec 4]. Available from: http://www.betterhealthpartnership.org/data_center/region_htn_standards.asp
38. Yoon SS, Burt V, Louis T, Carroll MD. Hypertension among adults in the United States, 2009–2010. NCHS Data Brief. 2012;(107):1–8.
39. National Center for Health Statistics. Health, United States, 2016: with chartbook on long-term trends in health [Internet]. Hyattsville (MD): NCHS; 2017 [cited 2017 Dec 4]. Available from: [https://www.cdc.gov/nchs/data/16.pdf](https://www.cdc.gov/nchs/data/hus/16.pdf)
40. Shi Y, Scanlon DP, Kang R, McHugh M, Greene J, Christianson JB, et al. The longitudinal impact of Aligning Forces for Quality on measures of population health, quality and experience of care, and cost of care. Am J Manag Care. 2016;22(12, Suppl): s373–81. [PubMed: 27567511]
41. Fingar KR, Barrett ML, Elixhauser A, Stocks C, Steiner CA. Trends in potentially preventable inpatient hospital admissions and emergency department visits [Internet]. Rockville (MD): Agency for Healthcare Research and Quality; 2015 11 [cited 2017 Dec 4]. (HCUP Statistical Brief No. 195). Available from: <https://www.hcup-us.ahrq.gov/reports/statbriefs/sb195-Potentially-Preventable-Hospitalizations.pdf>
42. Sundmacher L, Kopetsch T. The impact of office-based care on hospitalizations for ambulatory care sensitive conditions. Eur J Health Econ. 2015;16(4):365–75. [PubMed: 25904496]
43. King J, Patel V, Furukawa MF. Physician adoption of electronic health record technology to meet meaningful use objectives: 2009–2012 [Internet]. Washington (DC): Department of Health and Human Services, Office of the National Coordinator for Health Information Technology; 2012 12 [cited 2017 Dec 4]. (ONC Data Brief No. 7). Available from: <https://www.healthit.gov/sites/default/files/onc-data-brief-7-december-2012.pdf>
44. Cebul RD. Using electronic medical records to measure and improve performance. Trans Am Clin Climatol Assoc. 2008;119:65–76. [PubMed: 18596863]
45. Lin YH, Eberth JM, Probst JC. Ambulatory care-sensitive condition hospitalizations among Medicare beneficiaries. Am J Prev Med. 2016; 51(4):493–501. [PubMed: 27374209]

46. Freund T, Campbell SM, Geissler S, Kunz CU, Mahler C, Peters-Klimm F, et al. Strategies for reducing potentially avoidable hospitalizations for ambulatory care-sensitive conditions. *Ann Fam Med*. 2013;11(4): 363–70. [PubMed: 23835823]
47. Walker RL, Chen G, McAlister FA, Campbell NR, Hemmelgarn BR, Dixon E, et al. Relationship between primary care physician visits and hospital/emergency use for uncomplicated hypertension, an ambulatory care-sensitive condition. *Can J Cardiol*. 2014;30(12):1640–8. [PubMed: 25475466]
48. Fulton BD, Ivey SL, Rodriguez HP, Shortell SM. Countywide physician organization learning collaborative and changes in hospitalization rates. *Am J Manag Care*. 2017;23(10): 596–603. [PubMed: 29087631]

EXHIBIT 1

Summary characteristics of Cuyahoga County and five merged comparator counties in the baseline period (2003–08)

	Cuyahoga County	Comparator counties	Relative difference	
			Absolute difference	Percent
POPULATION CHARACTERISTICS				
Adult residents (millions)	0.97	0.51	0.46***	7.4
Residents older than 65 (%)	20.7	17.6	3.1***	15.0 (10.6, 18.8)***
Male	46.0	47.2	-1.2***	-2.6 (-3, -2.2)***
White	71.0	80.3	-9.3***	-13.1 (-14.2, -11.3)***
Black	26.7	17.7	9.0***	33.7 (28.8, 39.0)***
MARKET CHARACTERISTICS (PER 100,000 RESIDENTS)				
Hospital beds	516	463	53***	10.3 (4.6, 15.8)***
Uninsurance rate (%)	11.2	12.2	-1.0	-8.9 (-25.9, 7.1)
Unemployed rate (%)	6.3	6.0	0.3	4.8 (-4.8, 14.3)
AVERAGE HOSPITALIZATION RATES (PER 100,000 ADULT RESIDENTS)				
All ACSCs combined	1,440	1,211	229***	15.9 (13.0, 18.8)***
Congestive heart failure	619	488	131***	21.2 (15.7, 26.8)***
Hypertension	85	67	18**	21.2 (3.5, 40.0)**
Diabetes-related	320	266	54***	16.9 (10.6, 22.8)**
Pneumonia	416	391	25	6.0 (-2.4, 14.7)
Non-ACSCs	14,516	13,419	1,097***	7.6 (4.1, 10.9)
AVERAGE HOSPITALIZATION COST				
All ACSCs combined	\$ 6,625	\$ 7,743	-1,119***	-16.9 (-23.6, -10.2)***
Congestive heart failure	7,361	8,179	-818**	-11.1 (-19.6, -2.6)**
Hypertension	4,946	5,134	-178	-3.6 (-16.2, 9.0)
Diabetes-related	7,041	8,675	-1,634***	-23.2 (-29.4, -17)***
Pneumonia	6,594	7,504	-909***	-13.8 (-23.7, -2.4)***
AVERAGE OBSERVATION RATES ^d (PER 100,000 ADULT RESIDENTS)				

	Cuyahoga County	Comparator counties	Absolute difference	Relative difference	
				Percent	95% CI
All ASCs combined	113	88	25	22.1	(-23.0, 67.3)
Congestive heart failure	31	21	10	32.3	(-16.1, 77.4)
Hypertension	37	25	12	32.4	(-10.8, 75.7)
Diabetes-related	31	25	6	19.4	(-15.2, 58.1)
Pneumonia	14	17	3	21.4	(-114.3, 78.6)

SOURCE Authors' analysis of data from the Ohio Hospital Association and the Area Health Resources Files (note 24 in text). **NOTES** Hospitalization rates were adjusted for sex and age. Costs of hospitalizations for ambulatory care-sensitive conditions (ACSC) adjusted for inflation (using the Consumer Price Index) to represent 2014 dollars. Significance of differences was determined by standard t tests, with 95 percent confidence intervals presented for relative differences.

^aHospital observation data were not available for 2003–05. ACSC is ambulatory care-sensitive condition.

 $p < 0.05$

 $p < 0.01$

EXHIBIT 2

Hospitalization rates for ambulatory care-sensitive conditions for Cuyahoga County and five merged comparator counties with fitted linear trends, 2003–14

SOURCE Authors' analysis of data from the Ohio Hospital Association. **NOTES** The pre period (before the initiation of the Better Health Partnership) was 2003–08; the first post period (after the initiation) was 2009–11 and the second post period was 2012–14. The trend lines project the hospitalization rates in the pre period through the post period. The difference in pre-period trends was nonsignificant. During the two post periods, hospitalization rates declined significantly more in Cuyahoga County relative to the comparator counties.

EXHIBIT 3

Difference-in-differences (DD) between Cuyahoga County and five merged comparator counties before and after initiation of the Better Health Partnership in hospitalizations for ambulatory care-sensitive conditions (ACSCs)

Hospitalization rate	Pre period (2003–08)	Early post period (2009–11)	DD estimates for early post period	Later post period (2012–14)	DD estimates for later post period
ALL ACSCS COMBINED					
Mean difference in rates	229 ***	122 **	-106 ***	125 **	-91 **
Conventional standard error	(20.6)	(34.6)	(34.7)	(43.5)	(34.8)
CONGESTIVE HEART FAILURE					
Mean difference in rates	131.0 ***	98.8 ***	-30.7 *	81.7 ***	-48.5 ***
Conventional standard error	(15.5)	(17.3)	(15.7)	(16.1)	(15.7)
DIABETES-RELATED					
Mean difference in rates	54.1 ***	31.2 ***	-22.3 **	28.8 ***	-21.1 **
Conventional standard error	(8.9)	(10.2)	(8.7)	(9.1)	(8.7)
HYPERTENSION					
Mean difference in rates	18.4 **	3.6	-15.3 ***	4.1	-13.7 ***
Conventional standard error	(6.8)	(5.2)	(4.0)	(7.6)	(4.0)
BACTERIAL PNEUMONIA					
Mean difference in rates	25.4	-11.2	-37.9 **	10.9	-7.5
Conventional standard error	(16.6)	(12.5)	(15.9)	(19.5)	(15.9)
NON-ACSCS					
Mean difference in rates	1,097.3 ***	790.7 **	-291.6	906.3 **	-153.5
Conventional standard error	(234.4)	(328.0)	(334.6)	(367.6)	(335.2)

SOURCE: Authors' analysis of data from the Ohio Hospital Association. **NOTE:** Estimates were generated by applying analytic weights to address heteroskedasticity arising from variation in county populations.

* $p < 0.10$

** $p < 0.05$

*** $p < 0.01$

EXHIBIT 4

Averted hospitalizations for ambulatory care-sensitive conditions (ACSCs) and implied averted costs

	2009–11		2012–14		All	
	Number	95% CI	Number	95% CI	Number	95% CI
AVERTED HOSPITALIZATIONS						
Inferences from all ACSCs combined	3,146	(1,078, 5,214)	2,600	(600, 4,600)	5,746	(1,679, 9,814)
Inferences from specific ACSCs						
Congestive heart failure	913	(0 – 1,848)	1,390	(484, 2,295)	2,303	(460, 4,143)
Diabetes-related	661	(142 – 1,181)	605	(102, 1,108)	1,266	(243, 2,289)
Hypertension	453	(215 – 691)	393	(163, 623)	846	(377, 1,314)
Bacterial pneumonia	1,125	(179 – 2,072)	214	(0, 1,129)	1,339	(0, 3,201)
AVERAGE COST PER HOSPITALIZATION						
Inferences from all ACSCs combined	\$6,856	—	\$6,958	—	\$6,907	—
Inferences from specific ACSCs						
Congestive heart failure	8,345	—	9,052	—	8,699	—
Diabetes-related	7,298	—	7,287	—	7,293	—
Hypertension	4,882	—	5,624	—	5,253	—
Bacterial pneumonia	6,573	—	6,409	—	6,491	—
IMPLIED AVERTED COSTS (MILLIONS)						
Inferences from all ACSCs combined	\$21.6	(7.4, 35.7)	\$18.1	(4.2, 32.0)	\$39.7	(11.6, 67.7)
Inferences from specific ACSCs						
Congestive heart failure	7.6	(0.0, 15.4)	12.6	(4.4, 20.7)	20.2	(4.4, 36.1)
Diabetes-related	4.8	(1.0, 8.6)	4.4	(0.7, 8.1)	9.2	(1.7, 16.7)
Hypertension	2.2	(1.0, 3.3)	2.2	(0.9, 3.5)	4.4	(1.9, 6.8)
Bacterial pneumonia	7.4	(1.1, 13.6)	1.3	(0.0, 7.2)	8.7	(1.1, 20.8)

SOURCE Authors' analysis of data from the Ohio Hospital Association. **NOTES** Averted hospitalizations were calculated by applying the estimated reduction in hospitalization rates to the Cuyahoga County adult population size in each postintervention year. Costs per hospitalization reflect mean costs per hospitalization (of each type) for Cuyahoga residents in each post period. Costs of hospitalizations for ambulatory care-sensitive conditions (ACSC) adjusted for inflation (using the Consumer Price Index) to represent 2014 dollars. Confidence intervals (CIs) for averted cost estimates reflect uncertainty in hospitalization rate effect only and do account for uncertainty in mean cost per hospitalization.