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The Use of Quality Improvement and Health Information Technology Approaches to Improve Diabetes Outcomes in African American and Hispanic Patients

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Abstract

Differences in rates of diabetes-related lower extremity amputations represent one of the largest and most persistent health disparities found for African Americans and Hispanics compared with Whites in the United States. Since many minority patients receive care in underresourced settings, quality improvement (QI) initiatives in these settings may offer a targeted approach to improve diabetes outcomes in these patient populations. Health information technology (health IT) is widely viewed as an essential component of health care QI and may be useful in decreasing diabetes disparities in underresourced settings. This article reviews the effectiveness of health care interventions using health IT to improve diabetes process of care and intermediate diabetes outcomes in African American and Hispanic patients. Health IT

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interventions have addressed patient, provider, and system challenges in the provision of diabetes care but require further testing in minority patient populations to evaluate their effectiveness in improving diabetes outcomes and reducing diabetes-related complications.

Keywords

diabetes, health information technology, health disparities, quality improvement, underresourced settings

Background

Chronic conditions are the leading cause of disparities in health (Centers for Disease Control and Prevention [CDC], 2008; Wong, Martin, Shapiro, Boscardin, & Ettner, 2002). Minorities and low-income individuals suffer from the highest rates of chronic conditions, such as diabetes (CDC, 2008; National Institute of Diabetes and Digestive and Kidney Diseases [NIDDKD], 2008). Mexican Americans and African Americans are almost twice as likely as non-Hispanic Whites to have diabetes (CDC, 2008). Considering the projected increase of diabetes prevalence among Hispanics and African Americans, mitigating these disparities is crucial (Narayan, Boyle, Geiss, Saaddine, & Thompson, 2006).

Of particular concern, the projected increase in diabetes incidence among these ethnic groups may fuel growing disparities in diabetes complications if the disease is not controlled equally across ethnic groups (Agency for Healthcare Research and Quality [AHRQ], 2008). Diabetes puts individuals at risk for several major microvascular and macrovascular complications, including chronic kidney disease, diabetic retinopathy, coronary artery disease, peripheral vascular disease, and lower extremity amputations. Despite the availability of effective medications and well-published evidence-based treatments, only one third of Hispanics and African Americans with diabetes achieve optimal glycemic control (American Diabetes Association, 2008; "Intensive Blood-Glucose Control," 1998; Kirk, Ralph, Bell, Passmore, & Bonds, 2006; Koro, Bowlin, Bourgeois, & Fedder, 2004; Saydah, Cowie, Eberhardt, De Rekeneire, & Narayan, 2007; "Tight Blood Pressure Control," 1998). Hispanics and African Americans with diabetes also have lower rates of blood pressure and lipid control compared with Whites (Collins et al., 2007; Duru et al., 2009; Rosamond et al., 2007). The suboptimal control of blood glucose, blood pressure, and lipids places these individuals at higher risk for complications of diabetes.

Racial and ethnic disparities in lower extremity amputation (LEA) rates among people with diabetes have been well documented in numerous population-based studies (Dillingham, Pezzin, & Mackenzie, 2002; Morrissey et al., 2007; Regenbogen, Gawande, Lipsitz, Greenberg, & Jha, 2009). The 2008 National Healthcare Disparities Report (AHRQ, 2009) reported that African Americans were 2.3 times as likely as whites to be hospitalized for LEA. Similarly, the 2007 National Healthcare Disparities Report

(AHRQ, 2008) found that Hispanics were 2.9 times as likely as whites to be hospitalized for LEA from diabetes. According to the AHRQ, the difference in rates of LEA hospitalizations for African Americans and Hispanics compared with Whites is one of the largest disparities seen in health care quality for these groups and is worsening.

Quality improvement (QI) initiatives have shown promise in improving diabetes quality of care and may be critical in decreasing diabetes disparities (Peek, Cargill, & Huang, 2007). QI initiatives that address salient intermediate outcomes in diabetes—such as control of glycosylated hemoglobin (HbA1c), blood pressure, and lipids and improved processes of care, such as foot examinations and medication intensification—may be central to decreasing disparities in LEA (Schade & Hannah, 2007; Selvin, Wattanakit, Steffes, Coresh, & Sharrett, 2006). QI initiatives in all health care settings provide an opportunity to address disparities in diabetes care and quality, but QI initiatives in underresourced settings may present a particularly promising opportunity, since many minority patients receive care in rural health centers, county hospitals, or safety net clinics (Bach, Pham, Schrag, Tate, & Hargraves, 2004; Jha, Orav, Li, & Epstein, 2007; Jha, Orav, Zheng, & Epstein, 2008). Physicians in these settings often face resource constraints and report greater difficulties in obtaining access for their patients to subspecialists, high-quality diagnostic imaging, and nonemergency admissions to the hospital (Bach et al., 2004; Jha et al., 2007; Jha et al., 2008). Finding innovative ways to improve diabetes processes of care and intermediate outcomes in underresourced settings may be a powerful way to address disparities in diabetes complications (Bach et al., 2004).

Health information technology (health IT) is widely viewed as an essential component of health care quality improvement. QI interventions using health IT have been found to improve adherence to guideline-based care, enhance surveillance and monitoring, decrease medication errors, and decrease utilization of care (Chaudhry et al., 2006). Many health IT interventions, such as electronic medical records (EMRs), computerized prompts, population management (including reports and feedback), specialized decision support, electronic scheduling, and personal health records have been shown to improve diabetes processes of care and intermediate outcomes (Dorr et al., 2007). Implementation of health IT has become a national priority, but adoption still remains low (American Recovery and Reinvestment Act, 2009; DesRoches et al., 2008; Foxhall, 2009). Community health centers and small private practices lag in implementing health IT because of barriers prevalent in these settings (Jha, DesRoches, & Campbell, 2009; Shields et al., 2007). Encouraging health IT adoption as a part of QI initiatives to improve diabetes care in underresourced settings may provide a special opportunity to reduce diabetes disparities.

New Contribution

To our knowledge, no systematic literature review has examined the use of health IT in QI initiatives to reduce diabetes health disparities. Additionally, few studies examine the use of health IT in underresourced settings. We systemically review health IT

interventions to examine their impact on diabetes outcomes in African American and Hispanic patient populations. Our review focuses on intermediate diabetes outcomes and processes of care, which are on the causal pathway to LEAs. For this study, we review health care interventions that target diabetes disparities in African American and Hispanic patients and discuss the use of health IT for enhancing these QI efforts. We aim to (a) update from 2006 to 2009 a previous systematic review of QI initiatives to improve diabetes outcomes in minority patients, (b) systematically review QI interventions that utilized health IT to improve diabetes disparities from 2000 to 2009, and (c) give recommendations on the use of health IT to reduce diabetes disparities.

Conceptual Framework

Berwick's (2002) model summarizes the lessons from the Institute of Medicine's "Crossing the Quality Chasm" report. Using this model, we can organize QI initiatives from Level A to Level D and comment on QI strategies that target the patient experience (A), microsystems (B), organizations that house these microsystems (C), and policy or regulatory factors (D). We used Berwick's model to classify the types of QI initiatives previously reviewed in decreasing diabetes disparities (Peek et al., 2007).

Peek et al. (2007) published a systematic review of QI interventions in health care settings that aimed to reduce diabetes disparities in minority populations. The authors categorized interventions into those that focused on patients, providers, and health care systems. Among patient-oriented QI initiatives, those that used interpersonal relationships and social networks and were culturally tailored had the most success in improving diabetes outcomes. Provider QI initiatives that incorporated in-person feedback were also successful. Organizational changes—such as the use of case management, community health workers, and nonphysician providers—were effective at improved rates of making and keeping appointments; overcoming social, cultural, and linguistic barriers; and providing clinical care through treatment algorithms. The use of medical assistance programs increased prescription adherence and decreased hospitalizations. Disease management systems—such as patient registries, practice guidelines, case management, and tracking and monitoring of patients—improved diabetes processes and outcomes.

Similar to the goal of the Peek et al. (2007) study, we aimed to identify efforts to reduce diabetes disparities in Hispanic and African American populations in under-resourced settings. In our study, underresourced settings included federally qualified health centers, rural clinics, public hospitals, and public clinics. We begin by using the Berwick (2002) model to describe the challenges these settings face in reducing diabetes disparities and to identify promising points of intervention for health IT use at the patient, provider, and system levels. The health IT applications described here were not necessarily applied in underresourced settings; however, they are meant to serve as examples of what may be possible.

Patient-Centered Challenges

Studies with African American and Latino patients with diabetes have demonstrated that medication adherence, health care cost, and lack of health insurance serve as barriers to receiving effective diabetes care (Reichsman, Warner, & Cella, 2009; Rosal, Benjamin, & Pekow, 2008). Some patients also have poor access to diabetes education in underresourced settings, in particular information that is culturally tailored, in their language, and easy to comprehend (Reichsman et al., 2009). Poor communication, language barriers, lack of trust in the health care system, and lack of provider cultural competence each adversely affect patient satisfaction (Reichsman et al., 2009; Rosal et al., 2008). Patient-directed interventions, therefore, can help address these challenges by improving diabetes knowledge, encouraging provider communication, strengthening social support from peers, and providing access to care.

Health IT may improve diabetes care through patient directed interventions. Patient satisfaction, self-management, self-empowerment, and diabetes knowledge have been enhanced by patient-focused health IT applications, such as online, interactive personal health records, secure messaging with physicians, and video visits (Halamka, Mandl, & Tang, 2008; Katz, Nissan, & Moyer, 2004; Wakefield et al., 2008). Patients can schedule their appointments online while receiving social support and reminders from peers on a diabetes website (Eysenbach, 2008). Patient communication may be enhanced through secure messaging with physicians while simultaneously decreasing the cost of frequent visits for patients and providers. Patient-directed interventions also could be designed to specifically target those with low health literacy or English as a second language. Trust in the health care system also may be improved using an interactive personal health record that promotes transparency and secure messaging with providers.

Provider-Centered Challenges

Clinicians in safety net clinics note many financial, cultural, and psychosocial factors that affect the quality of diabetes care (Reichsman et al., 2009). Providers report inadequate time to counsel patients on lifestyle modifications, limited resources for dietary and physical activity counseling, limited documentation of diabetes-related risk factors, limited availability of medical records, and inconsistent delivery of diabetes prevention strategies (such as dietary or weight loss counseling and pharmacological interventions) to patients in underresourced settings (Rosal et al., 2008). Diabetes care may be enhanced through health IT applications that address these provider related challenges.

Safety net providers using health IT have reported benefit from increased efficiency in providing care through the use of EMRs (Kim, Chen, Keith, Yee, & Krushei, 2009). EMRs can also be used for clinical documentation, data storage and tracking, and results management (Davis, Doty, Shea, & Stremikis, 2009). Computerized order entry,

standardized histories, and clinical decision support can increase appropriate medication prescribing and reduce adverse drug interactions, and they have the potential to provide better adherence to prescribing guidelines (Davis et al., 2009).

System-Centered Challenges

Organizational- and policy-level challenges specific to underresourced health care settings also exist. These challenges include long waits for appointments, poor access to subspecialists, difficulty in the formation of multidisciplinary teams, and lack of access to funding for infrastructure upgrades. Other policy-level and regulatory barriers to QI implementation include lack of reimbursement for nonvisit care and coordination, drug costs, and lack of the presence and/or accessibility to community health workers and community outreach programs.

Health IT applications can address systems-based challenges to improve diabetes quality of care. Health care systems can track disparities through health information exchanges (HIEs), regional health information systems, and disease registries. Telemedicine and video visits may improve the timeliness of care and decrease long waits for appointments in underresourced settings. Improved communication through secure messaging or social networking sites can facilitate formation of multidisciplinary teams. Text messaging systems that provide messaging among clinics, patients, and outreach workers may enhance the presence and accessibility of community health care workers in community-level interventions.

Method

Systematic Quality Improvement Intervention Search

The review article, "Diabetes Health Disparities, A Systematic Review of Health Care Interventions," by Peek et al. (2007) described a detailed electronic database search and hand search of health system-based diabetes QI interventions targeting minority populations from 1985 to 2006. We updated this review with studies published from 2006 to 2009.

To update this review, we searched for diabetes QI intervention articles published from January 2006 to March 2009 using the following electronic databases: Cochrane, CINAHL, ACP Journal Club, Psycinfo, and Medline. We used prespecified Medical Subject Headings (MeSH) and keywords to identify evaluation studies (evaluation studies, clinical trials; effectiveness; improvement; performance) designed to address health care delivery (delivery of health care, integrated; quality of health care; health services accessibility) among African Americans and Hispanics (African Americans; Hispanic Americans; Mexican Americans; Latinos) and among adults and children with diabetes (diabetes mellitus, type 2; diabetes mellitus, type 1; diabetes complications; peripheral vascular disease). We also used reference lists from recently published QI intervention articles and major review articles. We supplemented our electronic

search with a hand search of issues from selected journals with a high likelihood of publishing diabetes QI studies (*Diabetes Care*, *The Diabetes Educator*, *Journal of General Internal Medicine*, and *Medical Care*) published within the preceding 2 years.

Studies were required to include at least a 50% minority sample population, be based in the United States, and focus on improving diabetes treatment processes and outcomes. We defined “minority” as African American or Hispanic American/Latino. We excluded studies that focused on diabetes prevention and gestational diabetes. We included all study types in our review (e.g., randomized controlled trials, pre–post, pilot, cross-sectional). We included QI interventions whether they used health IT or not.

From the Cochrane, CINAHL, ACP Journal Club, and Psychinfo databases we found 63 articles, but none met our inclusion criteria. Our Medline search returned 43 articles, and we retained one after application of inclusion/exclusion criteria. From our hand search, we found 18 articles that met exclusion/inclusion criteria.

Systematic Health Information Technology Search

While some of the articles from Peek et al. (2007) and our update search contained aspects of health IT, we conducted a supplementary health IT electronic database search from 2000 to 2009. For our systematic search of QI interventions that used health IT, we added keyword and MeSH terms for health IT (biomedical technology; medical informatics applications; data collection) and removed all other search terms except those referring to diabetes and peripheral vascular disease (diabetes mellitus, type 2; diabetes mellitus, type 1; diabetes complications; peripheral vascular disease) using the Medline database only and restricted the search to articles published between January 2000 and March 2009. This search yielded 286 articles, and after applying our inclusion/exclusion criteria, we kept none. In addition, a hand search of issues of selected journals with a high likelihood of publishing health IT interventions (e.g., *HealthCare Informatics* and the *Journal of the American Medical Informatics Association*) published within the previous 2 years was conducted. References from health IT review articles, including Peek et al.’s (2007) review, were investigated for eligibility for our review. Our hand search resulted in 31 articles; 10 met our inclusion/exclusion criteria.

The QI update from 2006 to 2009 yielded 18 articles. The expanded health IT QI search from 2000 to 2009, yielded 10 articles, with one overlapping article with the QI update (Shea et al., 2009). Since the overlapping article reported on the use of health IT in a diabetes QI intervention, we report that study’s findings in the health IT results section.

Data Abstraction

We used a validated instrument to guide our abstraction (Zaza et al., 2000). We abstracted data from each study into a table that included the objective of the improvement strategy, the population sampled, the setting, a description of the form of health

IT used, and the findings. We documented baseline and follow-up rates of diabetes processes of care (proportion of patients receiving HbA1c testing, lipid testing, blood pressure measurement, foot examination, and eye examination), health outcomes (HbA1c, total cholesterol, low-density lipoprotein [LDL] cholesterol, high-density lipoprotein [HDL] cholesterol, triglycerides, systolic blood pressure, and diastolic blood pressure), and diabetes complication rates (blindness, rates of myocardial infarctions, kidney failure, peripheral vascular disease, and lower extremity amputation hospitalizations) when noted in the article. In addition, each study in the table was given a quality score by two members of the research team using an adapted questionnaire based on the Downs and Black (1998) guidelines (27-point scale: 0, *worst*; 27, *best*). We report the average of the two quality scores.

Results

We report the findings from our review in two sections: (a) QI systematic review and (b) health IT systematic review. The QI review describes the 18 articles we found in our search for diabetes QI interventions from 2006 to 2009. We present an update on QI initiatives targeted at improving diabetes processes of care and outcomes in minority patient populations and highlight new findings and changes from Peek et al. (2007). The health IT review reports the findings from the 10 articles that used health IT in their diabetes QI interventions from 2000 to 2009.

Quality Improvement Systematic Review

A total of 18 articles used QI initiatives to improve diabetes processes of care and outcomes among African American and Hispanic patient populations, not including health IT-oriented initiatives (Babamoto et al., 2009; Cramer, Sibley, Bartlett, Kahn, & Loffredo, 2007; Davidson, Ansari, & Karlan, 2007; Gold et al., 2008; Ingram et al., 2007; Joshi, Rangel, Garcia, Brownson, & O'Toole, 2007; King et al., 2006; Liebman, Heffernan, & Sarvela, 2007; Lujan, Ostwald, & Ortiz, 2007; Mahotiere, Ocepek-Welikson, Daley, & Byssainthe, 2006; Mauldon, Melkus, & Cagganella 2006; C. D. Miller et al., 2006; Sixta & Ostwald, 2008; Steinhardt, Mamerow, Brown, & Jolly, 2009; Thom, Tirado, Woon, & McBride, 2006; Thompson, Horton, & Flores, 2007; Utz et al., 2008; Wagner, Pizzimenti, Daniel, Pandya, & Hardigan, 2008). Table 1 summarizes QI interventions from Peek et al. (2007) and from the 2006-2009 update that have demonstrated improvements in a range of diabetes processes of care and clinical outcomes.

Patient oriented. Of the 18 articles, 6 reported interventions that were patient oriented (Cramer et al., 2007; Liebman et al., 2007; Mauldon et al., 2006; Steinhardt et al., 2009; Utz et al., 2008; Wagner et al., 2008). Of these, five were culturally tailored for their specific population (Cramer et al., 2007; Liebman et al., 2007; Mauldon et al., 2006; Steinhardt et al., 2009; Utz et al., 2008). Studies emphasizing cognitive-behavioral education and self-care management and those that adapted the Diabetes Prevention Program demonstrated improvements in diabetes metabolic outcomes (Cramer et al.,

Table 1. Overview of Health Care System Quality Improvement (QI) Initiatives in Improving Diabetes Disparities

Level	Characteristics of QI That Are Associated With Improved Diabetes Outcomes	Evidence Exists to Support These Outcomes Can Be Affected	Limitations and Challenges
Patient	<ul style="list-style-type: none">• Use interpersonal (rather than computer-based) skills• Use social networks (family members, peer support groups, one-on-one interactive education, community health workers)• Use culturally tailored interventions• Emphasize cognitive-behavioral education, self-care management, and adaptations of the Diabetes Prevention Program (DPP)• Focus on improving patient resilience to stressors• Provide multidisciplinary patient diabetes education	<ul style="list-style-type: none">• Lower HbA1c• Dietary habits• Physical activity• Weight change• Depressive symptoms• Health knowledge• Health behaviors• Diabetes self-empowerment• Diabetes self-management• Low-density lipids• Systolic blood pressure• Increased diabetes knowledge	<ul style="list-style-type: none">• Need broader expansion into racial/ethnic populations• Lack of interventions targeting patients on the fringe of the health system
Provider	<ul style="list-style-type: none">• Use of in-person feedback instead of computerized decision support to sustain provider behavior change and health outcomes• Ensure timely availability of treatment algorithms factoring in HbA1c and random blood sugar at patient appointments	<ul style="list-style-type: none">• Glycemic control• Process measures: eye examinations, microalbumin testing, HbA1c monitoring, foot care, exercise counseling, lipid testing, influenza vaccines, nutrition education• Hypertension and cholesterol• Provider intensification of glucose management• Medication intensification leading to improved HbA1c	<ul style="list-style-type: none">• Lack of intensive provider training in diabetes care• Lack of provider communication or shared decision making training• Computer reminders can be easily ignored• Sustained change may require the use of continued medical education and practice guidelines
Health Care organization	<ul style="list-style-type: none">• Use of case management and community health workers (CHWs) and nonphysician providers: RN/CHW can act as a patient adjunct to primary care team to assist with case management and overcome social, cultural, and linguistic barriers; act as powerful change agents	<ul style="list-style-type: none">• Keeping appointments with physicians• HbA1c testing• Glycemic control• Pharmacist-led medication management: HbA1c levels, increased	<ul style="list-style-type: none">• Lack of partnering with communities• Lack of support for safety net providers caring for disproportionate share of racial/ethnic minorities

(continued)

Table 1. (continued)

Level	Characteristics of QI That Are Associated With Improved Diabetes Outcomes	Evidence Exists to Support These Outcomes Can Be Affected	Limitations and Challenges
Health Care organization	<ul style="list-style-type: none"> • Use of case management and community health workers (CHWs) and nonphysician providers: RN/CHW can act as a patient adjunct to primary care team to assist • Use of medical (or medication) assistance programs (MAPs) • Use of disease management systems • Elements: (1) identification of population with disease (diabetes registry); (2) guidelines for performance standards for care; (3) management of identified people; (4) tracking and monitoring 	<ul style="list-style-type: none"> • Blood pressure • Dyslipidemia • Delayed onset of retinopathy • Decreased hospitalizations • Diabetes and dyslipidemia control • Number of patients on medication for dyslipidemia and hypertension • Better diabetes control • Better processes of care: increased screening for neuropathy, dyslipidemia, and microalbuminuria 	<ul style="list-style-type: none"> • Lack of collaboration with national programs • Pharmacist-directed care is labor intensive • Physician resistance • Limited insurance reimbursement • Lack of Internet access and dependence on fax and telephone communication • Only used in pharmaceutical company-sponsored medications • No reviewed studies had all four system components
Multitarget interventions	<ul style="list-style-type: none"> • Use of multidisciplinary teams • Ensure that health care and academic institutions work as part of a broad community coalition • Focus on community involvement 	<ul style="list-style-type: none"> • Eliminated disparities in HbA1c testing, eye examinations, lipid profiles, and microalbumin testing • Low-density lipids testing and control • Lower extremity amputations • At least annual testing of HbA1c and serum creatinine • Annual screenings for hypertension and obesity 	

2007; Mauldon et al., 2006). Interventions based on enhancing patient resilience improved a range of patient outcomes (Steinhardt et al., 2009).

Provider oriented. We found two new studies that tested provider-directed interventions (C. D. Miller et al., 2006; Thom et al., 2006). Thom et al.'s study tested provider cultural competency training but failed to show any statistically significant clinical improvements in diabetes outcomes. When treatment algorithms factoring in HbA1c and random blood sugar were available at the time of patients' visits, providers were more likely to intensify medical therapy and lower patient HbA1c levels (C. D. Miller et al., 2006).

System oriented. We found nine studies that focused on health system interventions for improving diabetes care for minorities (Babamoto et al., 2009; Davidson et al., 2007; Gold et al., 2008; Ingram et al., 2007; Joshu et al., 2007; King et al., 2006; Lujan et al., 2007; Sixta & Ostwald, 2008; Thompson et al., 2007). Confirming Peek et al.'s (2007) work, we also found that the use of community health workers and promotoras facilitated improvements in diabetes intermediate outcomes, processes of care, knowledge, and social support (Babamoto et al., 2009; Ingram et al., 2007; Joshu et al., 2007; Lujan et al., 2007; Sixta & Ostwald, 2008; Thompson et al., 2007). Our update also provided evidence that promotoras can successfully reach out to patients with diabetes on the fringes of the traditional health care system (Ingram et al., 2007). All six community health worker studies were conducted in majority Mexican American populations. The use of nonphysician providers reduced diabetes-related urgent visits and emergency room visits (Davidson et al., 2007). The use of a centralized diabetes specialist in guiding off-site primary treatment of diabetes demonstrated trends in improvements in HbA1c, lipids, and blood pressure that were not statistically significant (King et al., 2006). Interventions using multidisciplinary teams improved patients' HbA1c levels (Gold et al., 2008).

Multitarget interventions. We found one study that used a multitarget approach for reducing the disparity in the rate of biennial lipid profiles between African Americans and White Medicare beneficiaries with diabetes in New York City (Mahotiere et al., 2006).

Health Information Technology Systematic Review

We identified 8 studies with 10 articles that used health IT to address diabetes quality improvement in minority populations (Bray, Roupe et al., 2005; Bray, Thompson, Wynn, Cummings, & Whetstone, 2005; Cherry, Moffatt, Rodriguez, & Dryden, 2002; Chin et al., 2004; Gerber et al., 2005; Levetan, Dawn, Robbins, & Ratner, 2002; Phillips et al., 2005; Shea et al., 2006; Shea et al., 2009; Ziemer et al., 2006). Table 2 describes these studies in detail.

Patient oriented. We identified two studies that utilized health IT in patient-oriented QI initiatives (Gerber et al., 2005; Levetan et al., 2002).

The Levetan et al. (2002) study evaluated the impact of computer-generated personalized goals on HbA1c among a majority African American patient population and had a quality score of 17. This randomized controlled trial found that those who

(text continues on p. 182S)

Table 2. Quality Improvement Interventions With Health Information Technology (IT) Focus in Minority Populations, 2000 to Present

Reference	Health IT Focus	Study Objective(s)	Study Design	Population Characteristics	Results Summary	Cost of Health IT Implementation	Health IT Use Lessons Learned	Quality Score (out of 27)
Chin et al. (2004)	Electronic registry implemented in 37% of community health centers; used to follow up on examination and lab data	Evaluation of the Diabetes Health Disparities Collaborative with the aim to reduce health disparities and improve diabetes care quality in 19 community health centers	Pre-post design (1 year: 1998-1999) Plan-do-study-act cycles using patient self-management tools, flowsheets, DM registry, group center visits regarding health system design All health centers were asked to perform at least two HbA1c tests at least 3 months apart over the year for 90% of their target population	19 Midwest community health centers (CHCs) Chart review of 969 patients 33% African American 22% Hispanic	Improved processes of care, including HbA1c measurement, foot examination, lipid assessments* Mean value of HbA1c improved, a drop of 0.2% Quality improvement initiatives in CHCs can significantly improve diabetes care/process measures and may improve diabetes control Overall, the collaborative was considered worthwhile and successful	No cost information reported	Only 37% of CHCs chose to use an electronic patient registry Staff found registry useful but burdensome Needed more technical support Difficulty developing registry Delay in finding an efficient and common electronic patient registry delayed identification of target population	13
Bray, Roupe, et al. (2005); Bray, Thompson, et al. (2005)	Electronic patient care registry system called the Cardiovascular/Diabetes Electronic Management System (CVDEMS)	Explore feasibility, cost-effectiveness, and efficacy of diabetes care management, group visits and electronic registry	Pre-post design (1 year) with control patients in separate practice Intervention: RN provided weekly intensive diabetes case management 4 session group visit DM education program, DM registry and visit reminder system Control: Usual care	Five solo or small group primary care fee-for-service practices in rural North Carolina 314 patients 72% African American	Increased provider productivity on group visit days (20.17 to 31.55 average daily encounter rate) 61% of patients in intervention group had a reduction in HbA1c, while control group increased HbA1c* Improved processes of care, including	Substantial increase in office productivity as measured by patient encounters Magnitude of increase in charges is sufficient to offset 75% of direct	Pilot experience with CVDEMS showed much info was duplicative of the medical record, as a result, leadership began moving toward full implementation of electronic medical record. New system will allow for provider reminders and decision support	11.5

(continued)

Table 2. (continued)

Reference	Health IT Focus	Study Objective(s)	Study Design	Population Characteristics	Results Summary	Cost of Health IT Implementation	Health IT Use Lessons Learned	Quality Score (out of 27)
Gerber et al. (2005)	Computer kiosks in waiting room, education with video testimonials, audio feedback, without text or complex navigation	Evaluate a clinic-based multimedia intervention for diabetes education among a low health literacy population	Randomized controlled trial (1 year) Intervention: Computer training (information, skills, support) kiosk in waiting room Control: Multiple choice computer quiz about diabetes	Five public clinics in Chicago 244 subjects enrolled; complete data for 183 subjects 29% African American 66% Latino	lipid panels and foot examinations improved in the intervention group No significant difference in weight or blood pressure Overall, intervention improved percentage of patients achieving diabetes management goals No significant difference in change in HbA1c, weight, blood pressure, knowledge, self-efficacy, or self-reported medical care Increased perceived susceptibility to diabetes complications in intervention group*	personnel costs on nurse case manager Demonstrated potential for sustainability	Digital divide—lower health literacy correlated with less computer use, despite equal access to the technology Touch-screen monitors take the place of mouse and keyboard which may remove some barriers for older, lower literacy, less computer experienced individuals Optimal computer location was uncertain; limited privacy of waiting rooms; waiting for computer	20

(continued)

Table 2. (continued)

Reference	Health IT Focus	Study Objective(s)	Study Design	Population Characteristics	Results Summary	Cost of Health IT Implementation	Health IT Use Lessons Learned	Quality Score (out of 27)
Levetan et al. (2002)	Computer-generated 11 in. x 17 in. color poster depicting an individual's HbA1c, goals, and steps to achieve goals Individual report was generated from a Microsoft Access-based decision support system that collected patient enrollment questionnaire and matched it against knowledge base of established diabetes, cardiovascular, nutrition, and exercise guidelines	Evaluate a system that provides uniquely formatted and personalized reports of diabetes status and goals on changes in HbA1c levels	Randomized controlled trial (6 months) All participants received diabetes education 3 months before enrollment Intervention: Computer-generated individually tailored poster and waller card; along with one phone call from health educator Control: Standard care	Participants were identified and enrolled from a group completing the American Diabetes Association educational program between October 1998 and April 1999 150 patients with diabetes who completed a diabetes education program during the 3-month period before study enrollment	63% of patients in control group and 69% of patients in the intervention group experienced a decline in HbA1c Among patients with baseline HbA1c \geq 7.0%, the control group experienced a 0.77% absolute reduction and the intervention group had a 1.69% absolute reduction* Overall, participants in the intervention group significantly lowered their HbA1c compared with the control group	No cost information reported	Intervention required no effort on the part of the provider Visual nature of the poster may have contributed to success of patients with less than college education	17
							availability when multiple patients want to log in; computer malfunctions Staff assistance improved participant acceptance Multimedia audiovisual prompting necessary; repeated staff prompting important for repeated sessions	20

(continued)

Table 2. (continued)

Reference	Health IT Focus	Study Objective(s)	Study Design	Population Characteristics	Results Summary	Cost of Health IT Implementation	Health IT Use Lessons Learned	Quality Score (out of 27)
Phillips et al. (2005)	Hard-copy computerized reminders that document critical values, notify when evaluations are due, and provide individualized recommendations for therapy	Target provider clinical inertia using computer reminders to improve diabetes patient clinical outcomes Part of the Improving Primary Care of African Americans with Diabetes (IPCAAD) study	Controlled trial (3 years); residents were randomized to intervention groups Three intervention groups: (1) residents received computerized reminders with patient-specific management recommendations, (2) residents received individual 5-minute face-to-face feedback every 2 weeks from endocrinologist (3) both reminders and feedback Control: Standard care	83% African American (control group) 89% African American (intervention group) Municipal hospital primary care clinic in large academic medical center 345 internal medicine residents serving 4,138 patients 94% patients African American	Change in HbA1c was greater for the feedback plus reminder group (Δ -0.6%) compared with control group (Δ -0.2%)* Improved systolic blood pressure in feedback plus reminder and feedback only groups compared to reminder only and control groups Low-density lipids (LDL) improved in all intervention arms compared with control In-person endocrinologist feedback (especially with reminders) modestly enhanced diabetes control and is more effective than reminders alone	No cost information reported	Printed reminders were easy to ignore while face-to-face feedback required the provider's attention	18

(continued)

Table 2. (continued)

Reference	Health IT Focus	Study Objective(s)	Study Design	Population Characteristics	Results Summary	Cost of Health IT Implementation	Health IT Use Lessons Learned	Quality Score (out of 27)
Ziener et al. (2006)	Computerized reminders generate flowsheet with lab values, weight, blood pressure, medications, and recommendations for diabetes management	Evaluate whether computerized reminders vs. face-to-face feedback from an endocrinologist improve provider clinical inertia defined as "did nothing/did anything/did enough." Part of the Improving Primary Care of African Americans with Diabetes (IPCAAD)	Controlled trial (3 years); residents were randomized to intervention groups Three intervention groups: (1) residents received computerized reminders with patient-specific management recommendations, (2) residents received individual 5-minute face-to-face feedback every 2 weeks from endocrinologist (3) both reminders and feedback Control: Standard care When patient glucose levels exceeded 150 mg/dL, provider behavior was characterized as "did nothing," "did anything" (intensification of therapy), or "did enough" (met intensification recommendations)	Municipal hospital primary care clinic in large academic medical center 345 internal medicine residents serving 4,138 patients total 4,038 patients with glucose levels high enough to trigger intensification of therapy 94% of patients African American	Intensification of therapy increased first 6 to 12 months, then declined throughout the 3-year period Therapy intensification increased when providers received in-person feedback with or without reminders (52%) compared with the group that received reminders alone or usual care (35%)* Adequate medication intensification was associated with fall in HbA1c* Therapy intensification among the reminder only group and control group did not remain above baseline levels	No cost information reported	Reminders might have been more effective if the health care providers had been "forced" to respond to them	16.5
Shea et al. (2006)	Telemedicine Home telemedicine unit (HTU) developed specifically for Informatics for Diabetes Education and Telemedicine (IDEATE) project	Improve HbA1c, blood pressure, and lipid levels using telemedicine	Randomized controlled trial (1-year follow-up) Intervention: RN telemedicine case management and treatment algorithms Control: Usual care	Urban patients identified and enrolled through Columbia University Medical Center	Intervention group experienced improvements in: HbA1c (net compared with control group of -0.18%)*	Burden on the health care delivery system—cost of technology and personnel for case management	Physical size of the HTU and difficulty in learning to use it, responsible for most dropouts of technology HTU could not be installed in some	21

(continued)

Table 2. (continued)

Reference	Health IT Focus	Study Objective(s)	Study Design	Population Characteristics	Results Summary	Cost of Health IT Implementation	Health IT Use Lessons Learned	Quality Score (out of 27)
	Designed for videoconferencing, remote monitoring of glucose and blood pressure, accessing web portal to clinical data, web-messaging with nurse case managers, and diabetes education website			Rural patients identified and enrolled through State University of New York 1,665 Medicare beneficiaries residing in federally designated medically underserved areas 15% African American 36% Latino	Systolic blood pressure (net -3.4 mmHg) and diastolic blood pressure (net -1.9 mmHg)* Total (net -11.06 mg/dL) and LDL lipid levels (net -9.5 mg/dL)*	Cost to project for HTU devices was \$3,425 Increase in Medicare claims in intervention group (increased use of services) Reimbursement models may not cover telemedicine visits	homes because of poor telephone line quality Providers still preferred traditional communication with nurse case managers despite access to secure web-based messaging Providers must be licensed in the state where telemedicine is accessed Digital divide (disproportionate experience using technology) was not a large barrier to use Comfort with technology and belief in benefit from it played an important role in enrollment (Palmas et al., 2006) Most frequent reason for participation was belief that technology could help them (52% urban, 42% rural; Palmas et al., 2006)	21

(continued)

Table 2. (continued)

Reference	Health IT Focus	Study Objective(s)	Study Design	Population Characteristics	Results Summary	Cost of Health IT Implementation	Health IT Use Lessons Learned	Quality Score (out of 27)
Shea et al. (2009)	Telemedicine HTU developed specifically for IDEATel project	To examine the effectiveness of telemedicine intervention to achieve clinical management goals in older, ethnically diverse, medically underserved patients with diabetes	Randomized controlled trial (5-year follow-up) Intervention: RN telemedicine case management and treatment algorithms Control: Usual care	Urban patients identified and enrolled through Columbia University Medical Center	Intervention group experienced improvements in: HbA1c: $-0.29\%^*$ Systolic blood pressure: -4.32 mmHg ^a Diastolic blood pressure: -2.64 mmHg ^a LDL: -3.84 mg/dL* Hazard ratio 1.01—	No cost information reported Costs to Medicare for this program are reported elsewhere (Moreno et al., 2009)	22% of rural nonparticipants were not comfortable with the technology (Palmas et al., 2006) 71% of urban nonparticipants did not believe technology could help them; 52% uncomfortable with it (Palmas et al., 2006)	20.5
	Designed for videoconferencing, remote monitoring of glucose and blood pressure, accessing web portal to clinical data, web-messaging with nurse case managers, and diabetes education website			Rural patients identified and enrolled through State University of New York 1,665 Medicare beneficiaries (793 after 5 years) residing in federally designated medically underserved areas 15% African American 36% Latino			High attrition rate	

(continued)

Table 2. (continued)

Reference	Health IT Focus	Study Objective(s)	Study Design	Population Characteristics	Results Summary	Cost of Health IT Implementation	Health IT Use Lessons Learned	Quality Score (out of 27)
Cherry et al. (2002)	<p>Telemedicine Diabetes Disease Management Program featuring the use of Health Hero iCare Desktop and the Health Buddy appliance</p> <p>Health Hero iCare Desktop allows for integrated patient enrollment, scheduling, monitoring tools, a secure website; used by Mercy's telephone support staff</p> <p>Health Buddy appliance allows for patient communication; monitoring through diabetes education, reinforcement, and prompts; connects to existing phone line and does not require Internet access</p>	To determine the impact of a web-based patient interface technology as part of a diabetes disease management program	<p>Pre-post design (1 year: 2000-2001)</p> <p>Participants had Health Buddy appliance installed on home telephone line, were prompted to answer self-management questions daily; care managers followed up with patients at highest calculated risk for hospitalization or adverse outcomes</p>	<p>Mercy Health Center in Laredo, Texas</p> <p>Indigent border residents with diabetes; economically disadvantaged</p> <p>169 patients with diabetes identified through hospital discharge data, physician private practices, local health department</p> <p>diabetic clinics, regional clinic registries and outreach programs</p>	<p>Intervention reduced: Inpatient hospitalizations: (-32%)</p> <p>Postdischarge care visits (-44%)</p> <p>Outpatient visits (-49%)*</p> <p>ER encounters (-34%)</p> <p>Improved perceived quality of life assessed by Medical Outcomes Study</p> <p>12-item Short Form survey: mental component improved 2.8 points,* physical component improved 2.1 points</p> <p>94% of participants self-reported regular medication adherence (up from 34%)</p>	<p>Saved approximately \$747/ member/year compared with 1999</p> <p>comparative sample of people with diabetes</p>	<p>Health Hero technology platform: flexibility, simplicity, timeliness, cost</p> <p>Health Buddy reportedly easy to use, high levels of perceived value</p> <p>Patient is required to have a home telephone line</p>	10.5

Note: CHC = community health center; CVDEMS = cardiovascular/diabetes electronic management system; DM = diabetes mellitus; ER = emergency room;

health IT = health information technology; HTU = home telemedicine unit; IDEXTel = Informatics for Diabetes Education and Telemedicine; IPCAAD = Improving

Primary Care of African Americans with Diabetes; LDL = low-density lipoprotein; RN = registered nurse.

* $p \leq .05$.

received the personalized goal report who had a baseline HbA1c $\geq 7.0\%$ had an absolute reduction of 1.69% in HbA1c versus 0.77% in HbA1c among control subjects at 6 months' follow-up ($p = .03$).

The Gerber et al. (2005) randomized controlled trial evaluated a clinic-based multimedia intervention using computer kiosks for diabetes education targeting individuals with low health literacy in five inner city, publicly run health centers with a mix of Latino and African American patients (quality score 20). This study found no changes in HbA1c, weight, blood pressure, diabetes knowledge, self-efficacy, or self-reported medical care at the end of 1 year.

The Levetan et al. (2002) study demonstrated that a personalized report of diabetes values and goals may hold promise for improving HbA1c, but a clinic needs to have an EMR already in use and a software algorithm to conduct this intervention. Gerber et al.'s work targeted those with lower health literacy and less computer experience but had problems with computer malfunction. The Gerber et al. (2005) study highlighted the additional challenges of appropriate technical support, testing, and user skills for implementing advanced IT interventions in safety net settings.

Provider oriented. We identified two articles that used health IT in provider-oriented QI initiatives from the Improving Primary Care of African Americans with Diabetes (IPCAAD) study (Phillips et al., 2005; Ziemer et al., 2006). IPCAAD was a randomized controlled trial that evaluated computerized reminders and in-person feedback from an endocrinologist on patient diabetes outcomes and provider behavior regarding medication intensification. The study was conducted in a municipal hospital primary care clinic within a large academic center serving primarily African American patients and had a 3-year follow-up.

The Phillips et al. (2005) study found that improvement in HbA1c was significantly greater for patients who saw providers receiving in-person feedback plus reminders compared with the providers in the control group (-0.6% vs. -0.2% , $p < .02$). It also found improvements in systolic blood pressure within the feedback plus reminder and feedback only groups but not in the reminders only or control arm. LDL within groups improved in all intervention arms. This study had a quality score of 18.

In the Ziemer et al. (2006) study, medication intensification occurred more frequently when providers received in-person feedback with or without reminders compared with the group that received reminders alone or usual care (52% vs. 35% , $p < .001$) at 3 years. Adequate medication intensification was associated with a significant fall in HbA1c (-0.19% , $p < .001$). This study had a quality score of 16.5.

The IPCAAD studies demonstrated that electronic clinical reminders can modify provider prescribing behavior and improve glycemic control. Reminders were more effective when the providers received in-person feedback from an endocrinologist. Considering the lack of access to subspecialty care in underresourced settings, this intervention may not be feasible to implement in safety net settings.

System oriented. We found five studies that published six articles assessing organization/system-based interventions (Bray, Roupe, et al., 2005; Bray, Thompson, et al., 2005; Cherry et al., 2002; Chin et al., 2004; Shea et al., 2006; Shea et al., 2009)

The Health Resources and Services Administration's Health Disparities Collaboratives is a QI model that used plan-do-study-act cycles, the MacColl Institute's Chronic Care Model, and learning sessions to improve diabetes outcomes. In the first year of the intervention in 19 Midwestern health centers, 37% of the community health centers chose to implement an electronic registry to track patient examination and laboratory data (Chin et al., 2004). Several key processes of care improved at 1 year with the intervention, including rates of HbA1c measurement (80% to 90%, adjusted odds ratio [OR] 2.1, 95% confidence interval [CI] 1.6-2.8), foot examination (40% to 64%; OR 2.7, 95% CI 1.8-4.1), and lipid assessments (55% to 66%, OR 1.6, 95% CI 1.1-2.3). HbA1c did not significantly improve. Staff from the sites that developed a registry found it useful but burdensome and requested more technical support. This study had a quality score of 13. There have been follow-up studies to Chin et al.'s initial evaluation. A national study of the Health Disparities Collaboratives found improvement in diabetes processes of care but not in intermediate outcomes compared to matched control clinics at 1- to 2-year follow-up (Landon et al., 2007). Follow-up at 4 years of diabetic patients in 16 Midwestern and West Central health centers in the Health Disparities Collaboratives found improvements in processes of care and HbA1c and LDL cholesterol values (Chin et al., 2007).

Bray et al.'s studies also describe interventions using an electronic registry called the Cardiovascular/Diabetes Electronic Management System (CVDEMS; Bray, Roupe et al., 2005; Bray, Thompson, et al., 2005). CVDEMS is an electronic patient care registry system that allows office staff to enter demographic information regarding each patient into a clinic population registry. Providers can query detailed patient and laboratory information and obtain summary reports. The two Bray et al. (2005) studies explored the feasibility, cost-effectiveness, and efficacy of using diabetes care management, group visits, visit reminders, and CVDEMS. The intervention was implemented in solo or small group primary care practices with a majority rural African American patient population with diabetes. This study used a pre-post design with control patients from a separate clinical site. HbA1cs were similar at baseline for both the intervention (8.2 ± 2.6) and control groups (8.3 ± 2.6), but mean HbA1c was significantly lower in the intervention group (7.1 ± 2.3) versus the control group (8.6 ± 2.4 ; $p < .05$) at 1 year. Patients receiving the intervention experienced a 61% reduction in HbA1c, while the control group increased HbA1c levels. Documentation of lipid panels (55% to 76%) and foot examinations (12% to 54%) improved within the intervention group at 1 year. Provider productivity also improved from 20.17 to 31.55 average daily encounters. Some clinical staff thought the CVDEMS was duplicative of the medical record, and the leadership began to move toward implementation of an EMR in the practices. These studies had an average quality score of 11.5.

Two studies evaluated telemedicine as a way to bridge the gap between office visits for patients and access to subspecialty care in underresourced settings (Cherry et al., 2002; Shea et al., 2006). Cherry et al.'s (2002) study tested a web-based patient interface technology that prompted patients to answer daily self-management questions. It

also allowed care managers to follow-up with patients at highest calculated risk for hospitalization or adverse outcomes. It used a pre-post design with 1-year follow-up and was conducted in a Mexican border community. The study found a reduction in inpatient admission (-32% , $p < .07$) and emergency room visits (-34% , $p < .06$). Patients also had improvement in mental health quality of life ($p < .03$) from baseline to follow-up. The home technology used a telephone line and was reported to be easy to use, but it required a partnership with a health care system that used an EMR. This study had a quality score of 10.5.

Shea et al. (2006, 2009) reported two randomized controlled trials that evaluated the effect of nurse guided telemedicine case management and treatment algorithms using a home telemedicine unit (HTU) on patient clinical outcomes in the Informatics for Diabetes Education and Telemedicine (IDEATel) Project. The IDEATel Project provided patients with an HTU, which consisted of a web-enabled computer with modem. The HTU allowed synchronous videoconferencing over standard telephone lines, electronic transmission of finger stick glucose and blood pressure readings, secure web-based messaging with nurse case managers, and the ability to review clinical data and access web-based education materials (Blanchet, 2008; Shea et al., 2006). Patients could take pictures of skin and feet and send those images to their nurse case managers. The study population included primarily African American and Latino patients with diabetes who were Medicare recipients living in federally designated medically underserved areas of New York State.

The IDEATel Project demonstrated significant decreases in HbA1c, blood pressure, and LDL at 1- and 5-year follow-up (Shea et al., 2006; Shea et al., 2009). There were net reductions in HbA1c (-0.18% , $p = .006$), systolic blood pressure (-3.4 mmHg, $p = .001$), and LDL cholesterol (-9.5 mg/dL, $p < .001$) in the intervention group after 1 year of follow-up (Shea et al., 2006). After 5 years of follow-up, there were net reductions in HbA1c (-0.29% , $p = .001$), systolic blood pressure (-4.32 mmHg, $p = .02$), and LDL (-3.84 mg/dL, $p < .001$) in the intervention group compared to the control group, but there was no difference in mortality between groups (Shea et al., 2009). The 2006 and 2009 studies had quality scores of 21 and 20.5, respectively.

Although the Shea et al. studies demonstrated improved diabetes outcomes, some challenges were noted. The HTU was expensive, and patients had difficulty learning how to use it. The intervention also required additional personnel for case management and to set up the technology in the clinic. There was a high attrition rate after 5 years (Shea et al., 2009). Cost analysis demonstrated that IDEATel did not reduce Medicare costs for health services; the cost per person per year was more than \$8,000, which was excessive compared with other non-health IT programs that had similar clinical impacts (Moreno, Dale, Chen, & Magee, 2009).

These system-oriented health IT interventions suggest that electronic registries and telemedicine may hold promise in improving diabetes outcomes. The telemedicine studies reduced health care utilization and improved diabetes clinical outcomes but were expensive and required additional personnel for case management.

Discussion

Our review provides an update on QI initiatives targeted at improving diabetes disparities and a review of health IT interventions to improve diabetes outcomes in minority patient populations. The 2006-2009 QI update presented many findings similar to studies published from 1985 to 2006, with some novel interventions. We found that QI projects using cognitive-behavioral education, self-care management, and resilience training tended to be more successful in improving diabetes outcomes (Cramer et al., 2007; Mauldon et al., 2006; Steinhardt et al., 2009). Treatment algorithms for providers improved diabetes clinical outcomes, though cultural competency training of providers did not lead to improvement in patient outcomes (C. D. Miller et al., 2006; Thom et al., 2006). The use of community health workers demonstrated improvements in diabetes intermediate outcomes, processes of care, knowledge, and social support and in outreach to patients who were on the fringe of the health care system (Babamoto et al., 2009; Ingram et al., 2007; Joshu et al., 2007; Lujan et al., 2007; Sixta & Ostwald 2008; Thompson et al., 2007). Nonphysician providers reduced diabetes-related urgent visits and emergency room visits (Davidson et al., 2007). From our review, we found mixed evidence from health IT studies designed to improve diabetes outcomes in minority patients.

Lessons Learned From Health IT Initiatives

In our review of diabetes QI initiatives using health IT, patient-level interventions included personalized diabetes reports and computer-based multimedia diabetes education. These interventions reported mixed results. Personalized reports of diabetes values and goals can improve HbA1c, but a clinic needed to have an EMR already in use and a software algorithm to conduct this intervention (Levetan et al., 2002). Another study aimed to involve patients with lower health literacy and those with less computer experience, but it showed no improvements in diabetes outcomes, and it reported problems with computer malfunction (Gerber et al., 2005). Patient directed health IT interventions required sophisticated technology and support from case managers or other health care personnel and did not consistently improve diabetes outcomes (Gerber et al., 2005; Levetan et al., 2002).

We found few studies that tested provider-oriented health IT interventions. The IPCAAD study tested the effect of clinical decision support systems for physicians in intensifying patient's medication regimens (Phillips et al., 2005; Ziemer et al., 2006). Medication intensification occurred more frequently when providers received in-person feedback regarding medication changes. The study also found improvements in HbA1c in patients who were in the intervention arm. These clinical reminders were more effective when the providers received in-person feedback from an endocrinologist, which may not be feasible to implement in all health care settings.

Registries facilitated tracking and analysis of data and improved diabetes outcomes in some studies. The Chin et al. (2004) and Bray et al. (2005) studies demonstrate how registries can be used to track data and be integrated within more multitargeted

interventions to improve diabetes outcomes. Yet the registries were found to be burdensome and duplicative of an EMR system.

Other systems-oriented health IT interventions used telemedicine to bridge the gap between office visits for patients and demonstrated improvements in diabetes clinical outcomes (Cherry et al., 2002; Shea et al., 2006; Shea et al., 2009). From the patient perspective, the home technology units were difficult to use (Shea et al., 2006; Shea et al., 2009). Telemedicine interventions show promise, but the cost of the technology and need for additional support staff may overshadow the benefit.

Limitations of Current Work

Although we found many studies of the use of health IT to improve diabetes outcomes that were conducted in the past 9 years, there were many limitations to the literature. Given the heterogeneous designs and varying patient populations and settings, we could not compare effect sizes across studies; however, the data may suggest trends in diabetes outcomes among racial/ethnic minority patients when using particular interventions. We found only a few health IT interventions that were tested in minority patient populations. We also did not find many studies that were conducted in under-resourced settings, such as public hospitals or rural clinics. Study follow-up periods were generally short, usually about 12 months. A previous review of health IT has found similar limitations (Jackson, Bolen, Brancati, Batts-Turner, & Gary, 2006). Additionally, few studies reported cost data, thus making cost-effectiveness difficult to assess. Although we made an effort to search multiple databases and conduct hand searches, there may be diabetes QI literature that we did not identify. In addition, some organizations that have conducted interventions to improve diabetes care may not have published their findings. Our review was also limited by publication bias because positive findings tend to be published more often than negative findings.

Conclusion and Future Directions

Health care is rapidly becoming digital. New technologies may be harnessed to improve diabetes disparities, yet there are many gaps in the literature on the role of health IT in decreasing diabetes disparities. From our review of the literature, we identify opportunities for policy implementation and areas that need further research. Health IT policy should encourage (a) the development of innovative health IT interventions that target diabetes processes and outcome measures, (b) rigorous evaluations of these interventions, and (c) support for underresourced settings to strengthen their infrastructure to implement health IT.

Development of Targeted Health IT Interventions to Improve Diabetes Processes and Outcomes

Culturally tailored interventions. Culturally tailored, low literacy health IT interventions need to be developed to improve patient access to health information. Few studies have

targeted non-English speakers and those with low literacy (Glasgow et al., 2005; Lorig, Ritter, & Laurent, 2006). People who speak and read little English or no English or have lower reading skills may face undue burden in using advanced technologies. Websites and other health IT applications often assume a level of English language comprehension and a baseline computer skill level that may place immigrants, nonnative English speakers, and those with limited literacy at a disadvantage. Designing health IT interventions that use voice recognition, television-based Internet, or touch screen systems may hold promise for these populations (Eng et al., 1998). Testing and modifying such technologies with these groups will be crucial to their application in reducing diabetes disparities (Gibbons, 2005).

Use of innovative technologies. Innovative technologies need to be integrated into health IT interventions. We found no studies that used mobile phones, social networking sites, YouTube, or Twitter to improve access or improve diabetes outcomes among minority populations or in underresourced settings. We found no studies that used health IT integrated into community health worker programs to address diabetes disparities. Health information technologies may be used to increase social support among patients, encourage behavioral changes, and enhance community health worker programs.

Communication and care coordination. Health IT can be used to enhance provider-to-provider communication and improve care coordination. Health IT may be used to alleviate the fragmentation of health care for minority patients in underresourced settings through improved communication between providers and access to subspecialists. Although we found many examples of telemedicine and e-referrals that extended the reach of subspecialists, few studies were conducted in minority patient populations (Kim et al., 2009; Shea et al., 2009). More studies are needed that aim to enhance communication across providers and subspecialists in addressing poor subspecialty access for patients and improving continuity of care among patients who may have fragmented care.

Cultural competency training. Health IT interventions that address patient-provider communication and cultural competency training need to be developed. Health IT interventions may be used in underresourced settings to facilitate communication with culturally diverse patient populations in innovative ways. We found no studies that used health IT applications to enhance patient communication with providers, facilitated shared decision-making, or emphasized culturally competent interactions with patients.

Patient-centered behavioral interventions. Health IT innovations can be used to design novel behavioral interventions and enhance current patient centered interventions. In underresourced settings, patients may not have access to diabetes behavioral management programs. Through the use of health IT innovations—such as mobile phone technologies, computerized simulations, and interactive web-based programs—individuals with diabetes may be able to monitor their physical activity, weight loss, and other physiological markers and receive prompts to encourage self-management. Other health IT innovations, such as personalized health records (PHRs) and social network applications, may enhance access to providers, provide consistency in care, empower patients, and provide peer support (Barrera, Glasgow, McKay, Boles, & Feil, 2002;

Zrebiec, 2005). PHRs that are portable and interoperable with EMRs can be of great benefit to patients in underresourced settings who may have fragmented care. There is also a need for more low literacy, culturally relevant patient applications. PHRs may benefit disadvantaged populations by enabling consistent care, electronic access to information on health conditions, and enhanced communication with primary care providers (Gibbons, 2005; Ueckert, Goerz, Ataian, Tessmann, & Prokosch, 2003). Many applications exist for PHRs, but they have not been tested in minority patient populations or underresourced settings (Weitzman, Kaci, & Mandl, 2009; see also MiVIA at <https://www.mivia.org>).

Enhanced data tracking. There needs to be further development and testing of interventions that enhance data tracking and that are interoperable between many health systems. Regional HIEs are developing, but we found no studies that tested the impact of these systems in decreasing diabetes disparities. Health systems to track and report data on race/ethnicity and other social determinants of health are a basic need (Ulmer, McFadden, & Nerenz, 2009). These systems can also facilitate disease tracking, allow quicker access to patient information, and improve continuity of care. Designing interventions that are interoperable between many health systems is crucial. Interoperable systems can enhance sharing of data among providers, laboratories, and health systems.

Rigorous Evaluations of Current Health IT Interventions and Their Impact on Diabetes Disparities

Effectiveness of health IT interventions and cost data. More studies are needed that examine the effectiveness of health IT interventions in underresourced settings that serve minority patients. We need to understand the feasibility, acceptability, and effectiveness of these technological interventions for reducing disparities in diabetes. More studies are also needed to examine implementation cost and the cost-effectiveness of these interventions, especially in underresourced settings where financial barriers may inhibit the use of health IT innovations. Understanding the true costs of implementation and any savings over time will allow better planning for underresourced settings to implement health IT (Goldzweig, Towfigh, Maglione, & Shekelle, 2009; Harris, Haneuse, Martin, & Ralston, 2009; Huang et al., 2007; Moreno et al., 2009; Welch et al., 2007). Although financial incentives are necessary to prevent safety net clinics from lagging in health IT implementation, analyses of long-term costs are also crucial to better understand the payoff of the initial investment in health IT for these settings. Longer follow up may also give better insight into the effect of health IT interventions because fine-tuning is necessary in the initial set-up phases. Additionally, more studies are needed that measure reduction in diabetes disparities across populations in addition to improvement of diabetes outcomes in minority patients.

Testing of EMR capabilities. Studies are needed to test the ability of EMRs to track and monitor patients, provide feedback, assess medication adherence, and improve diabetes outcomes. EMRs can provide the capacity for computerized provider order entry and clinical decision support (Aarts & Koppel, 2009). EMRs can also automate

the collection and movement of information that would enhance patient care and monitor quality of diabetes care. Tracking race data allows safety net clinics to identify trends among their patients and may facilitate recruitment of minority patients who are underrepresented in clinical trials. The studies we found using EMRs in minority patients did not fully use all of the EMRs' components to assess diabetes outcomes.

Multitargeted intervention evaluation. More studies are needed that assess multitargeted health IT interventions. Also, more studies are needed that integrate all aspects of health IT and harness their potential. Through the utilization of all the aspects of health IT—such as EMR, clinical decision support, computerized order entry, and interoperability with regional HIEs—we can understand how to fully use health IT innovations to reduce diabetes disparities.

Underresourced Settings Need Support to Build Infrastructure to Implement Health IT Interventions

Multipayer projects. Multipayer pilot projects and financial incentives are needed to encourage health IT implementation in underresourced settings that may face many financial barriers in implementing innovative health IT applications. These barriers may be overcome by providing external financial incentives, demonstration grants, and collaborations (R. H. Miller & Sim, 2004; Simon, Rundall, & Shortell, 2007). The American Recovery and Reinvestment Act (2009) provides financial incentives for providers and hospitals to use certified EMRs and subsidies for physicians with high volumes of Medicaid patients (Blumenthal, 2009). Other incentives may be necessary for underresourced settings to implement EMRs (Blumenthal, 2009). Nonvisit care, such as phone communication and electronic mail, is not generally reimbursed, so strong incentives exist for providers to delay EMR implementation. Rewarding practices for publishing performance reports and mandating specific quality improvement tactics or IT applications could hasten implementation (R. H. Miller & Sim, 2004; Simon et al., 2007). Financial resources need to be available for underresourced settings to partner with local organizations, businesses, and government organizations to install EMRs, participate in regional HIEs, and use innovative health IT applications to improve patient outcomes (Goroll, Simon, Tripathi, Ascenzo, & Bates, 2009; McDonald et al., 2005; Mostashari, Tripathi, & Kendall, 2009). Pilot grants to fund implementation projects and other financial incentives, such as payment for improved performance and for nonvisit care, will be critical in underresourced settings implementing QI interventions using health IT.

Assessing human capital needs. It is important to assess human capital needs to implement and maintain health IT interventions in underresourced settings. Although some of the studies we reviewed commented on the need for nursing staff, case managers, or staff to assist in maintaining health IT interventions, no studies reported the type of staff and number of staff needed to support health IT interventions in underresourced settings (Bray, Thompson, et al., 2005; Chin et al., 2007). Studies in EMR process measurement have noted the importance of a health IT champion, yet this

concept still needs testing in underresourced settings and in addressing diabetes (Zandieh et al., 2008). Chronic disease management requires a team of physicians, nurses, case managers, and other allied health professionals. Hiring nurse educators, nurse case managers, and case managers to triage clinical decision alerts or receive alerts on missed appointments or elevated laboratory values may be one way to decrease the burden of "reminder fatigue" for providers (Dixon & Samarth, 2009). Clinical reminders can provide better information at the time of clinical decision making for individual patients, but these reminders need to be supported by other personnel.

Best practices for underresourced settings. Best practices in how community health centers and nonprofit organizations can partner with for-profit organizations and state and federal governments to install health IT are needed. Demonstration projects and evaluations can identify critical implementation lessons and disseminate best practices. Descriptions of processes undertaken to encourage adoption of health IT technologies and how to integrate them into current work flow are necessary to plan and execute the implementation of health IT innovations in underresourced settings. Actively engaging providers in deciding what functions, clinical reminders, and alerts are most valuable is essential for integrating EMRs into the current infrastructure and avoiding provider fatigue and resistance to the EMR (Ko et al., 2007).

Technological support. Technological support needs to be implemented for underresourced settings because these organizations may not have adequate personnel trained in health IT or a physician IT champion who can ensure a smooth transition to EMR. The American Recovery and Reinvestment Act of 2009 described establishment of regional centers to assist providers seeking to adopt and become meaningful users of health IT. These centers will be key in offering technologic support to rural and other underresourced health care settings in the implementation and maintenance of health IT infrastructure (Centers for Medicare and Medicaid Services, 2009).

The rapid advancement of health IT offers unprecedented opportunities for policy makers, clinicians, and health systems to address disparities in diabetes care and outcomes. Integrating innovations in health IT with QI initiatives is likely to be a powerful way to reduce diabetes disparities.

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