Changes in Disparities Following the Implementation of a Health Information Technology-Supported Quality Improvement Initiative

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BACKGROUND: Health information technology (HIT)-supported quality improvement initiatives have been shown to increase ambulatory care quality for several chronic conditions and preventive services, but it is not known whether these types of initiatives reduce disparities.

OBJECTIVES: To examine the effects of a multifaceted, HIT-supported quality improvement initiative on disparities in ambulatory care.

DESIGN: Time series models were used to assess changes in racial disparities in performance between white and black patients for 17 measures of chronic disease and preventive care from February 2008 through February 2010, the first 2 years after implementation of a HIT-supported, provider-directed quality improvement initiative.

PATIENTS: Black and white adults receiving care in an academic general internal medicine practice in Chicago.

INTERVENTIONS: The quality improvement initiative used provider-directed point-of-care clinical decision support tools and quality feedback to target improvement in process of care and intermediate outcome measures for coronary heart disease, heart failure, hypertension, and diabetes as well as receipt of several preventive services.

MAIN MEASURES: Modeled rate of change in performance, stratified by race and modeled rate of change in disparities for 17 ambulatory care quality measures

KEY RESULTS: Quality of care improved for 14 of 17 measures among white patients and 10 of 17 measures among black patients. Quality improved for both white and black patients for five of eight process of care measures, four of five preventive services, but none of the four intermediate outcome measures. Of the seven measures with racial disparities at baseline, disparities declined for two, remained stable for four, and increased for one measure after implementation of the quality improvement initiative.

CONCLUSIONS: Generalized and provider-directed quality improvement initiatives can decrease racial disparities for some chronic disease and preventive care measures, but achieving equity in areas with persistent disparities will require more targeted, patient-directed, and systems-oriented strategies.

KEY WORDS: health care disparities; quality of care; ambulatory care; health information technology.
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INTRODUCTION

The US health care system suffers from the dual problems of suboptimal quality of care for the population overall[1,2] and widespread disparities in health care by race, ethnicity, gender, and socioeconomic status.[3,4] Health care organizations have become increasingly engaged in generalized quality improvement activities, yet relatively few organizations have undertaken efforts to specifically address disparities in care.[5] While it is possible that generalized quality improvement efforts may also help to reduce health care disparities, very few empirical studies have specifically addressed this question.[6–9]

Health information technology (HIT) has recently been the subject of particular enthusiasm and interest as a means to improve the delivery and quality of health care, and the potential role of HIT in addressing health care disparities has also begun to receive attention.[10,11] However, there is little published evidence regarding the effects of HIT-supported interventions on health care equity.[12]

Quality improvement initiatives, including those that are supported through HIT, may affect health care disparities by facilitating change at any of four levels: the experience of patients, the performance of microsystems of care (i.e., individual health care providers and care teams), the functioning of health care organizations (i.e., health centers and hospitals), and the operation of the health care environment (i.e., payment and regulatory systems).[2,13] Provider-directed HIT-supported quality improvement tools, such as clinical decision support and provider feedback, have been associated with improvements in quality in the domains of adherence to guideline-recommended care and patient safety,[14,15] and would be most likely to impact health care disparities by facilitating change at the microsystems level (i.e., changing the behavior of individual providers). Electronic clinical reminders, for example, could lead to decreased disparities by raising provider awareness of quality gaps for individual patients, and

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particularly for those patients for whom quality gaps are more likely to be overlooked due to competing medical and psychosocial priorities.[10] Clinical decision support could lead to decreased disparities by reducing clinical uncertainty and biased decision making, both of which have been demonstrated to contribute to disparities in care.[11,12] The more rapid retrieval of clinically relevant information could improve provider efficiency and potentially improve provider-patient communication by allowing providers more time to engage in shared decision making, which has been associated with reductions in health care disparities.[15–18] In addition, regular provider feedback could motivate providers to change their practice patterns in order to improve the overall quality of their patient care,[10] and patients who have traditionally had lower quality of care may benefit the most from these changes.

Alternatively, provider-directed HIT-supported quality improvement initiatives could negatively impact provider performance in ways that disproportionately affect patients from historically disadvantaged groups. Clinical reminders and clinical decision support tools could worsen provider communication skills[19] or increase patient mistrust[20]—either of which could worsen provider-patient interactions, decrease the patient-centeredness of care, exacerbate existing health care disparities, or even create new disparities.

Therefore, in order to better understand the effects of generalized, HIT-supported, and provider-directed quality improvement initiatives on disparities in ambulatory care, we examined the effects of a HIT-supported quality improvement initiative on racial disparities within a large general internal medicine practice. In particular, this study addresses two questions: following the implementation of the quality improvement initiative, were improvements in quality seen for both blacks and whites, and were baseline racial disparities between these groups eliminated? We hypothesized that the provider-directed HIT-supported quality improvement initiative would be associated with declining disparities for quality measures that are more directly under the control of health care providers (i.e., process of care measures) and that disparities would remain unchanged for measures that require more patient engagement (i.e., intermediate outcome measures).

METHODS

Study Setting

This study was conducted in an academic general internal medicine ambulatory care practice in Chicago that serves over 25,000 patients annually and has used a commercially available electronic health record (EHR) (EpicCare, Epic Systems Corp., Verona, Wisconsin) for over 10 years. About 49% of the patients are White, 12% Black, 5% Hispanic, and 34% other or unknown. Approximately 68% of patients are privately insured, 22% have Medicaid, 5% have Medicare, and 5% are uninsured.

Quality Improvement Initiative

The UPQUAL (Using Precision Performance Measurement to Conduct Focused Quality Improvement) initiative was implemented throughout the practice on February 7, 2008. The components of UPQUAL and the effects of the initiative on overall quality of care have been described elsewhere,[21] but to summarize, the intervention includes electronic point-of-care clinical reminders, decision support tools within the EHR to promote adherence to clinical guidelines, and regular provider feedback, which includes quarterly individual performance reports on all targeted measures and monthly lists of patients who are not prescribed essential medications (e.g., beta-blocker for a patient with a history of myocardial infarction). The quality improvement initiative was applied to all patients in the practice and was not specifically targeted or tailored based on patient race or other factors.

Quality Measures

We examined disparities in the quality of care over a 2-year period following the implementation of the UPQUAL initiative for 17 quality measures. These included process of care and intermediate outcome measures for coronary heart disease, heart failure, hypertension, and diabetes, and several preventive care measures (Table 1). The proportion of eligible patients satisfying each measure, stratified by race, was assessed on the first of every month from February 1, 2008, through February 1, 2010. Patients were eligible for a measure if they were 18 years or older, had made at least two visits to the practice in the 18 months prior to the time of the quality assessment, were assigned to an attending physician, and satisfied the denominator criteria based on age, gender, and medical diagnoses as detailed in Table 1. The proportion of patients satisfying a measure was defined as the number of patients satisfying the numerator criteria divided by the number of patients meeting the denominator criteria for the measure minus the number of patients who did not satisfy the measure but had a documented exception: number satisfied/(number eligible – number not satisfied with a documented exception). Measures were assessed by querying the enterprise data warehouse, which contains stored data from the EHR, and details regarding the queries have been published elsewhere.[21]

Patient Characteristics

Due to the small number of patients of other race or ethnicity, we limited the analysis to patients whose race/ethnicity was recorded as black or white in the EHR. We collected data regarding the distribution of age, gender, and number of chronic medical conditions for white and black patients who were eligible for at least one of the 17 quality measures at three time points: February 1, 2008, February 1, 2009, and February 1, 2010. The number of chronic medical conditions for each patient was assessed based on a count of ten possible chronic disease categories: nine categories included in the 2008 Dartmouth Atlas of Health Care (cancer, chronic pulmonary disease, coronary artery disease, congestive heart failure, peripheral vascular disease, severe chronic liver disease, diabetes, renal failure, and dementia) and hypertension.[22]

Table 1. Ambulatory Care Quality Measures: Criteria and Number of Eligible Patients at Baseline

Quality measure	Numerator criteria	Denominator criteria	Number eligible*
Chronic disease process of care measures			
Antiplatelet drug prescribed for patients with coronary heart disease	Antiplatelet drug on medication list	Diagnosis of coronary heart disease	920
Lipid-lowering drug prescribed for patients with coronary heart disease	Lipid-lowering drug on medication list†	Diagnosis of coronary heart disease	948
Beta-blocker prescribed for patients with history of myocardial infarction	Beta-blocker on medication list	History of myocardial infarction	168
ACEI or ARB prescribed for patients with coronary heart disease and diabetes	ACEI or ARB on medication list	Diagnosis of coronary heart disease and diabetes mellitus	272
Anticoagulant prescribed for patients with atrial fibrillation and heart failure	Anticoagulant on medication list	Diagnosis of heart failure and atrial fibrillation	107
ACEI or ARB prescribed for patients with heart failure with LVSD	ACEI or ARB on medication list	Diagnosis of heart failure‡	245
Beta-blocker prescribed for patients with heart failure with LVSD	Beta-blocker on medication list	Diagnosis of heart failure‡	242
Screening or treatment for diabetic nephropathy	Urine microalbumin test within 1 year§	Diagnosis of diabetes mellitus	1,348
Intermediate outcome measures			
Blood pressure control for patients with hypertension	Most recent blood pressure or mean blood pressure ≤140/90‖	Diagnosis of hypertension¶	2,914
Glycemic control for patients with diabetes	Hemoglobin A1C<8.0% within 1 year	Diagnosis of diabetes mellitus	1,348
Blood pressure control for patients with diabetes	Most recent blood pressure or mean blood pressure ≤130/80‖	Diagnosis of diabetes mellitus	934
LDL control for patients with diabetes	LDL <100 mg/dl (<2.6 mmol/l) within 1 year#	Diagnosis of diabetes mellitus**	1,146
Preventive care measures			
Pneumococcal immunization	Pneumococcal vaccine ever administered	Age ≥65	2,246
Osteoporosis screening or treatment	Bone density test completed at or after age 60††	Women age ≥65	1,451
Colorectal cancer screening	FOBT within 1 year, sigmoidoscopy or DCBE within 5 years, or colonoscopy within 10 years	Age 50–80	5,294
Cervical cancer screening	Cervical cytology within 3 years	Women ages 21–64	4,769
Breast cancer screening	Mammography within 2 years	Women ages 50–69	2,784

Number of black and white patients eligible for each measure on February 1, 2008
†*Patients were considered to have an exception for this measure if they had an LDL <100 mg/dl (<2.6 mmol/l) within the past 1 year*
‡*Patients were excluded from this measure if they had an ejection fraction >40%*
§*Patients were also considered to have satisfied this measure if they had an ACE inhibitor or ARB on their active medication list*
‖ *Patients were considered to have an exception for this measure if they had a diuretic medication and medications from 2 or more other antihypertensive drug classes on their active medication list*
¶*Patients with diabetes were excluded from this measure*
#*Patients were considered to have an exception for this measure if they had a maximum dose of a high potency statin (atorvastatin 80 mg daily, roswastatin 40 mg daily, or simvastatin 80 mg daily) on their active medication list*
**Women younger than 50 years were excluded from this measure*
††*Patients were also considered to have satisfied this measure if they had a bisphosphonate, systemic estrogen, selective estrogen receptor modulator, parathyroid hormone, or calcitonin on their active medication list*
Abbreviations: ACEI, angiotensin converting enzyme inhibitor; ARB, angiotensin receptor blocker; LVSD, left ventricular systolic dysfunction; LDL, low-density lipoprotein cholesterol; FOBT, fecal occult blood test; DCBE, double contrast barium enema

Statistical Analysis

Pearson's chi-square test was used to identify measures with statistically significant differences in the proportion of black versus white patients satisfying each measure at baseline (February 1, 2008). Time series models were used to assess the significance of temporal trends in the percentage of patients satisfying each quality measure over the 2 years following the implementation of the quality improvement initiative for black and white patients, separately, and to assess the significance of changes in racial disparities.

To construct the time series models, a regression model was fit to each quality measure using a single practice-level measurement (e.g., the percentage of all eligible white patients in the practice who satisfied the colorectal cancer screening measure) as the dependent variable and time in months as the independent variable. For all but one measure, a linear model was applied with time as a continuous predictor from 0 to 24 months. For one measure, the prescription of antiplatelet therapy for patients with coronary heart disease, the temporal trend was very different for months 0 to 7 compared to months 8 to 24 (Appendix available online); therefore, the regression model included time as a continuous predictor for months 0 to 24, a dichotomous indicator variable for months 0 to 7 versus months 8–24, and an interaction term between the dichotomous indicator variable and time. Since the practice-level quality measurements could be highly correlated from month to month, each time series model included the appropriate number of autoregressive error parameters.[21] The beta coefficient for the time variable was used to determine the modeled rate of change per year for each quality measure.

The study was not limited to a cohort of patients who were continually eligible for a given quality measure at all time points throughout the study period (i.e., based on the dates of

her two most recent visits to the practice, a woman might be eligible for the breast cancer screening measure on January 1, 2009 and ineligible for that measure on January 1, 2010). Thus, the results could be biased if changes in patient characteristics over time differed by race. To determine whether temporal changes in patient characteristics differed between black and white patients, we used linear regression models (for age and chronic medical conditions) and a logistic regression model (for gender) with time, race, and an interaction term between time and race as the independent variables.

Analyses were done using Stata10 (StataCorp, College Station, Texas). A two-sided p-value of less than 0.05 was used to determine statistical significance. The study protocol was approved by the Northwestern University Institutional Review Board, and a waiver of informed consent was obtained.

RESULTS

Temporal Trends in Patient Characteristics

At baseline, 8,919 black and white patients were eligible for at least 1 of the 17 quality measures. The number of patients eligible for each measure ranged from 107 to 5,294 (Table 1). Black and white patients did not differ in age, but a higher proportion of black patients were female, and black patients had more chronic medical conditions compared to white patients (Table 2). However, age and number of chronic medical conditions increased similarly among black and white patients, and the proportion of female patients did not change over time. A greater percentage of black patients who were eligible for any measure on February 1, 2008, remained eligible on February 1, 2009, and February 1, 2010, compared to white patients (52% vs 43%, p<0.001).

Table 2. Characteristics of Patients Eligible for at Least 1 of 17 Quality Measures on February 1, 2008, February 1, 2009, and February 1, 2010, Stratified by Race

	February 1, 2008	February 1, 2009	February 1, 2010	P Value*
Female, no. (%)				
White	4,163/5,972 (70)	4,241/6,141 (69)	4,149/6,060 (68)	0.76
Black	2,389/2,947 (81)	2,484/3,065 (81)	2,490/3,092 (81)	
P value†	<0.001	<0.001	<0.001	
Age, mean (SD), years				
White	54.9 (19.7)	55.7 (19.3)	56.6 (19.4)	0.48
Black	54.8 (25.9)	55.6 (25.3)	56.3 (25.6)	
P value†	0.82	0.87	0.36	
Number of chronic medical conditions, ‡mean (SD)				
White	0.97 (0.015)	1.03 (0.015)	1.10 (0.015)	0.92
Black	1.36 (0.022)	1.42 (0.022)	1.48 (0.023)	
P value†	<0.001	<0.001	<0.001	

P value for race-time interaction term from linear regression models (for age and number of chronic medical conditions) and logistic regression model (for gender) with time, race, and an interaction term for time and race as the independent variables

†*P value for comparison of white and black patients at each time point using chi-square test for categorical variables and t-test for continuous variables*

‡*Number of chronic medical conditions is based on a count of ten chronic disease categories, nine categories included in the 2008 Dartmouth Atlas of Health Care (cancer, chronic pulmonary disease, coronary artery disease, congestive heart failure, peripheral vascular disease, severe chronic liver disease, diabetes, renal failure, and dementia) and hypertension*

Changes in Quality of Care for White and Black Patients

Quality of care improved for 14 of 17 measures for white patients and 10 of 17 measures for black patients over the 2 years following the implementation of the quality improvement initiative (Table 3). For five of the eight process of care measures, quality improved for both white and black patients, and for three of these measures the rate of improvement in quality was at least as high for black patients as for white patients. For the remaining three process of care measures, improvements in quality were seen only among white patients. Of the four intermediate outcome measures, there were no measures for which improvements in quality were seen among both white and black patients. For two intermediate outcome measures quality improved for white patients only (glycemic control and LDL control for patients with diabetes), for one measure quality improved for black patients only (blood pressure control for patients with diabetes), and for one measure quality improved for neither group (blood pressure control for patients with hypertension). Quality improved for both white and black patients for four of the five preventive care measures, and the rate of improvement was at least as high for black patients as for white patients for all four measures. The percentage of patients up to date on breast cancer screening declined among both white and black patients.

Changes in Disparities Between White and Black Patients

There were racial disparities in quality for 7 of the 17 measures at baseline (Table 4). This included two process of care measures, one intermediate outcome measure, and four preventive care measures. The disparities ranged in absolute magnitude from 4.0% for pneumococcal vaccination to 12.3% for osteoporosis screening or treatment.

Racial disparities narrowed for two of the seven measures: the prescription of antiplatelet therapy for patients with coronary heart disease and colorectal cancer screening (Table 4). There were no significant changes in disparities for four of the seven measures, and racial disparities increased by 2.8% per year for the achievement of LDL control among patients with diabetes.

The racial difference in quality widened for two measures that did not have racial disparities at baseline: the prescription of beta-blockers to patients with a history of myocardial infarction and glycemic control

DISCUSSION

Understanding the effects of generalized and HIT-supported quality improvement initiatives on health care disparities is important given the pervasiveness of disparities and nation-

Table 3. Baseline Performance and Change in Performance for Chronic Disease Process of Care, Intermediate Outcome, and Preventive Care Measures, Stratified by Race

Measure	Baseline performance no. satisfied/no. eligible (%)		Modeled rate of change in performance % per year (95% CI)	
	White	Black	White	Black
Chronic disease process of care measures				
Antiplatelet drug prescribed for patients with coronary heart disease	570/627 (90.9)	246/293 (84.0)		
Months 0–7			6.6 (5.0–8.2)	17.8 (12.8–22.9)
Months 8–24			0.8 (0.3–1.3)	0.3 (−1.9–2.5)
Lipid-lowering drug prescribed for patients with coronary heart disease	582/655 (88.9)	240/293 (81.9)	2.8 (1.7–3.8)	4.3 (1.5–7.0)
Beta-blocker prescribed for patients with a history of myocardial infarction	98/111 (88.3)	50/57 (87.8)	2.4 (0.3–4.6)	0.6 (−2.1–3.4)
ACEI or ARB prescribed for patients with coronary heart disease and diabetes	137/166 (82.5)	93/106 (87.7)	5.8 (5.1–6.5)	2.1 (0.4–3.9)
Anticoagulant prescribed for patients with heart failure and atrial fibrillation	45/75 (60.0)	21/32 (65.6)	8.7 (0.6–16.7)	9.1 (4.9–13.3)
ACEI or ARB prescribed for patients with heart failure with LVSD	115/136 (84.6)	92/109 (84.4)	4.3 (3.8–4.9)	1.4 (−2.9–5.6)
Beta-blocker prescribed for patients with heart failure with LVSD	107/133 (80.5)	92/109 (84.4)	7.4 (6.2–8.5)	4.3 (1.9–6.7)
Screening or treatment for diabetic nephropathy	581/720 (80.7)	532/628 (84.7)	3.2 (1.5–4.9)	1.1 (−0.3–2.5)
Intermediate outcome measures				
Blood pressure control for patients with hypertension	1,433/1,722 (80.9)	911/1,142 (79.8)	0.9 (−0.7–2.5)	0.9 (−1.3–3.1)
Glycemic control for patients with diabetes	492/720 (68.3)	400/628 (63.7)	1.5 (0.5–2.6)	−0.2 (−1.0–0.7)
Blood pressure control for patients with diabetes	354/528 (67.1)	261/406 (64.3)	2.5 (−0.4–5.4)	1.9 (0.6–3.3)
LDL control for patients with diabetes	348/628 (55.4)	255/518 (49.2)	3.3 (2.2–4.4)	0.4 (−1.7–2.5)
Preventive care measures				
Pneumococcal immunization	1,299/1,595 (81.8)	504/651 (77.3)	5.9 (4.6–7.3)	8.4 (3.3–13.7)
Osteoporosis screening or treatment	745/911 (82.0)	375/540 (69.4)	5.1 (4.6–5.6)	5.5 (4.3–6.8)
Colorectal cancer screening	2,373/3,552 (66.8)	1,072/1,742 (61.5)	3.1 (2.1–4.1)	5.0 (3.6–6.4)
Cervical cancer screening	2,571/3,094 (83.1)	1,388/1,675 (82.9)	2.3 (1.9–2.8)	2.4 (1.3–3.5)
Breast cancer screening	1,408/1,691 (83.3)	851/1,093 (77.9)	−2.4 (−3.1–-1.6)	−3.3 (−4.5–-2.1)

Abbreviations: ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; LVSD, left ventricular systolic dysfunction; LDL, low-density lipoprotein cholesterol.

wide efforts to promote the adoption of HIT, and this study provides several key insights. First, the implementation of a generalized, HIT-supported, and provider-directed quality improvement initiative was associated with the narrowing of disparities for two of the seven measures with baseline disparities. Even when baseline disparities persisted, in general, the quality of care improved for both groups. Importantly, for measures with no disparities at baseline, the direction of the change in quality following the implementation of the quality improvement initiative was the same for black and white patients in most cases, and there were few new disparities.

Second, the changes in quality following the implementation of the quality improvement initiative tended to differ for intermediate outcome measures compared to process of care and preventive care measures. Quality improved for black and white patients for five of eight process of care measures, four of five preventive care measures, but none of the four intermediate outcome measures. In addition, the improvements in quality tended to be smaller for intermediate outcome measures compared to process of care and preventive care measures. Furthermore, it is notable that two of the three measures for which disparities widened were intermediate measures of disease control: glycemic control and LDL control for patients with diabetes. In both cases, the percentage of patients satisfying the measure improved for white patients only, resulting in a new, albeit small disparity.

Taken together, these findings suggest that generalized and provider-directed HIT tools are likely to have some positive effects on health disparities, particularly for chronic disease process of care measures and preventive care measures. However, in order to achieve more substantial improvements in health care equity, particularly in regards to important measures of disease control, additional strategies, such as tools to improve patient engagement,[23,24] patient-physician communication,[25,26] and access to care[10,20] as well as systems-oriented strategies to improve care delivery will still be needed.

The breast cancer screening measure is the only one for which there was a decline in quality, making it an anomalous case that merits discussion. At approximately the same time that the UPQUAL initiative began, we began to have very long delays (more than 6 months) in scheduling screening mammograms at our institution due to a regional shortage of trained radiologists. Despite efforts to refer women to other sites for mammography, there was a decline in the proportion of white and black women who were up to date on breast cancer screening.

This study has several important limitations. As a single institution study, the results may not be generalizable to other types of settings. We only examined differences between white and black patients, and we used a simple measure of comorbidity with no adjustment for severity of illness to explore differences in patient characteristics by race. We did not adjust our threshold for statistical significance for multiple comparisons. However, as most of the p-values for statistically significant results were <0.001, we do not believe this would have affected our results significantly. In some cases, adherence to quality measures was very high at baseline, particularly for white patients; therefore, the narrowing of disparities for some measures could have been due in part to a ceiling effect (e.g., the rate of improvement was lower for white compared to black patients because white patients had less room for

Table 4. Baseline Disparities and Changes in Disparities Between White and Black Patients for Chronic Disease Process of Care, Intermediate Outcome, and Preventive Care Measures

Measure	Baseline disparity in performance,* % (95% CI)	Modeled rate of change in disparity† % per year (95% CI)
Chronic disease process of care measures		
Antiplatelet drug prescribed for patients with coronary heart disease	7.0 (2.6–11.3)	
Months 0–7		−10.9 (−16.6–-5.2)
Months 8–24		0.5 (−1.7–-2.7)
Lipid-lowering drug prescribed for patients with coronary heart disease	6.9 (2.3–11.6)	−1.6 (−3.3–0.0)
Beta-blocker prescribed for patients with a history of myocardial infarction	0.6 (−9.9–11.1)	2.3 (0.5–4.2)
ACEI or ARB prescribed for patients with coronary heart disease and diabetes	−5.2 (−14.1–3.7)	3.7 (2.2–5.1)
Anticoagulant prescribed for patients with heart failure and atrial fibrillation	−5.6 (−26.1–14.9)	0.2 (−4.0–4.5)
ACEI or ARB prescribed for patients with heart failure with LVSD	0.2 (−9.0–9.4)	2.1 (−1.6–5.8)
Beta-blocker prescribed for patients with heart failure with LVSD	−4.0 (−13.7–5.8)	2.9 (0.7–5.1)
Screening or treatment for diabetic nephropathy	−4.3 (−8.1–0.0)	1.7 (1.0–2.3)
Intermediate outcome measures		
Blood pressure control for patients with hypertension	1.1 (−1.9–4.0)	−0.1 (−0.9–0.7)
Glycemic control for patients with diabetes	4.6 (−0.4–9.7)	1.8 (1.3–2.2)
Blood pressure control for patients with diabetes	2.8 (−3.4–8.9)	0.05 (−1.9–2.0)
LDL control for patients with diabetes	6.2 (0.4–12.0)	2.8 (0.2–5.4)
Preventive care measures		
Pneumococcal immunization	4.0 (0.4–7.6)	−1.5 (−4.2–1.1)
Osteoporosis screening or treatment	12.3 (7.9–16.8)	−0.5 (−1.7–0.6)
Colorectal cancer screening	5.3 (2.5–8.0)	−2.2 (−2.7–-1.3)
Cervical cancer screening	0.2 (−2.0–2.5)	0.02 (−0.8–0.8)
Breast cancer screening	5.4 (2.4–8.4)	0.9 (−0.6–2.4)

Disparity is defined as the percentage of white patients satisfying the measure minus the percentage of black patients satisfying the measure

†*A positive integer indicates that the rate of change in the proportion of patients satisfying the measure is higher for white vs. black patients. A negative integer indicates that the rate of change in the proportion of patients satisfying the measure is higher for black vs. white patients*

Abbreviations: ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; LVSD, left ventricular systolic dysfunction; LDL, low-density lipoprotein cholesterol

improvement). Furthermore, while we have demonstrated that changes in disparities followed the implementation of the quality improvement initiative, we cannot prove causality because of the quasi-experimental study design. However, we believe that a causal link is likely for several reasons. First, although black and white patients differed in some characteristics at baseline, the changes in key characteristics were similar for black and white patients over the study period. Therefore, we do not believe that changes in patient population over time contributed significantly to the observed changes in disparities. Second, no other major quality improvement initiatives (e.g., pay-for-performance incentives, changes in care team structure) were going on during the study period. Finally, the improvements in quality observed during the study period were greater than those expected based on temporal trends for most measures.[21]

Nonetheless, this study has several strengths and provides important evidence regarding the effects of HIT-supported quality improvement initiatives on disparities in ambulatory care. This study evaluated a very common form of quality improvement—clinical decision support and provider feedback—delivered via a commercially available and widely used EHR system that aimed to improve a range of ambulatory quality indicators. Thus, the findings should be relevant to a wide range of practices with comprehensive EHRs. Overall, we demonstrated that generalized and provider-directed quality improvement efforts can lead to reductions in disparities across several areas of preventive and chronic disease care, but will not be sufficient for achieving health care equity. Efforts focusing on other levels of the health care system (e.g., patients, heath care organizations, and payment/regulatory systems) and efforts focusing specifically on disparity reduction will still be needed. Moreover, we demonstrated that we do not need to wait until all the challenges surrounding the collection of patients' racial/ethnic data are resolved and the full implementation of "meaningful use" is completed in order to make meaningful steps towards advancing health care equity.[27]

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