JAMA | Original Investigation | INNOVATIONS IN HEALTH CARE DELIVERY

Association of Integrated Team-Based Care With Health Care Quality, Utilization, and Cost

Brenda Reiss-Brennan, PhD, APRN; Kimberly D. Brunisholz, PhD; Carter Dredge, MHA; Pascal Briot, MBA; Kyle Grazier, PhD; Adam Wilcox, PhD; Lucy Savitz, PhD; Brent James, MD, MStat

IMPORTANCE The value of integrated team delivery models is not firmly established.

OBJECTIVE To evaluate the association of receiving primary care in integrated team-based care (TBC) practices vs traditional practice management (TPM) practices (usual care) with patient outcomes, health care utilization, and costs.

DESIGN A retrospective, longitudinal, cohort study to assess the association of integrating physical and mental health over time in TBC practices with patient outcomes and costs.

SETTING AND PARTICIPANTS Adult patients (aged ≥18 years) who received primary care at 113 unique Intermountain Healthcare Medical Group primary care practices from 2003 through 2005 and had yearly encounters with Intermountain Healthcare through 2013, including some patients who received care in both TBC and TPM practices.

EXPOSURES Receipt of primary care in TBC practices compared with TPM practices for patients treated in internal medicine, family practice, and geriatrics practices.

MAIN OUTCOMES AND MEASURES Outcomes included 7 quality measures, 6 health care utilization measures, payments to the delivery system, and program investment costs.

RESULTS During the study period (January 2010-December 2013), 113 452 unique patients (mean age, 56.1 years; women, 58.9%) accounted for 163 226 person-years of exposure in 27 TBC practices and 171 915 person-years in 75 TPM practices. Patients treated in TBC practices compared with those treated in TPM practices had higher rates of active depression screening (46.1% for TBC vs 24.1% for TPM; odds ratio [OR], 1.91 [95% CI, 1.75 to 2.08), adherence to a diabetes care bundle (24.6% for TBC vs 19.5% for TPM; OR, 1.26 [95% CI, 1.11 to 1.42]), and documentation of self-care plans (48.4% for TBC vs 8.7% for TPM; OR, 5.59 [95% CI, 4.27 to 7.33]), lower proportion of patients with controlled hypertension (<140/90 mm Hg) (85.0% for TBC vs 97.7% for TPM; OR, 0.87 [95% CI, 0.80 to 0.95]), and no significant differences in documentation of advanced directives (9.6% for TBC vs 9.9% for TPM; OR, 0.97 [95% CI, 0.91 to 1.03]). Per 100 person-years, rates of health care utilization were lower for TBC patients compared with TPM patients for emergency department visits (18.1 for TBC vs 23.5 for TPM; incidence rate ratio [IRR], 0.77 [95% CI, 0.74 to 0.80]), hospital admissions (9.5 for TBC vs 10.6 for TPM; IRR, 0.89 [95% CI, 0.85 to 0.94]), ambulatory care sensitive visits and admissions (3.3 for TBC vs 4.3 for TPM; IRR, 0.77 [95% CI, 0.70 to 0.85]), and primary care physician encounters (232.8 for TBC vs 250.4 for TPM; IRR, 0.93 [95% CI, 0.92 to 0.94]), with no significant difference in visits to urgent care facilities (55.7 for TBC vs 56.2 for TPM; IRR, 0.99 [95% CI, 0.97 to 1.02]) and visits to specialty care physicians (213.5 for TBC vs 217.9 for TPM; IRR, 0.98 [95% CI, 0.97 to 0.99], *P* > .008). Payments to the delivery system were lower in the TBC group vs the TPM group ($3400.62 for TBC vs $3515.71 for TPM; β, −$115.09 [95% CI, −$199.64 to −$30.54]) and were less than investment costs of the TBC program.

CONCLUSIONS AND RELEVANCE Among adults enrolled in an integrated health care system, receipt of primary care at TBC practices compared with TPM practices was associated with higher rates of some measures of quality of care, lower rates for some measures of acute care utilization, and lower actual payments received by the delivery system.

JAMA. 2016;316(8):826-834. doi:10.1001/jama.2016.11232

Editorial page 822

Supplemental content

CME Quiz at jamanetworkcme.com and CME Questions page 876

Author Affiliations: Intermountain Healthcare, Salt Lake City, Utah (Reiss-Brennan, Brunisholz, Dredge, Briot, Wilcox, Savitz, James); Institut Driot et Sante, Paris, France (Briot); University of Michigan, Ann Arbor (Grazier).

Corresponding Author: Brenda Reiss-Brennan, PhD, Intermountain Healthcare, 36 S State, Salt Lake City, UT 84111 (brenda.reiss-brennan@imail.org).

Limited evidence is available to support the utility of medical home and accountable care integration with mental health and primary care teams.[1-4] In 2000, Intermountain Healthcare (hereafter referred to as Intermountain), a fully integrated delivery system, attempted to address this evidence gap by incorporating physical and mental health interdisciplinary teams in patient care.[5,6] The Intermountain Mental Health Integration (MHI) program is an essential component of preventive medicine and chronic disease management. This program has been deployed within local clinics[7,8] and has been sustained across diverse primary care practices (family medicine, pediatrics, and internal medicine) over the past 16 years. Preliminary evidence suggests that patients treated at MHI clinics compared with traditional practice management (TPM) clinics (ie, usual care) have higher satisfaction, improved quality outcomes, reduced cost for the health care system, and decreased utilization.[7,8]

In 2010, the MHI team structure provided the foundation for personalized primary care and sought to standardize the team-based care (TBC) strategy for population health management, expand nursing care management resources, and adhere to national medical home guidelines. Although the benefit of a team approach appeared promising,[4,9-11] additional evidence was needed to support its value within a large delivery system. The objective of this study was to evaluate the association of receiving primary care in TBC practices vs TPM practices with patient outcomes, health care utilization, and costs.

Methods

Study Design

A retrospective, longitudinal, cohort study was conducted to assess quality, hospital utilization, and cost outcomes associated with receipt of primary care in TBC practices. Adult patients (aged ≥18 years) were identified from unique Intermountain primary care practices over the observation period of 2003 through 2013 using Intermountain's enterprise data warehouse to query patient health information. Patients were included if they met the following criteria: (1) patients had to have at least 1 outpatient visit with a primary care physician (family medicine, internal medicine, geriatric, or pediatric specialty) during 2003 through 2005 and (2) a continuous service encounter from an Intermountain delivery location (either acute, ambulatory, radiologic, or laboratory services) at least once a year for each of the 10 years during the observation period (**Figure**). This extended duration was necessary to ensure that the clinics that adopted the TBC approach could implement it from an organizational perspective. Outcomes for patients with continuous encounters were assessed between 2010 and 2013 to determine the differences associated with their exposure to TBC compared with TPM. (Figure).

Exposure

TBC integrating physical and mental health was adopted and routinized over time in an attempt to improve quality outcomes compared with TPM for patients treated in internal medicine, family practice, and geriatric practices. Individual patients were assigned annually to TPM or TBC exposure based on the primary care practice visited. Practices were annually classified by Intermountain Medical Group leadership during the 4-year period of 2010 through 2013 using an MHI team scorecard administered according to the standardized MHI care process model[12] and a modified patient-centered medical home assessment based on the National Committee for Quality Assurance (NCQA) recognition. Furthermore, TPM practices had not implemented any components of MHI or NCQA elements toward a team care redesign and were designated as TPM (no-TBC). TBC practice status was achieved if teams satisfied coordinated care process goals defined by the 5 MHI components and 3 NCQA levels (eFigure 1 in the Supplement).

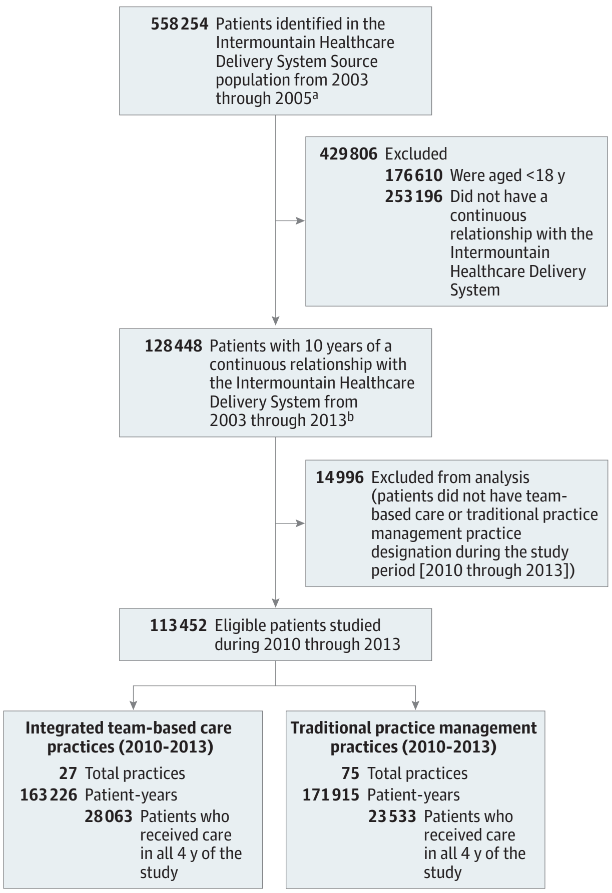
The MHI components (leadership and culture, clinical workflow, information system, financing and operations, and community resources) and NCQA levels guide clinic teams through planning, adoption, and routinized phases of TBC.[13] The interdisciplinary clinical team was organized around the primary care physician and monitored by the operations manager. Each team member was trained in specific responsibilities that contributed to a collective holistic patient care plan with measureable outcomes. Communication and shared decision making followed standardized care process model protocols and was linked by a common electronic medical record.[14,15] Process level clinical support was derived from longitudinal, disease-specific patient registries that tracked clinical and financial data for each patient. The core attributes of practices that achieved TBC included engaged physicians who have embraced normalizing mental health[7] and NCQA accreditation, care coordination for chronic disease with established routine workflows and protocols, knowledge of team roles with consistent use of standard assessment and decision support tools, communication through electronic medical records, patient engagement in care planning, and outreach to family and community. Patients who received TBC had access to accountable team members who were knowledgeable in addressing the complexity of their health concerns.

Baseline Patient Characteristics

Patients who received care in TBC practices and TPM practices were compared based on patient and clinical characteristics that existed prior to the study period (January 1, 2010). These included demographic information (age, sex, race/ethnicity, yearly payer status) and clinical characteristics (history of depression, diabetes, coronary heart disease, congestive heart failure, atrial fibrillation, high blood pressure, or cancer) (eTable 1 in the Supplement).

The Charlson Comorbidity Index[16] was used as a proxy for the number of chronic conditions. The number of years of patient exposure to routinized MHI was calculated prior to the study period (2003-2009) to adjust for previous MHI exposure, which may have been related to positive outcomes during the study period. Patients' sources of payment for services were recorded as self-pay or uninsured, Medicaid, Medicaid contracted, Medicare, Medicare contracted, other commercial, and Intermountain insurance plan (SelectHealth); patient payer was determined by assigning a patient's

Figure. Flow of Patients Through Study, Inclusion and Exclusion



TBC, team-based care; TPM, traditional practice management.

[a] Patients who had at least 1 outpatient visit with a primary care physician (family medicine, internal medicine, geriatric, or pediatric specialty) during the period of 2003-2005.

[b] Patients who had at least 1 outpatient visit with a primary care physician (family medicine, internal medicine, geriatric, or pediatric specialty) during the period of 2003-2005 and a continuous service encounter from an Intermountain delivery location (either acute, ambulatory, radiologic, or laboratory services) at least once a year for each of the 10 years in the baseline period.

insurance status together with the largest total annual payer category-based ambulatory and hospital charges.

Intermountain is organized as a geographic "center of excellence" model, based on historic travel and referral patterns. Each of its 5 geographic regions is anchored by hospitals, specialty and primary care clinics, and home health. Practice locations were stratified based on locally defined organizational regions. In addition, practices were stratified based on their referral pattern specialty (ie, family medicine, internal medicine, geriatrics, or pediatrics). All data were checked using both internal (ie, data measures were assessed for outliers and erroneous values using summary statistics for frequency and data distributions) and external (ie, a random selection of approximately 100 records were checked against the electronic medical records and internal patient registries) data validation processes.[17]

Outcomes Measures

Quality, Utilization, and Cost

Quality performance measures were determined by the primary care clinical program and derived from Intermountain data sources as target goals for measuring quality improvement and care process model adherence. Patients were screened and treated for depression according to the standardized depression and MHI care process model[12,18] and monitored through a longitudinal depression registry.

For patients diagnosed with diabetes,[19] all 5 components of the Intermountain diabetes bundle were required for patient adherence and included (1) a retinal eye examination performed in the previous 2 years, (2) a nephropathy screening or prescription of angiotensin-converting enzyme or angiotensin receptor blocker performed in the last year, (3) blood pressure lower than 140/90 mm Hg, (4) low-density lipoprotein level lower than 100 mg/dL, and (5) glycated hemoglobin level lower than 8.0% of total hemoglobin. For patients with hypertension, a blood pressure of less than 140/90 mm Hg based on the most recent outpatient visit was required to have blood pressure considered to be controlled. Annual primary care visits, documentation of advanced directives, and self-care plans for identified chronic diseases (ie, diabetes, depression) were collected for the TBC process goals.

Intermountain's enterprise data warehouse was queried for all hospital admission data, emergency department visits, and ambulatory visits (primary care, specialty care, and urgent care clinics). The number of ambulatory care-sensitive hospital admissions in combination with emergency department visits were calculated according to formulas developed by the National Quality Forum and Agency for Healthcare Research and Quality[20] using select admissions or visits that could be avoided if sufficient primary care was provided.

Cost of care was assessed as actual payments received by the delivery system from all payers and patients during the study period (2010-2013). The aggregated payments included all of the following services performed within the Intermountain delivery system: acute care, ambulatory care, laboratory, and radiology services. Because variation in payment exists among payers, this was stratified by the insurance type. The enterprise data warehouse provided diagnoses and procedure codes and Intermountain's financial data, which included total payments received from the insurance company and the patient. Cost of care was calculated from actual payments received and investment costs of the program.

Investment Costs of the TBC Program

Investment costs were computed based on actual expenses incurred during the study period (2010-2013). Data were obtained from internal payroll, accounting, and asset management data systems. Annual costs were divided into 2 categories: one-time transition costs and ongoing operational costs. All transition costs were conservatively treated as expenses in the year incurred. One-time transition costs included clinic or infrastructure expansions, phones, and computers. Infrastructure for all practices was continually added each year until they reached a stable state in 2013, which was used as a total investment cost of the program, including practices that had not reached TBC during the study period.

Ongoing operational costs included labor expenses, care coordination payments, and quality incentives. Labor expenses included additional salaries of nurse care managers, medical assistants, and mental health providers. Care coordination payments consisted of monthly per-member payments made to the TBC clinics based on the number of attributed members to each TBC clinic. Quality incentives consisted of lump sums paid to the TBC clinic annually based on quality performance. Care coordination payments and quality incentives were treated as deployment costs because they were only provided by Intermountain's own insurance company and, as such, these payments and incentives represented a cost of running the program.

Statistical Analysis

Generalized estimating equations were used to test the null hypothesis that quality, utilization, and reimbursement costs were not different among patients who received care in TBC practices compared with TPM practices.[21,22] The unit of analysis for this study was person-years of exposure. Each model was adjusted for quality, utilization, and cost outcomes based on patient demographic characteristics (age, sex, race/ethnicity), patient comorbidities (Charlson Comorbidity Index),[16] geographical region of care, type of insurance, number of years of routinized MHI prior to the study period (2003-2009), and the previous year of TBC implementation exposure.

Models were derived using robust standard errors to account for heteroscedasticity, colinearity, autocorrelation within observations, and patient clustering among practices. Because these statistical methods may be sensitive to missing data, and to avoid any potential bias related to missing data, only patients who had annual encounters with the Intermountain delivery system (2003-2013) were included (missing data for the patient cohort was less than 1%). Sensitivity analyses (ie, inclusion and exclusion of covariables and their perceived relationship to independent and dependent variables within statistical models) and postestimation (ie, confirmation of the correlation matrix structure and Hausman model specification test) were used to ensure validity of the models.

For measures of quality, a multivariable logistic analysis was fit using generalized estimating equations to derive odds ratios (ORs). When evaluating the association of utilization in acute and ambulatory settings, a Poisson distribution was used to calculate the incidence rate, defined by the number of incident events (ie, emergency department visits or admissions to the hospital) adjusted by the total person-years at risk. A linear analysis was fit with a generalized estimating equation when determining the association of costs with exposure. Due to the non-normal distribution of the dependent variable, models were adjusted using a γ distribution. We took the point estimate and applied or normalized the number of TPM events and percentages using the number of TBC events and percentage multiplied by the OR divided by the incidence rate ratio (IRR).

All outcome measures were defined a priori based on Intermountain's clinical program board goals for quality. Post hoc, stratified subgroup analyses were performed using these measures to identify meaningful differences among selected populations (patients with depression, diabetes, differing insurance payers, and by the number of chronic diseases). To corroborate findings post hoc, stratified analysis was performed to compare clinical and utilization outcomes for patients who received care only in TBC with patients who received care in only TPM practices over all 4 years of the study (ie, from practices that did not change designation as TBC or TPM over the 4-year study period).

Because the association of receiving care in TBC practices and in TPM with measures of quality, health care utilization, and reimbursements costs are 3 independent tests of change, multiple comparison adjustments were performed within categories for multiple measures.[23] For the primary analyses, *P* values are presented with a Bonferroni correction for multiple comparisons defined as .05 divided by the count of independent tests of hypotheses in each measurement category. Thus, for outcomes related to quality of care and health care utilization, a *P* value of less than .008 (.05 divided by 6 independent tests each) was needed to attain statistical significance. For the hypothesis related to decreasing actual payments to the system at *P* value of .05 or less (only 1 measure studied) was required to reach statistical significance. There was not a prespecified power estimate and statistical analysis were not performed for differences in baseline characteristics. All analyses were performed in Stata (StataCorp), version 12.0, and hypothesis testing was 2-sided.

Results

Identifying the Patient Cohorts

Of the 113 practices observed over the study period (2010-2013), 102 practices were classified annually as TBC (n = 27) or TPM (n = 75). Of the TBC practices, 12 practices (44%) were TBC practices for all 4 study years (2010-2013), whereas of the TPM practices, 20 practices (27%) were TPM practices for all 4 study years (**Table 1**). Eleven practices were classified in planning or adoption phases of TBC for the entire study period. The number of practices increased during the study period from 91 in 2010 to 113 in 2013 due to the growth of Intermountain Medical Group and the subdivision of larger practices. Subsequently, the same patients included in the analysis of outcomes could have accessed a greater number of practices.

During the baseline period for identification of the cohort (2003-2005), 558 254 patients had at least 1 outpatient visit with a primary care physician (family medicine, internal medicine, geriatric, or pediatric) within the Intermountain delivery system (Figure). Of these patients, 429 806 patients were excluded (176 610 who were younger than 18 years at the time of study enrollment and 253 196 who did not have a continuous relationship of 10 years and older with the Intermountain delivery system). Of the remaining 128 448 patients, 14 996 were attributed to practices that were in planning or adoption phases and did not have TBC or TPM exposure during the study period (2010-2013). The remaining 113 452 patients included over the

Table 1. Patient Participation and Involvement of Practices Within the TBC and TPM Groups Over the Study Period (2010-2013)

	All 4 Years	3 Years	2 Years	1 Year	Total
Patient Participation[a]					
TBC, No. of patients (% of person-years)	28 063 (69)	5196 (10)	5249 (6)	24 888 (15)	163 226
TPM, No. of patients (% of person-years)	23 533 (54)	12 827 (23)	11 149 (13)	17 004 (10)	171 915
Practice Involvement[b]					
TBC, No. of practices (%)	12 (44)	2 (7)	2 (7)	11 (41)	27
TPM, No. of practices (%)	20 (27)	19 (25)	18 (24)	18 (24)	75

Abbreviations: TBC, team-based care; TPM, traditional practice management.

[a] Of the 128 448 patients who had a consistent relationship with the delivery system, 14 996 patients did not have TBC or TPM exposure (only planning or adoption TBC) during the study period of 2010-2013. Only the remaining 113 452 patients (TBC, 163 226 person-years; TPM, 171 915 person-years) were included in the analysis.

[b] Of the 113 total practices were studied over the period of 2010-2013, 102 practices were designated as TBC (n = 27) and TPM (n = 75). Eleven practices were designated as planning or adoption TBC throughout the entire study period 2010-2013.

study accounted for 163 226 person-years of TBC exposure at 27 TBC practices and 171 915 person-years of TPM care at 75 TPM practices (some patients received care in both TBC and TPM practices, and contributed person-time to both groups). Of patients in these groups, 28 063 patients (69% of total person-years) were exposed to TBC and 23 533 patients (54% of total patient years) were exposed to TPM for all 4 years of the study period. Patient exposure and practice shifts over the study period are shown in Table 1. Mean patient follow-up in the TBC and TPM groups was 8.5 years (95% CI, 8.50 to 8.50) for TBC and 8.6 years (95% CI, 8.60 to 8.62) for TPM.

Patient and Practice Cohort Characteristics

Baseline demographics and clinical and practice characteristics are summarized in **Table 2**. There were no clinical differences in age, race/ethnicity, or insurance type among the cohorts. Patients in the TPM group were more likely to be women and had little to no exposure to TBC implementation prior to the study period. Patients in the TBC group had more chronic diseases, including high blood pressure, depression (specifically active depression), and diabetes, as well as higher Charlson Comorbidity Index scores. Practice specialty differences were present for TBC and TPM practices. Years of exposure to MHI at baseline were different for TBC and TPM practices (Table 2).

Quality Measures

All quality measures were adjusted for multiple comparisons with a significance level of a *P* value of .008 or less. Receipt of care in TBC practices compared with TPM practices, was associated with significantly higher rates of quality measures, including screening for depression among patients with active depression (46.1% for TBC vs 24.1% for TPM; OR, 1.91 [95% CI, 1.75 to 2.08], *P* < .001), adherence to a 5-part diabetes bundle (24.6% for TBC vs 19.5% for TPM; OR, 1.26 [95% CI, 1.11 to 1.42], *P* < .001), and documentation of self-care plans (48.4% for TBC vs 8.7% for TPM; OR, 5.59 [95% CI, 4.27 to 7.33], *P* < .001). Significant differences were observed among the proportion of patients with controlled hypertension below the recommended cutoff of 140/90 mm Hg (85.0% in the TBC group vs 97.7% in the TPM group; OR, 0.87 [95% CI, 0.80 to 0.95], *P* = .002) and the proportion of patients with an annual visit with a primary care physician (84.2% in the TBC group vs 77.2% in the TPM group; OR, 1.09 [95% CI, 1.03 to 1.15], *P* = .002). No significant difference was observed in the documentation of advanced directives between the 2 groups (9.6% in the TBC group vs 9.9% in the TPM group; OR, 0.97 [95% CI, 0.91 to 1.03], *P* = .28) (**Table 3**). Post hoc stratified analysis comparing outcomes for patients who received care only in TBC with patients who received care in only TPM practices over all 4 years of the study showed that TBC was also associated with higher rates of quality measures (screening for depression, *P* < .001; documented self-care plans, *P* < .001; and annual visit with a primary care physician, *P* < .001), but no significant difference in adherence to the diabetes bundle (eTable 3 in the Supplement).

Service Utilization Measures

All utilization measures were adjusted for multiple comparisons with a significance level of *P* value of .008 or less. Compared with patients receiving care in TPM practices, those in TBC practices had lower rates of health care utilization (emergency visits per 100 person-years: 18.1 for TBC vs 23.5 for TPM; IRR, 0.77 [95% CI, 0.74 to 0.80], *P* < .001; hospital admissions per 100 person-years: 9.5 for TBC vs 10.6 for TPM; IRR, 0.89 [95% CI, 0.85 to 0.94], *P* < .001). Per 100 person-years, ambulatory care–sensitive admissions and emergency visits (3.3 for TBC vs 4.3 for TPM; IRR, 0.77 [95% CI, 0.70 to 0.85], *P* < .001) and encounters with primary care physicians (232.8 for TBC vs 250.4 for TPM; IRR, 0.93 [95% CI, 0.92 to 0.94], *P* < .001) were lower in the TBC group compared with the TPM group. After adjustment for multiple comparisons (significance level of *P* ≤ .008), there were no significant differences between patients in the TBC vs TPM groups in the number of visits per 100 person-years to specialty care physicians (213.5 for TBC vs 217.9 for TPM; IRR, 0.98 [95% CI, 0.97 to 0.99], *P* = .02) or visits to urgent care facilities (55.7 for TBC vs 56.2 for TPM; IRR, 0.99 [95% CI, 0.97 to 1.02], *P* = .74). In post hoc analyses, compared with patients receiving care all 4 years in TPM, those receiving care in TBC all 4 years had lower rates of health care utilization (emergency visits, *P* < .001; hospital admissions, *P* < .001; ambulatory sensitive admissions and emergency visits, *P* < .001; and encounters with primary care physicians, *P* < .001).

Table 2. Baseline Characteristics for Patients and Practices

	Study Cohort, No. of Person-Years (%)[a]		
	Entire Cohort (335 141 Person-Years)	TPM (171 915 Person-Years)	TBC (163 226 Person-Years)
Patient Demographics			
Age categories, y			
18-29	24 586 (7.34)	15 666 (9.11)	8920 (5.46)
30-39	47 929 (14.30)	28 098 (16.34)	19 831 (12.15)
40-49	52 452 (15.65)	27 981 (16.28)	24 471 (14.99)
50-59	71 514 (21.34)	35 095 (20.41)	36 419 (22.31)
60-69	64 648 (19.29)	31 295 (18.20)	33 353 (20.43)
70-79	47 703 (14.23)	22 115 (12.86)	25 588 (15.68)
≥80	26 309 (7.85)	11 665 (6.79)	14 644 (8.97)
Sex			
Men	133 409 (39.81)	64 766 (37.67)	68 643 (42.05)
Women	201 725 (60.19)	107 149 (62.33)	94 583 (57.95)
Race/ethnicity			
Caucasian	316 947 (94.57)	162 408 (94.47)	154 539 (94.68)
Asian	3487 (1.04)	1409 (0.82)	2078 (1.27)
Black	1505 (0.45)	526 (0.31)	979 (0.60)
Other/unspecified	13 202 (3.94)	7572 (4.40)	5630 (3.45)
Practice Characteristics			
No. of years routinized MHI, median (IQR)[b]	0 (0-4)	0 (0-0)	4 (0-5)
Previous year of TBC implementation exposure			
None	155 556 (46.42)	148 624 (86.45)	6932 (4.25)
Planning	5213 (1.56)	2185 (1.27)	3028 (1.85)
Adoption	44 155 (13.18)	12 738 (7.41)	31 417 (19.25)
Routinized	130 217 (38.85)	8368 (4.87)	121 849 (74.65)
Charlson Comorbidity Index score			
0	100 934 (30.12)	54 884 (36.03)	46 050 (34.19)
1	85 643 (25.55)	45 877 (26.69)	39 766 (24.36)
2 or 3	83 048 (24.78)	40 575 (23.60)	42 473 (26.02)
>3	65 516 (19.55)	30 579 (17.79)	34 937 (21.40)
Chronic conditions			
Depression	135 716 (40.50)	66 234 (38.53)	69 482 (42.57)
Active depression during y	69 864 (20.85)	31 302 (18.21)	38 562 (23.62)
Diabetes	47 083 (14.05)	21 180 (12.32)	25 903 (15.87)
Coronary heart disease	56 954 (16.99)	26 359 (15.33)	30 595 (18.74)
Congestive heart failure	29 249 (8.73)	14 027 (8.16)	15 222 (9.33)
Atrial fibrillation	22 133 (6.60)	10 452 (6.08)	11 681 (7.16)
High blood pressure	131 188 (39.14)	54 063 (31.45)	77 125 (47.25)
Cancer	20 350 (6.07)	9352 (5.44)	10 998 (6.74)
Insurance design			
Commercial	102 307 (30.53)	53 085 (30.88)	49 222 (30.16)
Medicaid	6856 (2.05)	5222 (3.04)	1634 (1.00)
Medicaid contracted	4641 (1.38)	1712 (1.00)	2929 (1.79)
Medicare	55 253 (16.49)	26 861 (15.62)	28 392 (17.39)
Medicare contracted	30 896 (9.22)	14 157 (8.23)	16 739 (10.26)
Intermountain health plan	65 435 (19.52)	30 886 (17.97)	34 549 (21.17)
Uninsured	47 876 (14.29)	25 527 (14.85)	22 349 (13.69)
Unspecified	21 877 (6.53)	14 465 (8.41)	7412 (4.54)
Practice specialty type			
Family practice	186 853 (55.75)	88 494 (51.48)	98 359 (60.26)
Internal medicine	82 149 (24.51)	18 373 (10.69)	63 776 (39.07)
Geriatric	1929 (0.58)	1929 (1.12)	0 (0.0)
Pediatric	1273 (0.38)	182 (0.11)	1091 (0.67)
Other Intermountain specialty	62 937 (18.78)	62 937 (36.61)	0 (0.0)

Abbreviation: IQR, interquartile range; MHI, mental health integration; TBC, team-based care; TPM, traditional practice management.

[a] Percentages may not sum due to rounding.

[b] Routinized MHI practices had reached highest level of MHI implementation measured across these 5 key components (leadership and culture, clinical workflow, information systems, financing and operations, and community resources) yearly.

Table 3. Outcomes for Quality Measures, Service Utilization, and Payments for Patients and Practices Using TBC and TPM Models

	No. of TBC Events (%) (163 226 Person-Years)[a]	No. of TPM Events (%) (171 915 Person-Years)[a,b]	Odds Ratio (95% CI)[c]	*P* Value[c]
Quality Measures[d]				
Intervention variables[e]				
Depression screening among patients with active depression	21 787 (46.09)	11 407 (24.13)	1.91 (1.75 to 2.08)	<.001
Adherence to diabetes bundle	6646 (24.60)	5275 (19.53)	1.26 (1.11 to 1.42)	<.001
Documented self-care plan	4263 (48.35)	763 (8.65)	5.59 (4.27 to 7.33)	<.001
Nonintervention variables[f]				
Hypertension in control (<140/90 mm Hg)	54 198 (85.00)	62 297 (97.70)	0.87 (0.80 to 0.95)	.002
Documented advanced directives	15 686 (9.61)	16 171 (9.91)	0.97 (0.91 to 1.03)	.28 (NS)
Annual visit with PCP	137 357 (84.15)	126 016 (77.20)	1.09 (1.03 to 1.15)	.002
Service Utilization[d]	**No. TBC Events (Incidence Per 100 Person-Years)**	**No. TPM Events (Incidence Per 100 Person-Years)**	**IRR (95% CI)**	
Hospital admissions	15 427 (9.45)	17 334 (10.62)	0.89 (0.85 to 0.94)	<.001
Emergency department visits	29 555 (18.11)	38 383 (23.52)	0.77 (0.74 to 0.80)	<.001
Ambulatory sensitive visits	5350 (3.28)	6948 (4.26)	0.77 (0.70 to 0.85)	<.001
PCP visits	380 036 (232.83)	408 641 (250.35)	0.93 (0.92 to 0.94)	<.001
Specialty visits	348 507 (213.51)	355 619 (217.87)	0.98 (0.97 to 0.99)	.02 (NS)
Urgent care visits	90 852 (55.66)	91 770 (56.22)	0.99 (0.97 to 1.02)	.74 (NS)
Total Payments[g]	**TBC Rate (95% CI)**[a]	**TPM Rate (95% CI)**[a]	**β (95% CI)**	
Payments received, $	3400.62 (3353.39 to 3447.85)	3515.71 (3468.48 to 3562.94)	−115.09 (−199.64 to −30.54)	.008

Abbreviations: IRR, incidence rate ratio; IQR, interquartile range, NS, nonsignificant; PCP, primary care physician; TBC, team-based care; TPM, traditional practice management.

[a] The dataset was normalized by dividing by the odds ratio for quality measures and IRR for service utilization. This adjusted factors were next multiplied by TBC percentage and events to compute the corresponding TPM values.

[b] The TPM group was the referent.

[c] Generalized estimated equations modeling included adjustment for age, sex, race/ethnicity, Charlson Comorbidity Index, geographical region of care, type of insurance, number of years of routinized MHI prior to the study period (2003-2009), and the previous year of TBC implementation exposure.

[d] For outcomes related to quality measures and service utilization, a *P* value of .008 or less must be achieved to account for multiple interrelated comparisons.

[e] Intervention variables were measures linked specifically to TBC deployment.

[f] Non-intervention variables: measures that were not directly linked to TBC deployment.

[g] Total payment needed to achieve a *P* value of .05 or less to be considered statistical significant. Outcomes not meeting this threshold were designated as nonsignificant.

Cost of Care Measures

Payments received by the Intermountain delivery system demonstrated lower overall payment with TBC vs TPM ($3400.62 for TBC vs $3515.71 for TPM; β, −$115.09 [95% CI, −$199.64 to −$30.54], *P* = .008) (Table 3). Post hoc analyses stratified by payer showed the largest reduction was associated with other commercial insurance ($3864.33 for TBC vs $4123.62 for TPM; β, −$259.29 [95% CI, −$485.36 to −$33.22], *P* = .03), and self-pay ($1239.25 for TBC vs $1389.85 for TPM; β, −$150.60 [95% CI, −$287.00 to −$14.21], *P* = .03), but no significant difference within the Medicare contracted group ($3673.54 for TBC vs $4213.34 for TPM; β, −$263.20 [95% CI, −$539.80 to $13.40], *P* = .06). Post hoc analyses stratified by the number of chronic diseases was associated with payment reductions to the delivery system that were significantly higher for all patients with at least 1 condition (range, −$191.39 to −$1349.19) for the TBC group. Further post hoc analysis stratification of chronic conditions with targeted TBC process improvement goals such as active depression ($5260.48 for TBC vs $5545.69 for TPM; β, −$285.21 [95% CI, −$501.42 to −$69.00]) and diabetes ($4841.94 for TBC vs $5179.83 for TPM; β, −$337.89 [95% CI, −$585.10 to −$90.69]) were associated with significant reduction in payments to system compared with TPM.

The overall estimated cost of the program to Intermountain during the study period (2010-2013) was $12 065 467 at $9.86 per patient annually. The highest amount of cost $22.19 per patient annually (total of $7 747 083) was observed in the last year of the program (2013) when it was fully implemented (eTable 2 in the Supplement). The investment costs of the program were lower than the reduction in payments received by the delivery system.

Discussion

In this observational study, receipt of primary care in TBC practices compared with TPM practices was associated with significantly higher rates of some quality of care measures, reductions in some measures of acute care utilization, and decreased actual payments to the delivery system from all payers and patients. Compared with TPM, TBC also was associated with improved quality of care for patients with depression and diabetes, but with decreased quality for patients with hypertension.

The study suggests the value of coordinated team relationships within a delivery system emphasizing the integration of physical and mental health care. To our knowledge, this study has observed the largest cohort of patients, physicians, or clinics involved in team-based care and longitudinally evaluated to date.[24-28] It highlights the challenge of transforming physician practice over time to function as a team and manage the complexities of population health.[29] The TBC group only accounted for 8% of Intermountain's total Medical Group patients, and there may be potential savings with further implementation particularly for chronic diseases with focused quality goals, which showed greater reduction in payments received. Primary care visits in the TBC group were lower than in the TPM group possibly due to care management outreach, whereas urgent care and specialty care visits were not significantly different between the groups. Urgent care provides 24-hour access and is in close proximity to primary care clinics potentially diverting emergency department utilization. Visits to specialty care were coordinated and followed standard protocols as clinics matured their TBC.

Deploying patient-centered medical homes involves financial investment and management attention. For example, most clinics need modifications to their buildings to house more professionals working in new arrangements. It requires additional computer hardware, software, and training. Most importantly, current insurance systems usually have no mechanisms by which TBC clinics can bill for the collaborative services of the care management nurses, psychologists, psychiatrists, advanced practice nurses, and social workers that full TBC requires.

Although the investment costs of the program were lower than the reduction in payments received by the delivery system, the implementation of TBC practices was a resource-intensive health reform initiative. It required sustained investment in leadership, clinical and analytic workforce, a robust information system, and additional quality incentives. Transforming practice culture presents continuous operational challenges of monitoring and rewarding collaboration among teams and across systems of care. The cost of implementing TBC is an ongoing investment in which outcomes that provide value to the delivery system may need to be realized over time and if supported by value-based or accountable care organization reimbursement structures could represent decreased health care expenses. Further research would be needed to address value to the patient or the community.

Limitations

This study has several important limitations. First, only the highest and lowest levels of TBC were studied to understand the relationship between practice types and outcomes. Program evaluation techniques were not used to assess the marginal benefits of elements of the multifaceted TBC intervention. Additionally, total cost of implementation may not have been fully captured because we did not measure how the observed outcomes would be attenuated by intermediate levels of team-based integration.

Second, this study was performed in a fully-integrated delivery system, and direct translation of these findings may be limited until similar incentives and support infrastructures exist elsewhere.

Third, outcomes measured in this study were evaluated over 4 years, but were specific to Intermountain's corporate objectives and clinical integration structure and had established registries that permitted longitudinal analysis; thus, only the patients with a continuous relationship or a specific disease state were studied. As such, quality, utilization, and cost outcomes were not recorded if patients received primary care outside Intermountain's system; thus care received outside of the Intermountain system was not included in the analyzed data set.

Fourth, this was an observational study, so causality cannot be determined and confounders should be considered. The implementation of TBC was studied in clinical practice settings, and the propensity to change differed among people and practices; therefore, clinic levels of adoption changed over time and patients migrated across clinics and practice types.

Fifth, due to the lack of randomization, patients contributed person-time to both TPM and TBC groups among separate years depending on the practice's level of program implementation. However, the analysis did control for MHI and TBC exposure to address this concern. During the sensitivity analysis, other covariates (ie, practice specialty) were evaluated, but not included in the final models because they did not affect the final result. Furthermore, several secondary data elements such as patient engagement, overall functional status of health, and social determinants of health have also been associated with health outcomes, but were not available for study. Future analysis could include these variables to assess association with TBC.

Sixth, given the dynamic nature of health care, another limitation relates to differences in practices that reached routinized TBC compared with others that were slower at adoption. The reasons certain practices switched to TBC are unknown and could represent important confounders for the associations observed. For example, practices that were effective at TBC may have had early-adopter characteristics that were important effect modifiers for the results and may have also influenced the persistence of the patient-clinic relationship and be more likely to engage in outreach initiatives, use registries, schedule follow-up visits with patients, etc. Likewise, the Patient Health Questionnaire-9 survey, used as both a standardized depression assessment and outcome measure was more likely to be recorded in TBC practices, leaving inadequate data available from TPM practices to compare Patient Health Questionnaire-9 changes over time.

Conclusions

Among adults enrolled in an integrated health care system, receipt of primary care at TBC practices compared with TPM practices was associated with higher rates of some measures of quality of care, lower rates for some measures of acute care utilization, and lower actual payments received by the delivery system.

ARTICLE INFORMATION

Author Contributions: Drs Reiss-Brennan and Brunisholz had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
Acquisition, analysis, or interpretation of data: Reiss-Brennan, Brunisholz, Dredge, Briot, Grazier, Wilcox, James.
Drafting of the manuscript: Reiss-Brennan, Brunisholz, Dredge, Briot, Grazier, Wilcox.
Critical revision of the manuscript for important intellectual content: All Authors.
Statistical analysis: Brunisholz, Dredge, Briot, Grazier, James.
Administrative, technical, or material support: Reiss-Brennan, Brunisholz, Briot, James.
No additional contributions: Wilcox.
Other - Design/analysis review: Savitz.
Other - Interpretation of results: Grazier.

Conflict of Interest Disclosures: All authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Dr James reports serving on the boards for the Institute of Healthcare Improvement and Ascension Healthcare; being a member of the National Academy of Medicine and Uniformed Services University of the Health Sciences; and honoraria for lectures to various academic and community-based care organizations paid to his employer. No other disclosures were reported.

Funding/Support: This research was supported by Intermountain Healthcare's Medical Group, Primary Care Clinical Program, Institute for Healthcare Leadership, Office of Research, and Office of Population Health.

Role of the Funder/Sponsor: Intermountain Healthcare sponsored this research and was responsible for the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript.

Additional Contributions: We thank the Brad Isaacson, PhD, MBA, MSF; Rajendu Srivastava, MD, MPH; Susan Gagnier, MBA and Saralee Johnston, BS (all from Intermountain Healthcare), for providing additional writing, graphic design, and editing assistance. No compensation was received for these contributions.

REFERENCES

1. Kessler R, Miller BF, Kelly M, et al. Mental health, substance abuse, and health behavior services in patient-centered medical homes. *J Am Board Fam Med*. 2014;27(5):637-644.

2. Lewis MW, Brant JO, Kramer JM, et al. Angelman syndrome imprinting center encodes a transcriptional promoter. *Proc Natl Acad Sci USA*. 2015;112(22):6871-6875.

3. AcademyHealth. Evidence roadmap. https://www.academyhealth.org/files/FileDownloads/Roadmap.BehavioralHealth.pdf. Accessed August 1, 2016.

4. Bodenheimer T. Lessons from the trenches—a high-functioning primary care clinic. *N Engl J Med*. 2011;365(1):5-8.

5. James BC, Savitz LA. How Intermountain trimmed health care costs through robust quality improvement efforts. *Health Aff (Millwood)*. 2011;30(6):1185-1191.

6. Collins C, Henson DL, Munger R, Wade T. *Evolving Models of Behavioral Health Integration in Primary Care*. New York, NY:Milbank Memorial Fund; 2010.

7. Reiss-Brennan B. Mental health integration. *J Prim Care Community Health*. 2014;5(1):55-60.

8. Reiss-Brennan B, Briot PC, Savitz LA, Cannon W, Staheli R. Cost and quality impact of Intermountain's mental health integration program. *J Healthc Manag*. 2010;55(2):97-113;discussion 113-114.

9. Ghorob A, Bodenheimer T. Sharing the care to improve access to primary care. *N Engl J Med*. 2012;366(21):1955-1957.

10. Katon WJ, Lin EH, Von Korff M, et al. Collaborative care for patients with depression and chronic illnesses. *N Engl J Med*. 2010;363(27):2611-2620.

11. Mukamel DB, Temkin-Greener H, Delavan R, et al. Team performance and risk-adjusted health outcomes in the Program of All-Inclusive Care for the Elderly (PACE). *Gerontologist*. 2006;46(2):227-237.

12. Mental Health Integration Care Process Model. Overview of mental health integration. https://intermountainhealthcare.org/ext/Dcmnt?ncid=51080953. Accessed December 1, 2015.

13. Rogers E. *Diffusion of Innovations*. 4th ed. New York, NY: The Free Press; 1995.

14. James BC, Savitz LA. How Intermountain trimmed health care costs through robust quality improvement efforts. *Health Aff (Millwood)*. 2011;30(6):1185-1191.

15. Dorr DA, Wilcox A, Donnelly SM, Burns L, Clayton PD. Impact of generalist care managers on patients with diabetes. *Health Serv Res*. 2005;40(5 Pt 1):1400-1421.

16. Quan H, Li B, Couris CM, et al. Updating and validating the Charlson comorbidity index and score for risk adjustment in hospital discharge abstracts using data from 6 countries. *Am J Epidemiol*. 2011;173(6):676-682.

17. Bayley KB, Belnap T, Savitz L, Masica AL, Shah N, Fleming NS. Challenges in using electronic health record data for CER. *Med Care*. 2013;51(8)(suppl 3):S80-S86.

18. Intermountain Healthcare. Overview of mental health integration. https://intermountainhealthcare.org/ext/Dcmnt?ncid=51080953. Accessed August 2, 2016.

19. Intermountain Healthcare. Outpatient management of adult diabetes mellitus. https://intermountainhealthcare.org/ext/Dcmnt?ncid=51061827. Accessed August 2, 2016.

20. National Quality Measures Clearing House. Ambulatory care sensitive conditions. http://www.qualitymeasures.ahrq.gov/summaries/summary/48964? Accessed August 1, 2016.

21. Twisk JWR. *Applied Longitudinal Data Analysis for Epidemiology: A Practical Guide*. Cambridge, UK: Cambridge University Press; 2003.

22. Hanley JANA, Negassa A, Edwardes MD, Forrester JE. Statistical analysis of correlated data using generalized estimating equations. *Am J Epidemiol*. 2003;157(4):364-375.

23. Veazie PJ. When to combine hypotheses and adjust for multiple tests. *Health Serv Res*. 2006;41(3 Pt 1):804-818.

24. Boult C, Reider L, Leff B, et al. The effect of guided care teams on the use of health services. *Arch Intern Med*. 2011;171(5):460-466.

25. Friedberg MW, Schneider EC, Rosenthal MB, Volpp KG, Werner RM. Association between participation in a multipayer medical home intervention and changes in quality, utilization, and costs of care. *JAMA*. 2014;311(8):815-825.

26. Reid RJ, Coleman K, Johnson EA, et al. The Group Health medical home at year two. *Health Aff (Millwood)*. 2010;29(5):835-843.

27. Rosenthal MB, Friedberg MW, Singer SJ, Eastman D, Li Z, Schneider EC. Effect of a multipayer patient-centered medical home on health care utilization and quality. *JAMA Intern Med*. 2013;173(20):1907-1913.

28. Werner RM, Duggan M, Duey K, Zhu J, Stuart EA. The patient-centered medical home. *Med Care*. 2013;51(6):487-493.

29. Osborn R, Moulds D, Schneider EC, Doty MM, Squires D, Sarnak DO. Primary care physicians in ten countries report challenges caring for patients with complex health needs. *Health Aff (Millwood)*. 2015;34(12):2104-2112.