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Primary care team communication networks, team climate, quality of care, and medical costs for patients with diabetes: A cross-sectional study

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Abstract

Background—Primary care teams play an important role in providing the best quality of care to patients with diabetes. Little evidence is available on how team communication networks and team climate contribute to high quality diabetes care.

Objective—To determine whether primary care team communication and team climate are associated with health outcomes, health care utilization, and associated costs for patients with diabetes.

Methods—A cross-sectional survey of primary care team members collected information on frequency of communication with other care team members about patient care and on team climate. Patient outcomes (glycemic, cholesterol, and blood pressure control, urgent care visits, emergency department visits, hospital visit days, medical costs) in the past 12 months for team diabetes patient panels were extracted from the electronic health record. The data were analyzed using nested (clinic/team/patient) generalized linear mixed modeling.

Participants—155 health professionals at 6 U.S. primary care clinics participated from May through December 2013.

Results—Primary care teams with a greater number of daily face-to-face communication ties among team members were associated with 52% (Rate Ratio=0.48, 95% CI: 0.22, 0.94) fewer hospital days and US$1220 (95% CI: -US$2416, -US$24) lower health-care costs per team diabetes patient in the past 12 months. In contrast, for each additional registered nurse (RN) who reported frequent daily face-to-face communication about patient care with the primary care

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practitioner (PCP), team diabetes patients had less-controlled HbA1c (Odds Ratio=0.83, 95% CI: 0.66, 0.99), increased hospital days (RR=1.57, 95% CI: 1.10, 2.03), and higher healthcare costs (β=US$877, 95% CI: US$42, US$1713). Shared team vision, a measure of team climate, significantly mediated the relationship between team communication and patient outcomes.

Conclusions—Primary care teams which relied on frequent daily face-to-face communication among more team members, and had a single RN communicating patient care information to the PCP, had greater shared team vision, better patient outcomes, and lower medical costs for their diabetes patient panels.

Keywords

communication; diabetes; nurse; primary care; social network; team; team climate

INTRODUCTION

Delivering evidence-based high-quality care for patients with diabetes (Type 1 and Type 2), a leading cause of morbidity and mortality, is a challenging public health issue. Prevalence of diabetes is 9.6% in the US population, being disproportionally high among the elderly.[1] The economic costs of diagnosed diabetes in the US are US$245 billion per year.[2]

Collaborative primary care teams are a key component of health care initiatives for chronic illness prevention and management.[3,4] Team-based diabetes care leads to better glycemic, lipid and blood pressure control, patient follow-up, patient satisfaction, lower risk for diabetes complications, better quality of life, and lower health care costs.[5–9] A meta-analysis of 66 diabetes intervention studies revealed that team-based interventions demonstrate the most robust improvements in patients' glycemic control.[10]

While emerging consensus shows that primary care teams play an important role in providing the best quality of care to patients with diabetes, little evidence exists on how teams communicate about patient care and how team climate contributes to a team's capacity to deliver high quality diabetes patient care. Communication within the team could influence diabetes patient outcomes through team coordination (i.e., management of interdependent but distinct activities involved in care provision).[11–14] Furthermore, a team's communication may contribute to the development of trust among team members performing distinct roles and provide the ability to deal with complex tasks. In addition, better communication may foster better team climate, where shared team vision and common goals contribute to patient outcomes, patient satisfaction and quality of care.[15–25] From this vantage point, teams which are more highly interconnected through timely communication may be best suited to meet the diverse needs of patients with diabetes.

This paper evaluates the patterns of primary care team communication (i.e., communication networks) in relation to team climate, patient outcomes, and associated healthcare costs for the team's diabetes patient panels. The study's theoretical model is based on the well-regarded Donabedian Structure–Process–Outcome model of health care quality.[26] Figure 1 provides a simple schematic of pathways to be assessed in this study based on the Donabedian model. We assess team communication in the "Structure" model component.

We estimate team climate as a mediator of team structure in the “Process” model component. Patient outcomes, health care utilization and associated medical costs for diabetes patient panels of the team constitute the “Outcome” model component.

METHODS

Participants

Six primary care clinics associated with a large Midwestern University participated in the study. Study sites were chosen based on consultation with the leadership of the health care system to obtain clinics that varied in location, size, and urban/rural location. Sites invited to participate were non-residency-based primary care clinics that were not currently involved in other research or quality improvement initiatives initiated by the leadership of the health care system. A total of 8 primary care clinics were invited and 6 clinics agreed to participate. The two clinics that refused participation did so for reasons of short staff and timing constraints. Among the participating clinics, two were urban clinics, 3 suburban, and 1 rural. All participating clinics had used Electronic Health Records (EHRs) for more than a decade.

Clinics employed between 3 and 11 primary care practitioners (PCPs), such as physicians, physician assistants, or nurse practitioners, with average active patient panel sizes (i.e., patients had at least 2 visits in the past 3 years) ranging from 987 to 1548 patients per PCP. The Institutional Review Board of the University of Wisconsin approved the study.

Design

Study data were collected from May to December, 2013 in a cross-sectional survey. The first author initially introduced the study procedures and provided study consent forms at an all-staff clinic meeting in participating clinics. All PCPs, registered nurses (RNs), medical assistants (MAs), licensed practical nurses (LPNs), laboratory technicians, radiology technicians, clinic managers, medical receptionists, and other patient care staff were invited to participate. Eligibility criteria included 18 years of age or older, ability to read and understand English, and employment at the study site in a patient care or patient interaction capacity. 97% (155 of 160 invited) of eligible participants took part in the study.

Data Collection Procedures

Team Member Questionnaire—Study participants completed a 30-minute face-to-face structured questionnaire administered by a trained research assistant who was not known to the study participants. The survey included the team climate inventory and sociometric survey questions referring to communication with other team members about patient care. In addition, the respondents provided individual demographic characteristics of gender, job title, percentage of full-time employment, and years working at the clinic. To minimize response bias and enhance data validity, the study team assured participants of the confidentiality and anonymity of their responses, that the data would not be shared with the clinic administration and management, and that results would be reported in aggregate format.[27,28] A more detailed description of the study questionnaire is available in Mundt et al.[29]

Active Diabetes Patient Panel of the Primary Care Team—An EHR search linked primary care teams with Type 1 and Type 2 diabetes patients age 18 and older seen by the team. To ensure continuity of care, the active patient panel consisted of patients who had at least one visit with the lead clinician in the past 12 months, and at least 2 visits in the past 36 months. Patients with visits to multiple primary care clinicians were assigned to the clinician whom they saw most frequently, or, in the case of a tie, to the clinician seen at the most recent visit. Diabetes diagnoses were determined by the presence of 2 validated ICD-9 diabetes codes (250.00–250.03, 250.10–250.13, 250.20–250.23, 250.30–250.33, 250.40–250.43, 250.50–250.53, 250-60–250.63, 250.70–250.73, 250.80–250.83, 250.90–250.93, 357.2, 362.01, 362.02, 366.41) on 2 separate occasions within the past 3 years.[30,31]

Primary Care Team Measures

Team Membership—To determine membership in a care team, clinic staff considered a team definition as 'the smallest unit of individuals within the clinic that care for a specific patient panel.' The participants indicated on a clinic staff roster who is on their care team. For the analysis, care teams were comprised of a lead PCP and all clinic employees who indicated on the survey that they belonged to that lead PCP's care team. Finally, any individual whom the PCP named as a care team member was also included in the care team.

By definition, PCPs were members of a single care team; other team members (RNs, LPNs/MAs, etc.) could belong to multiple care teams as self-reported on the team membership question. For example, an RN could indicate belonging to the care teams of multiple PCPs. In this case, care team memberships would overlap as the RN would be considered a member of each PCP-led team.

Team Communication Network Variables—Using the clinic staff roster as an aid for memory recall, clinic staff members identified how frequently they communicated about patient care with other staff members in the clinic both face-to-face and by EHR in the past 6 months.[27,32] Response options for frequency of communication included 'multiple times per day', 'daily', 'a few times per week', 'once per week', '1–2 times per month', and 'rarely/never'. Validation studies suggest that the correlation between self-reported communication and observed communication is high, with average correlation in the 0.8 range.[33]

A dichotomous (0/1) member-by-member communication matrix was created for face-to-face communication and EHR communication for each team. A connection between two team members was coded as present in the communication network (=1) if frequency of communication was reported as 'multiple times per day', or absent (=0) otherwise. We measured 6 aspects of team communication. We evaluated who communicated with whom (whole care team, RN-PCP, and RN-other team members) through face-to-face interactions and by EHR. The sum of all face-to-face and EHR communication connections present provided the total number of ties within the team, between team RNs and the PCP, and between team RNs and all other team members. This type of sociometric survey measures the connectedness within the team from the collective perspective of the team as a whole as opposed to an individual point of view.[34]

Figure 2 visually represents two primary care team face-to-face communication networks. Symbol sizes in the figure are proportional to the number of communication connections received by each member of the team. Panel A displays a team with more face-toface communication connections (45% of all possible face-to-face communication ties among all teammates present in the team) and fewer patient hospital visit days and healthcare costs (i.e., the lowest quartile among all teams). Panel B provides an example of a team with fewer face-to-face communication connections (35% of all possible face-to-face communication ties among all teammates present in the team) and more patient hospital visit days and healthcare costs (i.e., the highest quartile among all teams). Note that the RNs in the Team B team had four incoming connections each from their team members, compared to one RN in Team A who received seven communication connections from her team members (i.e., almost twice as many connections than the nurses in Team B).

Team Climate—Team climate was measured with the 14-item validated Team Climate Inventory (TCI-14), using 5-point Likert scales.[35,36] The TCI-14 includes four teamwork subscales: (1) focusing on clear and realistic goals (*shared vision*), (2) team member interactions that are participatory and interpersonally non-threatening (*psychological safety*), (3) high standards of performance and appraisal of weaknesses (*task orientation*), and (4) support for innovation attempts (*innovation support*). TCI-14 items were coded from 1 to 5 and summed to produce individual subscale scores, which were then averaged across team members. The TCI-14 has been validated in healthcare settings with subscale alphas ranging from 0.79 to 0.84.[35]

Diabetes Patient Outcome Measures from the EHR

Biometric Outcomes—The analysis constructed three dichotomous biometric outcome measures: glycemic, cholesterol, and blood pressure control. In the EHR, an indication of HbA1c <7.0%, LDL <100mg/dL, or BP <130/80 mm/Hg in the past 12 months was taken as effective glycemic, cholesterol and blood pressure control, respectively. According to the US Agency for Healthcare Research and Quality, the number of patients for whom an HbA1c test has been documented in the EHR or other health record system within the past 12 months is a good indicator of care quality.[37]

Healthcare Utilization—Frequency of urgent care visits, emergency department (ED) visits, and number of hospital visit days were extracted from the EHR as utilization counts over the past 12 months. We used ED visits and hospital visit days because they are primary care sensitive for diabetes patients and potentially avoidable with higher quality of diabetes care.[38,39]

Healthcare Costs—Healthcare costs in the past 12 months were calculated by applying average healthcare costs derived from published reports to health care utilization counts.[40–42] An average 2013 cost of US$266 per urgent care visit, US$664 per ED visit, and US$1628 per hospital day was applied to each recorded visit.

Patient-Level Control Variables

To control for differences in patient panel characteristics across primary care teams, we adjusted for patient age, gender, race/ethnicity, Type 1 vs Type 2 diabetes, insurance type, tobacco use, alcohol use, body mass index (BMI), and available EHR diagnoses of chronic conditions referenced in the U.S. Centers for Medicare and Medicaid Services Chronic Condition Warehouse (e.g., acute myocardial infarction, asthma, atrial fibrillation, cancer, chronic kidney disease, chronic obstructive pulmonary disease, depression, hyperlipidemia, hypertension, ischemic heart disease, osteoarthritis, osteoporosis, rheumatoid arthritis) or in the Charlson Comorbidity Index (e.g., cerebrovascular disease, congestive heart failure, dementia, peptic ulcer disease). The Charlson Comorbidity Index (CCI) was also included to adjust for potential confounding by multiple simultaneous chronic conditions.[43]

Statistical Analysis

The analysis first calculated the number of face-to-face and EHR communication ties within the primary care team as a whole. Connections between team members were dichotomized as present (=1) if frequency of communication was reported as ‘multiple times per day’, or absent (=0) otherwise. Next, we totaled number of RNs who communicated about patient care with the PCP multiple times per day. Finally, we calculated the number of face-to-face and EHR ties between the team RNs and the other team members not including the PCP. To control for differences in team size, the number of communication ties in each category (i.e., full team, RN to PCP, RN to non-PCP team members) was standardized by dividing by the total number of team members in that clinic role so that a one unit increase in the predictor variable was equivalent to one team member having one additional likewise connection.

Diabetes patient panel outcome data were structured as patient outcomes nested by primary care team nested within clinic. Multivariate analyses used 3-level (clinic/team/patient) generalized linear mixed models (GLMM)[44] to test the association between team-level communication network variables and patient-level outcomes. The 3-level GLMMs employed a logit link function for binary patient outcomes (HbA1c, LDL, BP control), a log link function for count outcomes (urgent care visits, ED visits, hospital days), and a normal link function for healthcare costs. A random intercept term in the model captured clinic-level fixed effects.

The GLMM models evaluated the association between team communication network measures and diabetes patient panel outcomes while controlling for patient-level covariates and clinic-level fixed effects. Initially, separate team communication network variables were entered one at a time in the GLMM models as predictors of diabetes patient outcomes. Finally, a multivariate GLMM estimated diabetes patient outcomes as a function of simultaneously-entered communication network variables while adjusting for patient-level covariates, clinic-level fixed effects, and team size.

Exploratory structural equation modeling[45,46] tested the mediating role of team climate (TCI-14) subscales between team communication and patient panel outcomes. TCI-14 subscales and patient outcomes were aggregated to the team level and tested sequentially in the structural equation model.

RESULTS

The study included 31 primary care teams operating at 6 primary care clinics. A total of 160 health professionals were invited to participate and 155 (97%) completed the study interview (Table 1). Participants were 95% female, which is consistent with U.S. Census Bureau data indicating that 91% of all nurses, nurse practitioners, and licensed practice nurses, and 97% of all medical receptionists, are women.[47] One fifth of study participants had worked at their practice for 1 year or less and just under a third worked part-time, defined as 75% time or less.

Study care teams ranged in size from 12 to 35 individuals, with an average team size of 19 team members. On average, clinic health practitioners other than the PCP belonged to 4 primary care teams.

Diabetes patient (n=2066) panel sizes ranged from 12 to 166 patients per PCP, with a median of 75 diabetes patients per PCP. Clinic panels ranged from 165 to 638 diabetes patients per clinic.

As seen in Table 1, overall, 40% out of all possible face-to-face communication ties were present within the primary care team (Table 1). EHR communication ties were less prevalent throughout the team as a whole, with 22% of all possible connections between team members present.

On average, two RNs (mean=1.78, sd 1.01) communicated face-to-face about patient care with the team PCP multiple times per day. In contrast, an average of four RNs communicated by EHR with the PCP multiple times per day (mean=3.48, sd 1.67), suggesting more frequent RN to PCP communication by EHR than face-to-face, potentially by as much as a 2-1 ratio (Table 1).

A total of 2066 patients with diabetes met criteria for inclusion in the team patient panels. Study patients had on average 0.16 urgent care visits, 0.51 emergency department visits, and 1.35 hospital days per patient, for a total healthcare cost of US$2578 per patient in immediate or acute care events in the past 12 months (Table 2).

The Table 3 GLMM models evaluate team communication connections and diabetes patient outcomes while adjusting for patient-level variables and clinic-level fixed effects. For each additional face-to-face RN to PCP connection there was a 48% increase (Odds Ratio(OR): 1.48, 95% CI: 1.10, 1.85) in hospital days and US$757 (95% CI: US$86, US$1428) higher healthcare costs per diabetes patient in the past 12 months. In contrast, teams with more members communicating frequently, daily, and face-to-face demonstrated fewer urgent care visits (Relative Rate (RR)=0.93, 95% CI: 0.85, 1.00), fewer hospital days (RR=0.56, 95% CI: 0.38, 0.86), and lower associated healthcare costs (β=-US$887 (95% CI: -US$1711, -US $63) per patient in the past 12 months. Greater numbers of EHR communication ties among all team members were not significantly associated with diabetes patient outcomes. Notably, more frequent EHR connections from RN to non-PCP team staff were associated with lower likelihood of optimal blood pressure control (OR=0.79, 95% CI: 0.63, 0.95) in the past 12 months in the team's diabetes patient panels.

The multivariate model results presented in Table 3 show that, for each additional RN who reported having frequent daily face-to-face communication with the PCP, there was an associated 17% (OR=0.83, 95% CI: 0.66, 0.99) reduction in odds of HbA1c less than 7%, 57% (RR=1.57, 95% CI: 1.10, 2.03) more hospital visit days, and US$877 (95% CI: US$42, US$1713) higher healthcare costs per diabetes patient. Conversely, every additional team member who indicated frequent daily face-to-face communication with other team staff was linked to a 52% (RR=0.48, 95% CI: 0.22, 0.94) reduction in hospital days and US$1220 (95% CI: -US$2416, -US$24) lower associated healthcare costs. Furthermore, more EHR communication ties between the team's RNs and non-PCP team staff were associated with lower odds of optimal blood pressure control.

Finally, Figure 3 presents structural equation modeling results which evaluated the role of team climate in mediating team communication and patient outcomes. A sequential analysis showed that team shared vision, derived from the TCI-14, mediated the relationship between team face-to-communication ties and urgent care visits, hospital days, and healthcare costs for the team's patients with diabetes. As seen in Figure 3, for every additional team member who communicated face-to-face multiple times per day with the other team members, team shared vision increased by 0.675 points. Greater team shared vision was then associated with an 11% decrease in urgent care visits (OR=0.889), a 49% reduction in hospital days (RR=0.512), and US$930 lower healthcare costs per patient for the team's patients with diabetes. By aggregating effects across the structural equation model, adding one face-to-face daily communication connection per team member was associated with a decrease of 7.5% (0.675*0.111) in urgent care visits, 32.9% (0.675*0.488) in hospital days, and US$628 (0.675*US$930) in healthcare costs per patient.

The other TCI-14 subscales (*psychological safety*, *task orientation*, *innovation support*) were not significant mediators of patient outcomes. Notably, the number of EHR communication connections was not significantly associated with any of the TCI subscales or with patient outcomes in the structural equation model.

DISCUSSION

The study's objective was to estimate whether communication patterns within primary care teams are associated with team climate, patient health outcomes, and associated healthcare costs for the team's patients with diabetes. Overall, our results show that teams with more interconnected, dense communication which occurs face-to-face multiple times per day have greater shared team vision and significantly better diabetes patient outcomes with lower healthcare costs. The addition of one daily face-to-face connection per team member was associated with 52% fewer hospital visit days and US$1220 lower healthcare costs per diabetes patient in the past 12 months.

It is noteworthy that teams whose PCP received frequent daily face-to-face communication from a single RN had better patient outcomes than teams whose PCP received daily face-to-face communication from multiple RNs. A team with a single RN-to-PCP connection was associated with US$877 lower medical costs per diabetes patient than a team with multiple RN-to-PCP connections. It is possible that PCPs working daily with a single RN benefit

from the nurse communication processes (e.g., information seeking, information processing, individualizing information for PCP)[48,49] which lead to high quality care.

Our structural equation modeling reveals that frequent daily face-to-face communication among team members contributes to better team climate as evidenced by greater shared team vision. An increase in the number of face-to-face communication connections among staff members was associated with almost a full point increase on the team climate shared vision scale, which translated into 7.5% fewer urgent care visits, 33% fewer hospital visit days and US$628 lower healthcare costs. Cast in this light, facilitating more face-to-face daily interactions about patient care between team members could be a cost-effective way to achieve significant improvements in diabetes care.

Our results suggest that team interconnectedness and team climate with shared vision, or teamwork, result in better quality of care for patients with diabetes. Interestingly, research shows that a lack of teamwork is associated with missed nursing care (i.e., required nursing care that is not completed), a known factor in worse patient outcomes.[50] The U.S. Agency for Healthcare Research and Quality states that “errors of omission are more difficult to recognize than errors of commission but likely represent a larger problem.”[51] Team members may avoid errors of omission and/or commission in nursing care if they are offered communication and teamwork training opportunities which develop their skills in working effectively as team members. Future interventions targeting teamwork in teams could include team coaching in relational learning, leadership development of team members, enhancing psychological safety among teammates, and role modeling.[52,53]

Interestingly, our results showed that the number of EHR communication connections did not contribute to team climate and did not lead to better patient outcomes. Our data suggest that technology solutions to diabetes patient care alone may not substitute for face-to-face communication among team members. Future interventions may want to focus on team members’ interdependence and ways to enhance their ability to work together through better face-to-face communication patterns.

Finally, it is important to note that this analysis cannot argue for a causal mechanism between team communication networks and patient diabetes outcomes due to the observational nature of the study. Experimental trials are necessary to explore the causal pathways between team communication variables, team climate, and diabetes patient care.

Our results should be viewed in light of several limitations. First, our study is based on data from only 6 practices in the same geographical location, so the results may not be generalizable to a broad national level context. Second, our study looked only at frequency of communication and did not attempt to measure communication content. Third, our study did not explore why different team members choose a particular mode of communication (i.e., face-to-face vs EHR) to discuss patient care. Fourth, we did not have data available to control for duration of diabetes. Diabetes is a progressive disease and duration of illness could affect illness severity, health outcomes, healthcare utilization and cost. Future studies should consider adding duration of diabetes illness as a covariate. Fifth, self-reported communication may be biased. However, supplementary analyses of our study data

(available upon request) indicate a strong correlation between self-reported EHR communication and communication which could be documented from the EHR system (QAP correlation=0.24, p<.001). Finally, care events which occurred outside of the purview of the EHR would not be captured in our study results. While we do not expect there to be bias in care obtained outside of the system based on team communication, we may be underestimating the overall effects.

In conclusion, this study contributes to the growing evidence on primary care team communication patterns as a means for providing better diabetes care quality at lower cost. Patients with diabetes may fair better if they are cared for by teams with a PCP supported by a single nurse and by teams with shared vision that rely on highly interconnected frequent daily face-to-face interactions among all team members.

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What is already known about the topic?

- Team-based diabetes care is associated better patient health outcomes, lower risk for diabetes complications, and lower health care costs for patients with diabetes.
- The role of primary care team communication and team climate in delivering high quality diabetes care has not been fully explored.

What the paper adds

- Primary care teams with frequent daily face-to-face communication among more team members have fewer hospital visit days and lower healthcare costs per team patient with diabetes.
- Single nurse-to-clinician communication patterns are associated with better diabetes patient outcomes than multiple nurse-to-clinician communication networks.
- Shared team vision, a measure of team climate, is a mediator in the link between primary care team communication and diabetes patient outcomes.

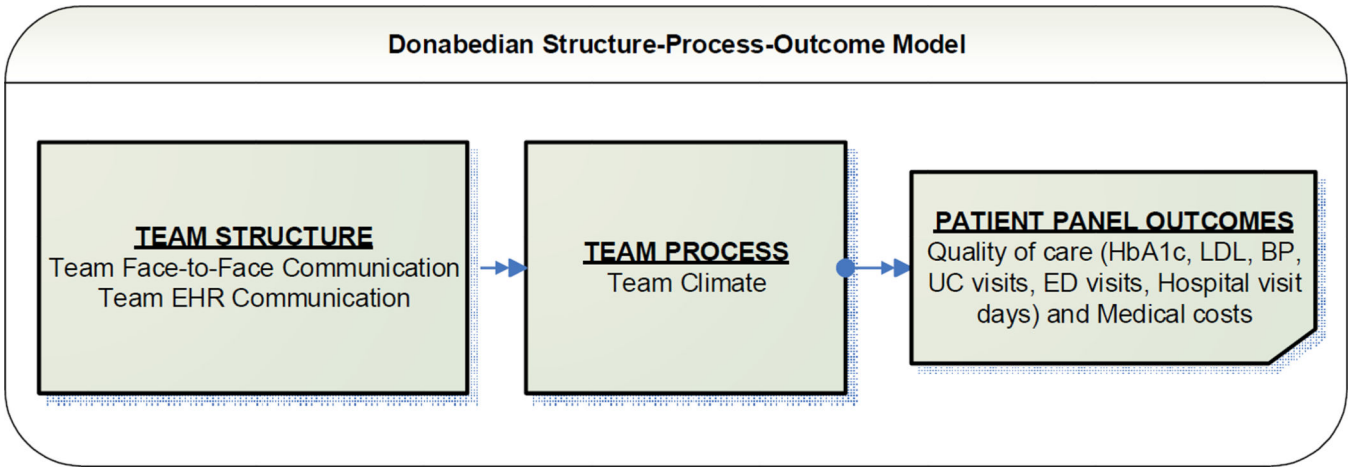
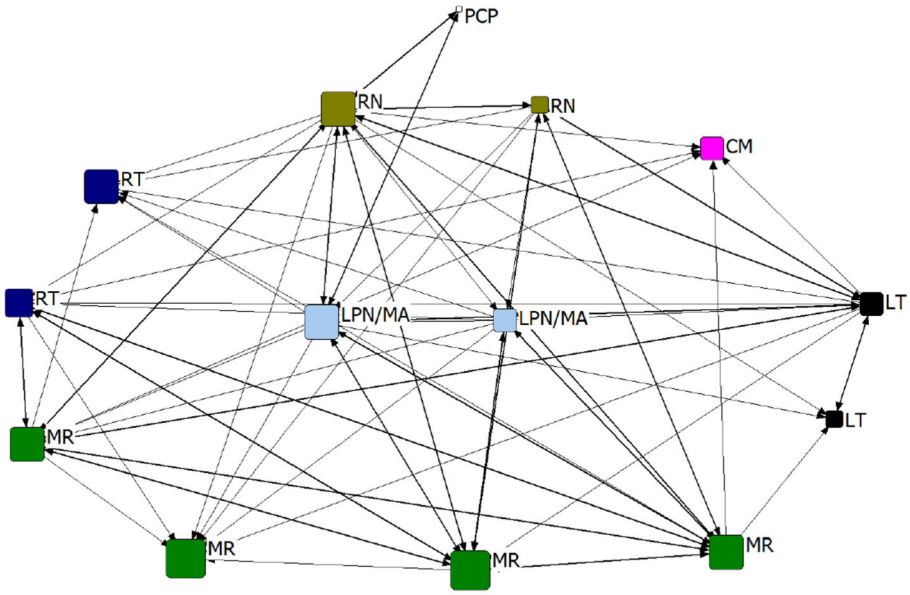


Figure 1.
Conceptual Model for This Study

A. Visual representation of a highly connected face-to-face communication network (45% of all possible ties present) in a primary care team with bottom quartile ED visits, hospital days, costs



B. Visual representation of a less connected face-to-face communication network (35% of all possible ties present) in a primary care team with top quartile ED visits, hospital days, costs

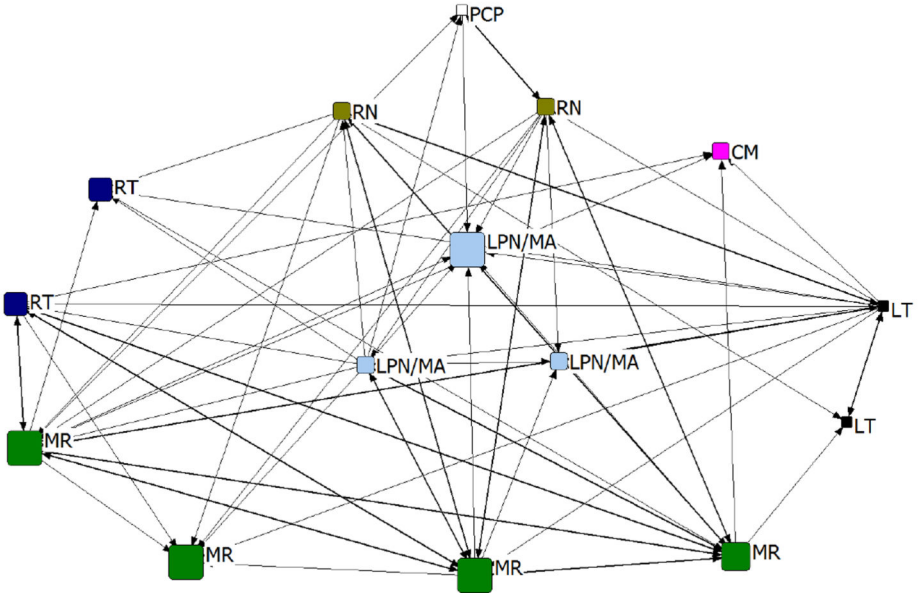


Figure 2.

Primary Care Team Communication Networks about Patient Care

Legend: Symbol size proportional to number of in-coming connections received; Bold line=2-way connection (sent and received), Pale line=Single connection (either sent or received); PCP=Primary care practitioner, RN=Registered nurse, CM=Clinic manager, LPN/MA=Licensed practical nurse/Medical assistant, MR=Medical receptionist, LT=Laboratory technician, RT=Radiology technician

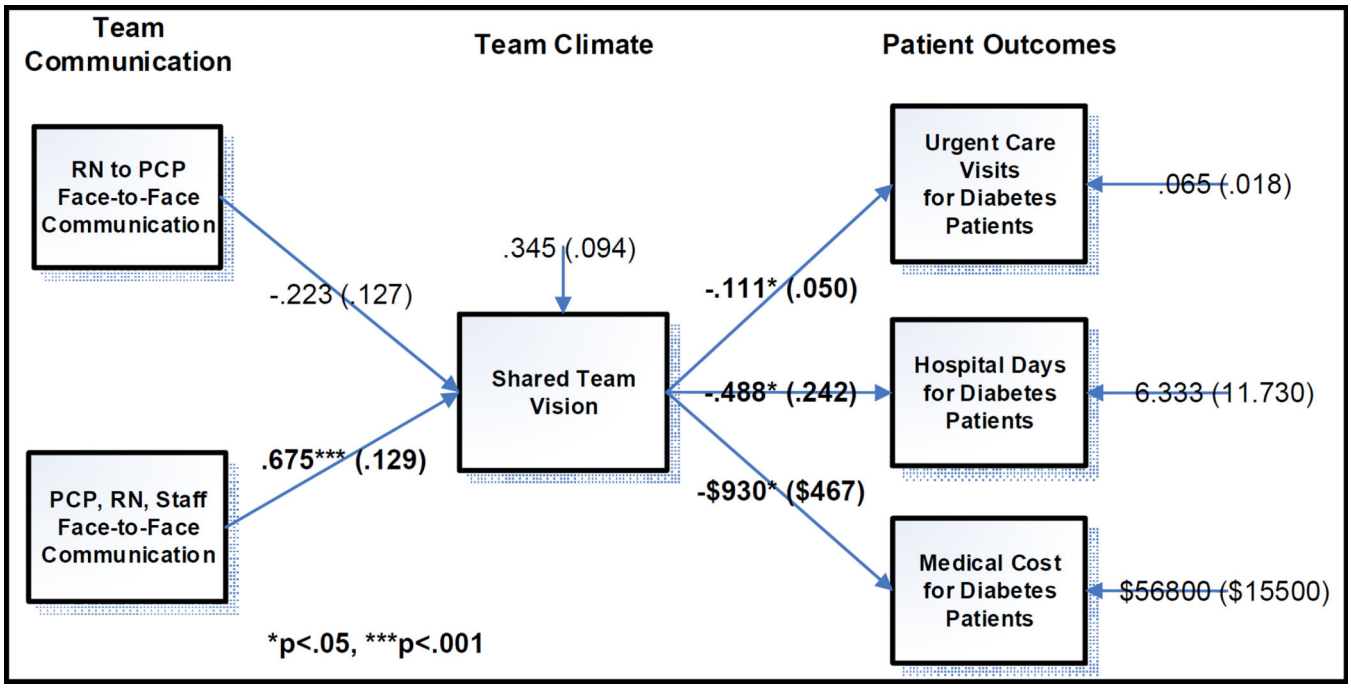


Figure 3.

Structural Equation Model of Team Communication Networks and Quality of Care for Diabetes Patients (n=31 primary care teams, N=2,066 diabetes patients)

Legend: Pathway coefficients denote the change in endpoint outcome variable associated with a one unit increase in lead predictor variable. By multiplying pathway coefficients between team communication, team climate and team outcome measures, the analysis estimates team communication network impact on healthcare utilization and costs. For every one unit increase in PCP, RN, and staff (i.e., whole team) face-toface communication, urgent care visits, hospital days, and healthcare costs decrease by 7.5% (0.675*0.111), 32.9% (0.675*0.488), and US$628 (0.675*US$930), respectively.

Table 1

Primary Care Team Study Sample and Team Communication Network Characteristics (n=155)

Demographics	**N (%)**
Female	147 (94.8)
Position in Clinic	
Physician	20 (12.9)
Nurse Practitioner/Physician Assistant	7 (4.5)
Clinic Manager	6 (3.9)
Registered Nurse	30 (19.4)
Licensed Practical Nurse/Medical Assistant	30 (19.4)
Medical Receptionist	38 (24.5)
Lab/Radiology Tech	24 (15.4)
Years at Clinic	
1 year or less	30 (19.4)
>1 to 3 years	43 (27.7)
>3 to 6 years	29 (18.7)
>6 to 10 years	16 (10.3)
>10 years	37 (23.9)
% Full Time Employment	
50% or less	23 (14.8)
>50% to 75%	28 (18.1)
>75%	104 (67.1)
Team Communication Network Characteristics	
Face-to-Face communication ties	*Mean (sd)*
RN to PCP	1.78 (1.01)
RN to and from non-PCP staff (%)	0.47 (0.17)
Entire care team (%)	0.40 (0.10)
EHR communication ties	
RN to PCP	3.48 (1.67)
RN to and from non-PCP staff (%)	0.30 (0.14)
Entire care team (%)	0.22 (0.09)
Team Climate Inventory (TCI-14)	*Mean (sd)*
Shared Vision (scale: 0–16)	12.8 (0.4)
Psychological Safety (scale: 0–16)	11.4 (1.1)
Task Orientation (scale: 0–12)	8.5 (0.5)
Innovation Support (scale: 0–12)	7.9 (0.6)

RN=Registered Nurse; PCP=Primary Care Practitioner (Physician/Nurse Practitioner/Physician Assistant); EHR=Electronic Health Record

Table 2

Diabetes Patient Panel Sample (n=2,066)

Patient Demographics and Diagnoses	**N (%)**
Male	1064 (51.5)
Age, mean (sd)	60.6 (13.1)
Race/Ethnicity	
Non-Hispanic White	1821 (88.1)
Black	56 (2.7)
White Hispanic	74 (3.6)
Type 1 Diabetes	68 (3.3)
Insurance	
Commercial	1035 (50.1)
Medicare	877 (42.4)
Medicaid	80 (3.9)
Uninsured	74 (3.6)
Chronic Conditions	
Acute Myocardial Infarction	177 (8.6)
Asthma	251 (12.1)
Atrial Fibrillation	249 (12.1)
Cancer	166 (8.0)
Cerebrovascular Disease	227 (11.0)
Chronic Kidney Disease	545 (26.4)
Chronic Obstructive Pulmonary Disease	151 (7.3)
Congestive Heart Failure	138 (6.7)
Dementia	56 (2.7)
Depression	640 (31.0)
Hyperlipidemia	1687 (81.7)
Hypertension	1586 (76.8)
Ischemic Heart Disease	310 (15.0)
Osteoarthritis	416 (20.1)
Osteoporosis	98 (4.7)
Rheumatoid arthritis	56 (2.7)
Peptic Ulcer	33 (1.6)
Charlson Comorbidity Index, mean (sd)	2.7 (1.9)
Tobacco User	310 (15.0)
Alcohol Drinker	1283 (62.1)
Body Mass Index, mean (sd)	33.1 (10.9)
Team Diabetes Patients Outcomes, Past 12 Months	*N (%)*
Controlled glycemia, HbA1c <7.0%	917 (44.4)
Controlled cholesterol, LDL <100 mg/dl	1057 (51.2)
Controlled blood pressure, BP <130/80 mm HG	816 (39.5)
Health Care Use per Diabetes Patient, Past 12 Months	*Mean (sd)*

Patient Demographics and Diagnoses	N (%)
Urgent care visits	0.16 (0.91)
Emergency department visits	0.51 (2.78)
Hospital days	1.35 (7.30)
Healthcare costs (US$)	US$2578 (US$12576)

Table 3

Generalized Linear Mixed Models (GLMM) of Team Communication Networks and Diabetes Patient Panel Outcomes[a] (N=31 teams, n=2,066 patients)

Face-to-Face (F2F) communication about patient care							
	HbA1c Control	**LDL Control**	**BP Control**	**UC Visits**	**ED Visits**	**Hosp Days**	**Cost ($)**
Variable	***OR (95% CI)***	***OR (95% CI)***	***OR (95% CI)***	***RR (95% CI)***	***RR (95% CI)***	***RR (95% CI)***	***Beta (95% CI)***
RN to PCP	**0.85** ** **(0.74, 0.96)**	0.92 (0.76, 1.09)	0.85 (0.68, 1.02)	0.98 (0.92, 1.03)	1.01 (0.84, 1.19)	**1.48** * **(1.10, 1.85)**	**757** * **(86, 1428)**
RN ↔ non-PCP Staff	0.91 (0.78, 1.05)	0.87 (0.69, 1.06)	**0.75** ** **(0.59, 0.91)**	1.02 (0.96, 1.07)	1.02 (0.83, 1.22)	0.90 (0.49, 1.31)	−195 (−920, 530)
Entire Care Team	1.07 (0.95, 1.20)	1.09 (0.92, 1.26)	1.15 (0.98, 1.32)	**0.93** * **(0.85, 1.00)**	0.86 (0.62, 1.09)	**0.56** ** **(0.38, 0.86)**	**−887** * **(−1711, −63)**
Electronic (EHR) communication about patient care							
	HbA1c Control	**LDL Control**	**BP Control**	**UC Visits**	**ED Visits**	**Hosp Days**	**Cost ($)**
Variable	*OR (95% CI)*	*OR (95% CI)*	*OR (95% CI)*	*RR (95% CI)*	*RR (95% CI)*	*RR (95% CI)*	*Beta (95% CI)*
RN to PCP	1.03 (0.92, 1.14)	0.97 (0.86, 1.07)	0.94 (0.81, 1.08)	0.97 (0.90, 1.03)	0.94 (0.78, 1.10)	1.21 (0.88, 1.53)	219 (−431, 869)
RN ↔ non-PCP Staff	0.93 (0.79, 1.06)	0.90 (0.73, 1.08)	**0.79** * **(0.63, 0.95)**	1.00 (0.95, 1.05)	1.18 (0.99, 1.36)	0.98 (0.60, 1.36)	16 (−646, 677)
Entire Care Team	1.00 (0.85, 1.14)	0.94 (0.76, 1.11)	0.92 (0.74, 1.15)	0.97 (0.88, 1.06)	1.09 (0.83, 1.34)	1.12 (0.52, 1.73)	247 (−846, 1340)
Multivariate model[b] of team communication (F2F and EHR) about patient care							
	HbA1c Control	**LDL Control**	**BP Control**	**UC Visits**	**ED Visits**	**Hosp Days**	**Cost ($)**
Variable	*OR (95% CI)*	*OR (95% CI)*	*OR (95% CI)*	*RR (95% CI)*	*RR (95% CI)*	*RR (95% CI)*	*Beta (95% CI)*
RN to PCP, F2F	**0.83** * **(0.66, 0.99)**	1.04 (0.82, 1.25)	0.91 (0.72, 1.09)	0.95 (0.89, 1.01)	0.93 (0.71, 1.15)	**1.57** * **(1.10, 2.03)**	**877** * **(42, 1713)**
Entire Care Team, F2F	1.02 (0.79, 1.26)	0.90 (0.59, 1.22)	0.85 (0.56, 1.14)	0.95 (0.86, 1.05)	0.83 (0.49, 1.17)	**0.48** * **(0.22, 0.94)**	**-1220** * **(−2416, −24)**
RN ↔ non-PCP Staff, EHR	0.99 (0.85, 1.13)	0.86 (0.67, 1.06)	**0.80** * **(0.63, 0.97)**	1.02 (0.97, 1.07)	1.19 (0.99, 1.39)	0.92 (0.54, 1.30)	−16 (−719, 686)
Team Size	1.01 (0.96, 1.06)	0.95 (0.88, 1.02)	0.98 (0.91, 1.04)	1.01 (0.99, 1.03)	1.01 (0.94, 1.08)	0.89 (0.75, 1.04)	−175 (−441, 92)

RN=Registered Nurse; PCP=Primary Care Practitioner (Physician/Nurse Practitioner/Physician Assistant); UC=urgent care; ED=emergency department; F2F=face-to-face communication about patient care; ↔= to and from

[a]Patient-level covariates entered in all GLMM models: gender, age, age squared, race/ethnicity, Type 1 vs Type 2 diabetes, insurance, tobacco use, alcohol use, body mass index, acute myocardial infarction, asthma, atrial fibrillation, cancer, cerebrovascular disease, chronic kidney disease stage, chronic obstructive pulmonary disease severity, congestive heart failure, dementia, depression, hyperlipidemia, hypertension, ischemic heart disease, osteoarthritis, osteoporosis, peptic ulcer disease, rheumatoid arthritis, and Charlson Comorbidity Index

[b]Team communication network variables entered simultaneously into a single model

*p<.05,

**p<.01