Published in final edited form as:
Med Care Res Rev. 2007 October ; 64(5 Suppl): 101S–156S.

Diabetes Health Disparities:

A Systematic Review of Health Care Interventions

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Abstract

Racial and ethnic minorities bear a disproportionate burden of the diabetes epidemic; they have higher prevalence rates, worse diabetes control, and higher rates of complications. This article reviews the effectiveness of health care interventions at improving health outcomes and/or reducing diabetes health disparities among racial/ethnic minorities with diabetes. Forty-two studies met inclusion criteria. On average, these health care interventions improved the quality of care for racial/ethnic minorities, improved health outcomes (such as diabetes control and reduced diabetes complications), and possibly reduced health disparities in quality of care. There is evidence supporting the use of interventions that target patients (primarily through culturally tailored programs), providers (especially through one-on-one feedback and education), and health systems (particularly with nurse case managers and nurse clinicians). More research is needed in the areas of racial/ethnic minorities other than African Americans and Latinos, health disparity reductions, long-term diabetes-related outcomes, and the sustainability of health care interventions over time.

Keywords

diabetes; disparities; interventions; minorities

Significant diabetes disparities exist among racial/ethnic minorities in both health outcomes and quality of care. With the aging of the U.S. population and the rising prevalence of chronic diseases, these disparities have important public health implications for the near future. Healthy People 2010, which provides the prevention agenda for the United States, has set a goal of eliminating disparities in diabetes health outcomes by the year 2010 (U.S. Department of Health and Human Services 2000).

To meet the goals of Healthy People 2010, it is important for health care leaders and policy makers to be aware of what interventions appear to be effective currently and what direction future interventions should take. Within the past two decades, significant public resources have been devoted to developing and evaluating interventions designed to improve diabetes care in the general population. Quality improvement (QI) programs and disease management programs have been found to be effective individually and in quantitative literature reviews (Norris et al. 2002). While these interventions may be effective for the general population, we know less about how these QI programs have affected ethnic/minority patients or how these programs have affected disparities in diabetes outcomes.

New Contribution/Conceptual Framework

There have been no attempts to evaluate and summarize the available evidence about the effectiveness of interventions designed to improve diabetes health outcomes among racial/

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ethnic minorities and reduce health disparities. Interventions to reduce disparities in diabetes outcomes can be categorized based on their intended target: patients, providers, health systems, or a combination (multitarget interventions), each of which is an important determinant of health disparities (see model in Chin et al. 2007 [this issue]). *Patients* have the ability to affect their health care and health outcomes through self-education, treatment adherence, and health-promoting behaviors. This is particularly important in chronic diseases such as diabetes, where self-management is a central tenet of care and has been linked to positive health outcomes (Norris, Engelgau, and Narayan 2001). *Providers*, particularly primary care physicians (PCPs), are another essential determinant of diabetes health care and health outcomes because they coordinate all aspects of care. Providers with more “clinical inertia,” defined as a lack of medication intensification despite clinical indications, have patients with worse diabetes control (Rhee et al. 2002). Early research also indicates that African American patients are more likely to experience clinical inertia, thus indicating the importance of addressing providers in interventions designed to reduce health disparities (Miller et al. 2003). *Health care organization* interventions have the potential to effect significant changes in health care processes and health outcomes. Diabetes has been the focus of disease management programs and other health care organization innovations, such as the increasing use of nonphysician providers to deliver care (Garfield et al. 2003).

With this organizational framework, we set out to (1) summarize the existing knowledge regarding the epidemiology of diabetes health disparities, (2) systematically review the medical literature for health care interventions that have the potential to reduce diabetes disparities, and (3) identify promising areas for future interventions. Our review includes programs that specifically target racial/ethnic minorities (some of which have been culturally tailored) as well as general QI initiatives that include a subgroup analysis by race. We conclude the report by making recommendations for future areas of investigation based on the epidemiology of disparities and the limitations of current interventions. Our goal is to provide physicians, administrators, and health policy analysts with rigorous scientific information about potentially effective strategies to reduce diabetes health disparities within our health care system.

Epidemiology of Disparities in Type 2 Diabetes

Diabetes Incidence and Prevalence

Diabetes is a major cause of morbidity and mortality in the United States. It is the seventh leading cause of death (Aubert et al. 1998), and the direct cost of medical care is approximately $100 billion annually (Caravalho and Saylor 2000). There are approximately 15 million adults currently living with diabetes, and the prevalence rates have continued to escalate for the past decade, with racial/ethnic minority populations suffering a disproportionate burden of disease (McBean et al. 2004). In 2000, the Behavioral Risk Factor Surveillance System reported that 7% of Americans have diabetes, with prevalence rates of 7% among non-Hispanic whites compared to 9% among Hispanics and 11% among African Americans (Mokdad et al. 2001). Little national representative data exists about Native Americans/Alaskan Natives (NA/ANs), Asian Americans/Pacific Islanders (AA/PIs), and other racial/ethnic groups (i.e., South Asians), but regional data indicates that diabetes is more common among these racial minority groups as well (Venkataraman et al. 2004; Will et al. 1997). For example, the prevalence of diabetes among the Navajo is 41% (Will et al. 1997) among persons age 65 and older, and among the Northern Plains Native Americans, diabetes prevalence is 33% for men and 40% for women age 45-74 (Lee et al. 1995).

Diabetes Complications and Control

Racial/ethnic minorities also have significantly higher rates of diabetes-related complications. For example, African Americans have 2-4 times the rate of renal disease, blindness, amputations, and amputation-related mortality of non-Hispanic whites (Carter, Pugh, and Monterrosa 1996; Lanting et al. 2005; Lustman et al. 2000). Similarly, Latinos have higher rates of renal disease and retinopathy (Carter, Pugh, and Monterrosa 1996; Emanuele et al. 2005; M. A. Harris et al. 1998; Lanting et al. 2005). Diabetes age-adjusted mortality rates (per 100,000) in California in 1998 were 60 for Latinos and 98 for African Americans compared to 38 for non-Hispanic whites (California Medi-Cal Type 2 Diabetes Study Group 2004). Diabetes-related mortality is 2.7 times higher in NA/ANs than whites, and when adjusted for underreporting, the rate is estimated to be 4.3 times that of non-Hispanic whites (American Public Health Association 1999).

These higher rates of complications may be the product of disproportionately poor control of diabetes as well as associated cardiovascular risk factors such as blood pressure and cholesterol (Gaede et al. 2003). One national data set reported average glycosylated hemoglobin (HbA1c) levels of 7.6% among non-Hispanic white women compared to 7.9% among Mexican American women and 8.3% among African American women (M. I. Harris et al. 1999). In addition, racial/ethnic minorities have higher rates, and worse control, of dyslipidemia and hypertension (Centers for Disease Control and Prevention 2005; Sundquist, Winkleby, and Pudaric 2001).

Disparities in Diabetes Quality of Care

While the reasons for the disparities in diabetes prevalence and health outcomes are multifactorial, there is important evidence that the provision of a lower quality of care may be an important contributor to the current state of diabetes disparities (M. I. Harris 1999). The Institute of Medicine report *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care* reviewed the literature and found that while health care access and demographic variables account for some of the racial disparities in health status, there is a persistent residual gap in outcomes attributed to differences in the quality of care received (Smedley, Stith, and Nelson 2002). For example, Puerto Rican adults with diabetes in New York State are less likely than whites to receive annual HbA1c testing (73% vs. 85%), cholesterol testing (68% vs. 87%), hypertensive medications (82% vs. 92%), and pneumococcal vaccinations (19% vs. 29%) despite having equal access to health care, as measured by insurance, medical home, and the frequency of physician visits (Hosler and Melnik 2005). Another study found that whites were more likely to have a lipid profile and a dilated ophthalmologic examination than all other racial/ethnic groups including African Americans, Hispanics, NA/ANs, and AA/PIs (Thackeray, Merrill, and Neiger 2004). Similar studies have found racial differences in the quality of care for comorbid conditions, including both testing and treatment for hypertension and dyslipidemia among Hispanics and African Americans compared to non-Hispanic whites (Arday et al. 2002; Hertz, Unger, and Ferrario 2006; Jenkins et al. 2004; Massing et al. 2003). There is evidence that managed care plans with large numbers of minority patients provide a lower quality of care to their patients than plans with fewer minority patients (E. C. Schneider, Zaslavsky, and Epstein 2002).

It is important to note, however, that the problem of suboptimal diabetes care is one that exists for both minorities and whites. For example, a medical chart review of rural private practices reported the following adherence rates to diabetes guidelines: 15% for foot exams, 23% for annual eye examinations, 33% for annual microalbuminuria testing, and 20% for annual HbA1c measurement (Kirkman et al. 2002). According to the 1999-2002 National Health and Nutrition Examination Survey, only 38% of persons with diabetes had ever had a pneumococcal vaccination, and only 28% reported getting recommended amounts of physical activity (Resnick et al. 2006). A review of diabetes quality measures at community health centers reported that 70% of patients had at least one HbA1c measurement annually, but only 26% had a dilated eye examination, 51% had appropriate foot care, 32% had influenza vaccinations, and 7% had received a dental referral (Chin et al. 2000).

To address the problem of suboptimal diabetes care, the federal government, insurance companies, and health care delivery systems have invested heavily in QI programs (Kerr et al. 2004). With the philosophy that a rising tide floats all boats, these programs have the potential to improve health disparities for racial/ethnic minorities. Recent data from Medicare Managed Care beneficiaries show that diabetes care is improving overall and that racial disparities may be improving as well (Trivedi et al. 2005). Improvements were noted in both whites and blacks for each performance measure, and disparities decreased for each measure (including eye exams, low-density lipoprotein [LDL] testing and control, and HbA1c testing) with the exception of diabetes control (Trivedi et al. 2005). The Veterans Health Administration (VHA), the largest U.S. health care provider, has also implemented a number of QI initiatives and recently reported measures of diabetes care and diabetes health outcomes that are much higher than the national average, including annual rates of HbA1c testing and eye examinations at 93% and 91% and rates of control of diabetes and dyslipidemia at 83% and 86% (Kerr et al. 2004). Some studies suggest that these generalized QI efforts within the VHA system have diminished or eliminated diabetes health disparities among racial/ethnic minority populations (Gordon, Johnson, and Ashton 2003; Heisler et al. 2003; Jha et al. 2001).

While the studies of these two health care systems are quite promising, caution must be exercised in interpreting these findings. First, Medicare Managed Care patients do not represent the entire spectrum of Medicare beneficiaries; these patients may be more likely to encounter preventive care initiatives in their managed care plans than other Medicare beneficiaries. Similarly, studies within the VHA system do not present the total health care experience of our nation’s veterans, many of whom receive additional care outside of the VHA. Recent studies that supplemented VHA utilization data with Medicare claims data found that among African Americans and Hispanics, health disparities reemerged or worsened when compared to VHA-only data (Halanych et al. 2006). A disproportionate utilization of non-VHA health care by non-Hispanic whites accounted for the worsening trends in health disparities. Thus, there is some evidence suggesting that generalized QI initiatives may not be particularly effective at reducing disparities when applied broadly within the population. One team of researchers used cross-sectional data to examine this question and found that among a diverse group of managed care plans, more intensive diabetes QI programs (including a diabetes registry, physician feedback, or physician reminders) did not consistently attenuate disparities in diabetes care when compared to the same programs at lower intensity levels (Duru et al. 2006).

In summary, there is evidence that racial/ethnic minorities have a higher diabetes disease burden and experience disparities in the quality of care they receive. Health care interventions that seek to improve diabetes care have the potential to improve health outcomes and reduce health disparities among racial/ethnic populations. This report synthesizes the available evidence about the effectiveness of such interventions.

Method

Sources

We searched multiple electronic databases (MEDLINE, Cochrane Register of Controlled Trials, PsycINFO, Cochrane Database of Systematic Reviews, ACP Journal Club, and CINAHL) for evaluation studies of interventions published from 1985 to 2006 that were designed to improve diabetes care for adult minority patients living with type 2 diabetes mellitus.

We supplemented the search with a hand search of the past 2 years of issues from selected journals with a high likelihood of publishing diabetes care interventions (*Diabetes Care, Diabetes Educator*). The hand search also included an examination of reference lists from initially identified trials and recent review articles on the topics of diabetes care and health disparities. The hand search was conducted by all three authors.

Search Terms and Strategies

We used prespecified Medical Subject Headings (MeSH) and keywords to identify evaluation studies (Evaluation Studies, Clinical Trials [PT]) designed to address health care delivery (Health Services Accessibility; Delivery of Health Care, Integrated; Quality of Health Care) among minority patients (African Continental Ancestry Group; African Americans; Blacks; Hispanic Americans; Mexican Americans; Latinos; Indians, North American; Inuits; Asian Americans; Inner City; Urban Health) living with diabetes (Diabetes Mellitus, Type 2; Diabetes Complications).

Inclusion and Exclusion Criteria

Patients of minority backgrounds were either the focus of studies (defined as >50% racial/ethnic minority patients) or subgroups of larger trials where minority subject data were specifically described. We excluded reports of interventions that were not based in health care settings, involved children, or exclusively addressed diabetes prevention. We included multiple study designs such as prospective observational studies, before/after studies, controlled trials, and randomized controlled trials. We included interventions that were culturally tailored as well as those that were not. We define “culturally tailored” programs as those that utilized individualized programming that takes into account participants’ personal preferences that are rooted in culture (Kreuter and Strecher 1996; T. R. Schneider et al. 2001). Culturally tailored programs are an important part of “cultural leverage,” defined by Fisher and colleagues as a “focused strategy for improving the health of racial and ethnic communities by using their cultural practices, products, philosophies, or environments as vehicles that facilitate behavior change of patients and practitioners” (Fisher et al. 2007 [this issue]).

Abstract Review

Specific inclusion and exclusion criteria were applied at each of the three levels of review. A total of 573 studies were found with 477 studies from the electronic database search and 96 from the hand search. Two authors independently reviewed the identified articles for possible inclusion; disagreements were resolved by consensus. Forty-three studies met our initial inclusion criteria.

Data Abstraction

Using an abstraction form adapted from Zaza and colleagues (Zaza et al. 2000), we collected information on intervention characteristics, patient demographics, baseline complications, and diabetes duration. We documented baseline and follow-up rates of delivery of standard processes of care for diabetes mellitus, including variables such as proportion of patients with HbA1c testing, lipid testing, blood pressure measurement, foot examination, and eye examination. We also abstracted the values for diabetes control (fasting blood glucose and HbA1c) and diabetes-related comorbid conditions (total cholesterol, LDL cholesterol, high-density lipoprotein cholesterol, triglycerides, systolic blood pressure, and diastolic blood pressure).

Study Quality Assessment

Studies were also rated on their quality by two of the reviewers using a scale of study quality developed by Downs and Black (1998), intended for use with randomized and nonrandomized intervention studies. We utilized the first 26 criteria in this instrument, with a maximum possible score of 27 (Downs and Black 1998). We created the following qualitative assessment scale: >20=*very good*, 15-19=*good*, 11-14=*fair*, and <10=*poor*. We conducted a 17% re-review of publications, and the interrater correlation coefficient was .73.

Analysis

Our primary outcomes of interest were diabetes processes of care (i.e., measurement of HbA1c, blood pressure, and cholesterol) and intermediate diabetes health outcomes (i.e., control of HbA1c, blood pressure, and cholesterol). We primarily define the effect as the difference in the parameter change from baseline in the intervention group compared to the control group (the “difference in differences”). When these data were not available, we report the effect as an intragroup parameter change from baseline in the intervention group. As described in our initial organizational framework, we divide interventions into those focusing on patients, providers, health care systems, and multitarget interventions. Among patient-targeted interventions, we make distinctions between generic programs and culturally tailored interventions.

We also performed a meta-analysis of HbA1c values across interventions comparing the final mean HbA1c between the intervention and the control group. The analysis was limited to controlled trials and randomized controlled trials, comparing an intervention with usual care, with available HbA1c data (means and standard deviations), following the inclusion/exclusion criteria noted in a prior meta-analysis (Chodosh et al. 2005). We used both fixed effects and random effects models for synthesizing continuous outcomes (Petitti 2000). Because there was no meaningful difference in fixed or random effects model results, we present fixed effects model results as the absolute difference in HbA1c with 95% confidence intervals.

Results

Our systematic review produced 43 studies that were described in 48 reports. Approximately two-thirds of the studies were controlled trials or randomized controlled trials, with the study type distribution as follows: controlled trials (7), randomized controlled trials (22), before/after studies (13), and observational studies (1). Twentyone (49%) of the studies had quality scores in the *very good* range (>20), 17 (40%) had scores in the *good* range (15-19), 4 (9%) studies were in the *fair* range (11-14), and 1 (2%) was rated as *poor* (<10). All but two studies involved comparisons within a given racial/ethnic minority population and sought to determine the intervention’s effectiveness at improving health outcomes. These two studies provided data on the intervention’s impact on reducing health disparities as well as data on changes in health outcomes among racial/ethnic minorities. Neither of these studies, however, utilized a control group; consequently, the amount of change due to secular trends cannot be quantified (Jenkins et al. 2004; Sequist et al. 2006).

In our meta-analysis of all eligible studies, diabetes programs that sought to improve health outcomes among racial/ethnic minority populations resulted in a mean HbA1c value in the intervention group that was 0.36% less (95% CI: 0.27 to 0.45) in absolute terms than that of the control group (figure 1). Subanalysis results based on intervention type are described below.

Patient Interventions

We found 17 studies that targeted patients within the health care organization. Seven of the studies were general QI initiatives, summarized in table 1a (Banister et al. 2004;Basch et al. 1999;Clancy et al. 2003;Erdman et al. 2002;Gerber et al. 2005;Piette et al. 2000;Ziemer et al. 2003), and 10 were culturally tailored to the racial/ethnic target population, summarized in table 1b (Anderson-Loftin et al. 2005;A. Brown et al. 2005;S. A. Brown et al. 2002;S. A. Brown and Hanis 1999;Corkery et al. 1997;Keyserling et al. 2002;Mayer-Davis et al. 2001;Mayer-Davis et al. 2004;McNabb, Quinn, and Rosing 1993;Rosal et al. 2005;Two Feathers et al. 2005;Vazquez et al. 1998). Thirteen were randomized controlled trials, 1 was a controlled trial, and 3 were before/after studies. Nine (53%) of the trials had quality scores of *very good*, 7 (41%) were rated as *good*, and 1 (6%) was rated as *fair*. The interventions took place within academic primary care clinics and community-based health centers. All interventions were patient education programs that sought to improve dietary habits, physical activity, and/or self-management activities (i.e., glucose self-monitoring). Each intervention provided data on intermediate health outcomes, but only three assessed process measures.

Of the 17 patient-targeted interventions, 6 met the inclusion criteria for meta-analysis of HbA1c values, 5 of which were culturally tailored and 1 of which was a general patient intervention. In our analysis, culturally tailored patient initiatives resulted in a mean HbA1c value in the intervention group that was 0.69% (95% CI: 0.37 to 1.0) lower than the control group, while the general patient intervention resulted in a mean absolute reduction in HbA1c of 0.10% (95% CI: -0.28 to 0.48); this finding was not statistically significant (figure 1).

Interventions that involved peer support and one-on-one interactions more often reported positive results than those using computer-based patient education. Online self-management coaching, peer support, and computer-based education modules produced negative or negligible results. All but one of the interventions that measured dietary habits, physical activity, and weight changes noted an improvement, even for interventions that did not affect other health outcomes such as mean HbA1c or LDL levels. One of the nutrition/physical activity interventions among a predominantly African American population (Project POWER) reported an average weight loss of 2.2 kg at 6 months, compared to the 7.0 kg weight loss observed in the NIH-funded Diabetes Prevention Program, after which Project POWER was modeled (Mayer-Davis et al. 2001; Mayer-Davis et al. 2004). In one study comparing the effectiveness of usual care, a maximally reimbursed Medicare intervention for diet/physical activity, and an intensive intervention of diet/physical activity, differences in weight (-2.2 kg) and HbA1c (-0.44%) were seen at 6 months with the intensive, culturally tailored intervention (vs. control), but no differences were found between the Medicare-reimbursable intervention and the usual-care group. A study examining depressive symptoms found a decrease in symptoms at 3 months that returned to baseline within 6 months of follow-up (Rosal et al. 2005). Most interventions relied on nurses, nutritionists, or health educators for patient education, but one intervention used a combination of physicians and nurses; this study noted improvements in 10 processes of care measures and also reported an increase in physician trust by patients (Clancy et al. 2003). Culturally tailored interventions reported positive impacts on health knowledge, behaviors, and outcomes, although they varied in which health outcomes were affected.

Provider Interventions

We found five studies of interventions that targeted physician providers: one randomized controlled trial, two controlled trials, and two before/after studies, which are summarized in table 2 (Benjamin, Schneider, and Hinchey 1999;Din-Dzietham et al. 2004;Fox and Mahoney 1998;Phillips et al. 2002;Phillips et al. 2005;Ziemer et al. 2006). Two of the studies had *very good* quality scores, one had a *good* score, one was rated as *fair*, and one was rated as *poor* quality. Interventions occurred in public hospital academic general internal medicine (GIM) clinics and community-based private physician practices. Four of the interventions reported both process and outcome measures. None of the interventions included culturally tailored components such as cultural competency or Spanish fluency training. Of the five provider-targeted interventions, only the study by Benjamin, Schneider, and Hinchey met inclusion criteria for the meta-analysis of HbA1c values. This study reported a mean absolute reduction in HbA1c of 0.47% (95% CI: -0.36 to 1.30) that was not statistically significant (figure 1).

Apart from differences in glycemic control at study completion, there were improvements in multiple other process and outcome measures noted in the provider-targeted interventions, which typically included reminder systems and/or provider education such as practice guidelines, continuing medical education (CME), computerized decision-support reminders, in-person feedback, and problem-based learning. Statistically significant improvements were noted in the following process measures: eye examinations, microalbumin testing, HbA1c monitoring, foot care, and exercise counseling, while trends toward improvement were noted in lipid testing, influenza vaccinations, and nutrition education. Two different studies at an urban public hospital evaluated provider education strategies through four-arm trials (a controlled trial and a randomized controlled trial) of usual care, computerized patient-specific reminders, bimonthly in-person feedback, or reminders plus feedback (Phillips et al. 2002; Phillips et al. 2005; Ziemer et al. 2006). Provider feedback (especially with reminder systems) resulted in improved diabetes control (compared to the control group), and improved intragroup control of hypertension and cholesterol as well as provider intensification of glucose management (Phillips et al. 2002; Phillips et al. 2005; Ziemer et al. 2006). Computerized reminders resulted in negligible or negative results. In general, the largest reductions in HbA1c levels were seen among patients with the worst diabetes control at baseline. The follow-up times for the studies ranged from 2 to 48 months, with all but one study having outcomes assessed at >12 months. One intervention utilizing practice guidelines showed waning effectiveness in health outcomes at 15 months, while another practice-guideline intervention showed sustained outcomes at 4 years. Sustained change was also seen (at 3 years of follow-up) with the use of CME plus practice guidelines.

Health Care Organization Interventions

We found 14 interventions that implemented health systems changes—8 randomized controlled trials, 4 controlled trials, and 2 before/after studies, which are summarized in table 3 (Bray, Roupe, et al. 2005;Bray, Thompson, et al. 2005;California Medi-Cal Type 2 Diabetes Study Group 2004;Davidson 2003;Fanning et al. 2004;Gary et al. 2004;Hopper et al. 1984;Jaber et al. 1996;Miller et al. 2003;Pettitt et al. 2005;Philis-Tsimikas et al. 2004;Rothman et al. 2005;Shea et al. 2006;Strum et al. 2005;Thaler et al. 1999). Eight (57%) of the studies had*very good* quality scores, 4 (29%) had *good* scores, and 2 (14%) were rated as *fair*. These interventions occurred in a wide variety of practice settings including rural and urban locations, academic and community-based primary care clinics, and a public hospital diabetes clinic. Half of the studies evaluated either process or outcome measures, and half reported both process and outcome measures. Of the 14 health systems interventions, 6 were available for inclusion in our meta-analysis of HbA1c results. For these interventions, the mean HbA1c among the study groups was 0.34% less (95% CI: 0.24 to 0.45) than the control group (figure 1).

Many of the interventions identified in our review used a registered nurse (RN) for case management and/or clinical management via treatment algorithms, often with incorporation of a community health worker (CHW) for peer support and community outreach. Studies of RN case management/clinical management reported improvements in process measures of large magnitudes (i.e., 90% of study patients with biennial HbA1c testing compared to 26% of control patients) and clinically significant patient outcomes, including control of diabetes, hypertension, and dyslipidemia. In a study of nurse case management, the control group had 5.35 times the odds of the onset of retinopathy after an average 23 months of follow-up (Pettitt et al. 2005). Physician billing for RN-led group visits increased productivity on group visit days from 20 to 32 encounters per day (Bray, Roupe, et al. 2005). One randomized controlled trial consisted of RN case management/treatment, CHWs, RN +CHW, or usual care. Within this urban population, the combined RN + CHW intervention was the most effective; comparable results were seen in the RN intervention and the CHW intervention (Gary et al. 2004). One study compared nurse-directed care at a community health center (using end-of-week contact with the primary care provider) with nurse-directed care in an academic center (with daily access to an endocrinologist) and usual physician care (Fanning et al. 2004). In both settings, the nurse-directed care had equivalent patient outcomes in diabetes (HbA1c level), dyslipidemia (LDL level), and blood pressure (systolic BP).

Two studies evaluated pharmacist-led medication management (without the use of treatment algorithms) and patient education; both reported improvements in HbA1c levels and one reported increased aspirin use, lowered systolic blood pressure, increased diabetes knowledge, and enhanced patient satisfaction (Jaber et al. 1996; Rothman et al. 2005). Two studies examined the utilization of rapid HbA1c results (via finger-stick testing) and reported positive findings—more appropriate diabetes management (lower likelihood of intensifying treatment for patients with HbA1c values under 7% and higher likelihood of intensifying treatment for values more than 7%) and improved diabetes control (0.4% absolute HbA1c reduction) (Miller et al. 2003; Thaler et al. 1999). Researchers at an academic medical center (located in a midsize southern town) evaluated the implementation of a clinic-based medication assistance program (MAP) in their internal medicine clinic, wherein patients received 2-3-month increments of pharmaceutical company-sponsoredmedications. Patients enrolled in the program had no insurance coverage for prescriptions and 67% had Medicare. The program increased the number of patients on medication for dyslipidemia and the average number of diabetes and hypertensive medications; it also resulted in clinical improvements in HbA1c, LDL, and triglyceride levels (Strum et al. 2005).

Multi-target Interventions

We found eight interventions that involved more than one target: patients, providers, and/or health care organizations, which are summarized in table 4 (Chin et al. 2007;Chin et al. 2004;Cook et al. 1999;Hosler, Godley, and Rowland 2002;Jenkins et al. 2004;Landon et al. 2007;Rith-Najarian et al. 1998;Sequist et al. 2006). Seven were before/after studies (one of which was controlled), and one was an observational study. Of the seven studies, three (38%) received a quality score of *very good* and the remaining five (63%) were rated as *good*. The settings were varied, including rural and urban locations throughout the United States, and took place in academic GIM clinics, community health centers, and Indian Health Service clinics. Half of the studies reported both process and outcome measures. Of the seven multitarget interventions, none met our criteria for inclusion in the meta-analysis.

Five of these studies incorporated multidisciplinary teams, and five implemented a diabetes registry. One study evaluated a REACH 2010 initiative consisting of health care and academic institutions working as part of a broad community coalition that targeted patients (through education and empowerment strategies), communities (via CHWs, coalition building, and advocacy), providers (through audits/feedback), and health systems change (through diabetes registries, community-based case management, and continuous QI teams) (Jenkins et al. 2004). Previous disparities in process measures (HbA1c testing, eye examinations, lipid profiles, and microalbumin testing) were eliminated within 2 years of implementation. Another intervention targeted physicians (electronic chart reminders), patients (automated letters and lab orders), and the health care organization (diabetes registry), but did not involve community partnerships (Sequist et al. 2006). Improvements in LDL testing and control, along with a reduction in disparities in these areas, were noted among African Americans (Sequist et al. 2006). Although rates of HbA1c testing (and eye examinations) were already high and no health disparity existed over time, disparities in diabetes control remained constant, with the percentage of African Americans with controlled diabetes remaining approximately 10% lower than that of whites throughout the 4-year study interval (Sequist et al. 2006).

The five other multi-target interventions also reported significant improvements in process and/or outcome measures. One program reported a 48% reduction in lower extremity amputations among Native Americans, an effect comparable to those reported in specialized treatment centers (Foster et al. 1995; Litzelman et al. 1993; Rith-Najarian 1998). At the end of another initiative, implemented throughout an entirestate, more than 75% of patients had received at least annual testing of HbA1c and serum creatinine, and annual screenings for hypertension and obesity, which is twice the reported rate among urban health centers and a health maintenance organization in a large multiethnic state (Davidson 2003; Peters et al. 1996). One study found that the Health Disparities Collaborative, a QI collaborative in community health centers incorporating a chronic care model and techniques of rapid QI, improved processes of care and outcomes for 4 years. Among these health centers, training of physicians in patient/provider communication and behavioral change techniques as part of a high-intensity intervention that also included patient empowerment led to marginal improvements in diabetes care and no differences in diabetes outcomes compared with the standard Health Disparities Collaborative (Chin et al. 2007).

Discussion

We found good evidence for the ability of current health care interventions to enhance diabetes care, improve diabetes health outcomes (control of diabetes, hypertension, and dyslipidemia; microvascular and macrovascular complications), and potentially reduce health disparities among racial/ethnic minorities, including African Americans, Latinos, and Native Americans. While these findings are quite promising, the design and evaluation of current health care interventions leave us with many unanswered questions regarding the benefits of cultural tailoring, the impact of interventions on health disparities, and the ideal target of interventions (patient, provider, organization).

One particular question facing health care leaders is whether cultural tailoring of diabetes QI programs produces benefits above and beyond that of generic diabetes QI programs. Unfortunately, our review did not allow us to answer this question definitely because there were few head-to-head comparisons. The majority of interventions involved the application of generic diabetes QI programs to racial/ethnic minority populations. Sixteen interventions were culturally tailored for the racial/ethnic group under study; interventions primarily targeted patients through the use of culturally appropriate patient education and/or case management (often with the use of CHWs), or the use of community outreach (i.e., health fairs) and partnerships. Although there was no comparison between patient intervention types, the meta-analysis of culturally tailored patient interventions resulted in a larger reduction in HbA1c values than the analysis of general QI patient interventions. We found only one provider-targeted intervention that incorporated a culturally tailored component. Physician cultural competency training was included as part of a multitarget intervention, and as such the independent effects of this training component could not be ascertained (Hosler, Godley, and Rowland 2002). We found no culturally tailored interventions that targeted health organizations (i.e., the use of interpreter services or bilingual communications technology).

A more fundamental question is whether health disparities are affected by current diabetes QI interventions. To address this question, studies must separately track the health outcomes of both non-Hispanic whites as well as racial/ethnic minorities. We found only two studies that collected data on non-Hispanic whites as a comparison group and measured a change in diabetes health disparities (all other studies examined change within a given racial/ethnic minority population). One of these studies included whites in the intervention group (an initiative that targeted both patients and providers), thereby allowing researchers to compare the program's efficacy by race (Sequist et al. 2006). While significant reductions in disparate care were reported, the investigators found that the intervention produced smaller reductions (lipid control) or no effect (diabetes control) for individual health outcomes. In the other study, whites were used as the usual-care comparison group, which gave insight into the ability of a racially targeted intervention to reduce health disparities (Jenkins et al. 2004). This intervention incorporated a community-based component and reported a reduction of all disparities in care (except aspirin usage) and outcomes. Although caution must be used in generalizing findings from two studies, this research suggests that—like patient-targeted interventions—culturally tailored programs with enhanced community involvement may be an important factor in the success of multitarget interventions at improving diabetes health outcomes. Nonetheless, much more research needs to be done evaluating program effectiveness at reducing health disparities before any conclusions can be made.

We found interventions that took place in a variety of clinical settings and geographic locations, suggesting that improvements in diabetes care and outcomes can be achieved under heterogeneous circumstances, including underresourced environments such as public hospitals and community health centers. Only a few of the studies in our review had long-term follow-up, which is necessary to assess the sustainability of interventions and to capture the effect on health outcomes that may take longer to manifest. For example, one study of community health centers reported no change in diabetes outcomes at 1 and 2 years of follow-up (Landon et al. 2007), yet another study of community health centers in the same Health Disparities Collaborative reported improvements in glucose and lipid control after 2 and 4 years of follow-up (Chin et al. 2007).

In terms of the ideal target for diabetes disparities interventions, our review indicates that there is no single optimal target for interventions. In fact, we found that interventions targeting patients, providers, and health care organizations were all able to bring about improvements in the care and health outcomes of racial/ethnic minorities. There are specific lessons learned from each of these intervention categories.

Patient Interventions

Successful patient-targeted interventions tended to utilize interpersonal (rather than computer-based) skills and social networks such as family members, peer support groups, interactive or one-on-one education, and CHWs. In addition to the benefits of interpersonal interventions, we found that culturally tailored interventions were much more effective among racial/ethnic minorities, while the effects of generalized diabetes self-management training interventions were modest. This is not surprising given that multiple observational studies have found that culture, socio-economic status, and psychosocial factors such as social support, self-efficacy, and coping skills play a large role in explaining diabetes self-care and health outcomes (Chipkin and de Groot 1998; Fitzgerald et al. 1997). For example, one study found that 16%-40% of low-income African American and Latino patients limited diabetes care because of financial concerns (Horowitz et al. 2004). Limited access to recreational facilities and supermarkets with recommended diabetes food items disproportionately limit the participation of racial/ethnic minorities in recommended physical activity and healthy nutritional habits (Bach et al. 2004; Benjamin, Schneider, and Hinchey 1999; California Medi-Cal Type 2 Diabetes Study Group 2004; Clancy et al. 2003; Glasgow et al. 2003).

Provider Interventions

Among the various types of provider interventions, several studies found that in-person feedback to providers was superior to computerized decision-support in effecting sustained provider behavioral change and health outcomes (diabetes and blood pressure control) (Phillips et al. 2002; Phillips et al. 2005; Ziemer et al. 2006). Some of the findings from provider interventions were particularly relevant for racial/ethnic minorities, who are less likely to have access to subspecialty care and who are more likely to have worse control of their diabetes compared to whites. In one intervention, primary care providers who received feedback and reminders had patients with equivalent diabetes control to those seen in the diabetes specialty clinic, indicating real promise for primary care provider interventions to affect health outcomes (Phillips et al. 2005). In a separate provider intervention, patients with higher HbA1c values at baseline had the greatest improvements in glycemic control (Benjamin, Schneider, and Hinchey 1999). These results suggest that targeting providers and facilities that serve racial/ethnic minority populations may be a highly effective public health strategy to improve diabetes outcomes.

Health Care Organization Interventions

The majority of health system interventions focused on innovative use of human capital, including nurse case management, CHWs, nonphysician clinicians, and staff-led prescription assistance programs.

Case management and CHWs—Our review found strong evidence for the effectiveness of nurse case managers to affect quality of care as well as patient outcomes, including diabetes control and the onset of retinopathy. More than half of the health care organization interventions incorporated case management as a key component. More modest outcomes were reported in studies using telemedicine case management than in those using on-site nursing staff. CHWs were effective in the following: making and keeping appointments with PCPs and subspecialists; acting as a patient adjunct to the primary care team; and perhaps being as effective as a nurse in case management, which, for health centers with limited resources, may make case management a financially viable option (Gary et al. 2004). Case management is particularly important within medically underserved racial/ethnic minority populations because it addresses barriers to adherence by educating patients in the areas of nutrition, exercise, and self-management; identifying adjunct health services (i.e., home health); providing ancillary services such as laboratory testing and vaccination; and addressing logistical issues such as transportation (California Medi-Cal Type 2 Diabetes Study Group 2004). CHWs may also be particularly important to health care teams serving racial/ethnic minority populations. CHWs can overcome the social, cultural, and linguistic barriers of underserved women and have been shown to be powerful change agents within African American, Latino, Native American, and Asian communities (Erwin et al. 1996; Gotay et al. 2000; Gray 1980; Navarro et al. 1998; Strum et al. 2005).

Nonphysician providers—We found good evidence that nurses acting as clinicians (via treatment algorithms and physician support) can produce significant improvement in both process and outcome measures, and were more effective than when they were employed as case managers. Nurse clinicians were equally effective in community health centers and academic settings, indicating that medically underserved clinics with nurse-directed care can provide comparable care to health care organizations with better infrastructure and ready access to endocrinologists (Fanning et al. 2004). Unlike nurse-led care, pharmacist-directed care was significantly more labor intensive, with patient visits occurring every 1-4 weeks (Jaber et al. 1996). Although it led to significant improvement in glycemic control, physician resistance and limited insurance reimbursement may inhibit the widespread application of this method (Jaber et al. 1996).

Medical Assistance Programs (MAPs)—We found one study that improved diabetes and dyslipidemia control after helping patients obtain free medications for these chronic diseases (Strum et al. 2005). MAPs have been shown to increase prescription adherence, improve clinical outcomes, decrease hospitalizations, and reduce hospital costs (Nykamp and Ruggles 2000; Schoen et al. 2001). For federally funded community health centers and hospitals that provide prescriptions to uninsured patients, MAPs can result in cost savings that can be reallocated for direct patient care.

Disease management systems—Disease management has been defined as "an organized, proactive, multicomponent approach to health care delivery that involves all members of a population with a specific disease entity such as diabetes" (Norris et al. 2002, 19). Disease management consists of the following four elements: (1) identification of a population with the disease (i.e., diabetes registry), (2) guidelines for performance standards for care, (3) management of identified people (i.e., nurse case management), and (4) health information systems for tracking and monitoring (Norris et al. 2002). However, they may also contain additional components such as patient or provider education, visit reminders, and practice redesign.

None of the health care organization interventions in our review met the definition of disease management, although many had one or more components. One study included a diabetes registry, case management, and visit reminders (Bray, Roupe, et al. 2005; Bray, Thompson, et al. 2005). This intervention improved both process and outcome measures. A systematic review of the effectiveness of disease management among patients with diabetes reported better diabetes control and increased screening for neuropathy, dyslipidemia, and microalbuminuria (Norris et al. 2002). However, this review was based primarily on small efficacy trials. A recent study of 63 physician groups and 11 health plans found that disease management programs were associated with better processes of care, but not with improvements in health outcomes or intensity of medication management (Mangione et al. 2006).

Multi-target Interventions

Multi-target interventions provide several sources of unique information in our review: data about the effectiveness of interventions among Native Americans (significant health outcomes were noted; Rith-Najarian et al. 1998), information about macrovascular outcomes (48% reduction in lower extremity amputations; Rith-Najarian et al. 1998), and evidence about the reduction of health disparities in addition to improvements in health outcomes (Jenkins et al. 2004; Sequist et al. 2006).

Current Research Limitations and Future Directions

Our review has identified health care interventions that have the potential to improve diabetes health outcomes and reduce disparities among racial/ethnic minorities. However, there are limitations to the current body of evidence and many remaining unanswered questions. In this section, we discuss such limitations, identify ongoing public health initiatives not included in this review, and offer recommendations in the areas of research methodology and program design to help advance the field of diabetes health disparities research.

It is first important to recognize that this review is limited by potential publication bias, where studies with positive findings are more likely to be published than those with negative findings. Many health care organizations undertake diabetes care improvement interventions that are undocumented in the medical literature. Another challenge in interpreting our findings is that interventions often depend on organizational culture and infrastructure, which vary between organizations and are typically not assessed, thus making it difficult to make comparisons across studies.

In addition, we found only two reports that investigated the effectiveness of a health care intervention at reducing health disparities; all other reports documented changes in health outcomes among racial/ethnic minority populations. While understanding what works within minority communities is important, we also need information about what works to reduce the existing gap in health care delivery and health outcomes.

Research Methods

Relatively few interventions in our review reported both process and outcome measures. It is important to know whether an intervention changed how health care was delivered (process measures) and whether it affected health status (outcome measures) in order to fully understand its effectiveness. As such, future research should assess both process and outcome measures in order to draw better inference about a correlation between the two.

There is also a need to develop better process measures that are tightly linked, or well correlated, to outcome measures because growing evidence suggests that measuring testing rates (i.e., HbA1c or LDL testing) does not correlate well with diabetes health outcomes (Grant et al. 2004; Sequist et al. 2006; Trivedi et al. 2005). This may be due to the multiple intermediate processes that must occur in order for a test to affect health outcomes. Physicians must receive the test result, communicate findings to patients, and recommend changes in the treatment regimen; patients must share the goal of improved disease control and be willing and able to adhere to changes in their treatment. Future research should identify more downstream process measures that are tightly linked to health outcomes. For example, the intensification of treatment for patients with diabetes may be an important process measure that correlates better with health outcomes (A. Brown et al. 2005; Rodondi et al. 2006).

Moreover, future research should explore which downstream activities have the most potential to affect diabetes disparities. For example, one health plan reported a larger reduction in the disparity for LDL testing than in LDL control that researchers attribute to the higher rates of statin use among whites in the health plan (Sequist et al. 2006). Determining whether physician prescribing patterns or patient adherence accounted for the differential use of statins would help to identify important targets for future interventions.

Finally, studies with longer periods of follow-up are needed in order to understand the sustainability of health care interventions and to capture long-term effects on health outcomes.

Patient Interventions

Broader expansions into racial/ethnic minority populations. We found only one health system intervention that targeted racial/ethnic minorities other than African American or Hispanic American populations. More research is needed in NA/AN and AA/PI populations who have documented disparities in diabetes prevalence, control, and comorbid conditions as well as lower rates of patient satisfaction and appropriate care delivery (Saha, Arbelaez, and Cooper 2003). In addition, older racial/ ethnic minorities are largely understudied, despite the fact that they represent the fastest growing population of persons with diabetes and have unique challenges to diabetes management and control (Peek and Chin 2007).

Patients on the fringe of the health system—All of the interventions in our review were designed to improve care for patients that are well established within the health system—those with a regular primary care provider and an established medical home. However, the patients most at risk for poor health outcomes are those on the fringe of health care systems—those who disproportionately rely on urgent and emergent care facilities for routine care. Finding innovative ways of transitioning these persons into the primary care system will be important to future efforts at reducing racial/ethnic disparities in chronic disease outcomes such as diabetes.

Results from two pilot studies show promise in the ability to provide chronic disease management to patients without primary care providers (Ezike and Vachon 2006; Khan et al. 2005). In one intervention, an urban public hospital created a diabetes walk-in clinic consisting of aggressive optimization of medication management and an interactive patient education computer module that focuses on self-management (Khan et al. 2005). At 3 months, improvements in systolic blood pressure, fasting blood glucose, dietary habits, and diabetes knowledge were reported, and more than 70% of patients were prescribed aspirin, an angiotensin-converting enzyme inhibitor, and a statin (Khan et al. 2005). Patients are seen regularly in the walk-in clinic until their appointment with a new primary care provider. The second pilot targets persons with diabetes who are on a waiting list to become patients at an urban community health center (Ezike and Vachon 2006). Study participants utilize monthly health fair-style group visits and also receive RN case management and 5-min physician encounters to adjust medications. Patients with four or more visits had better control of their diabetes, blood pressure, and cholesterol (Ezike and Vachon 2006).

Provider Interventions

Although the majority of provider interventions focused on physician education, none in our review involved intensive training of PCPs in diabetes care. There are, however, several innovative programs designed to do so, and because racial/ethnic minorities are less likely to have access to subspecialist care, such programs have the potential to reduce disparities by providing high-quality diabetes care within the primary care setting. For example, the National Committee for Quality Assurance (NCQA) provides special diabetes certification for providers that, in partnership with the not-for-profit organization Bridges to Excellence, offers physician incentives for the delivery of safe, effective diabetes care (Bridges to Excellence 2007; NCQA 2007a). In addition, the American Board of Internal Medicine and American Board of Family Practice offer practice improvement modules in diabetes.

None of the provider-targeted interventions in our review addressed provider communication, cultural competence, or shared decision making, despite a growing literature correlating positive health outcomes, including diabetes control, with enhanced communication and shared decision making (Greenfield et al. 1988; Greenfield, Kaplan, and Ware 1985; Stewart 1995). This is particularly relevant for racial/ethnic minorities, who have less shared decision making, less patient-centered care, and more physician verbal dominance in their clinical encounters (Cooperet al. 2003, Johnson et al. 2004). Moreover, there is a growing awareness that provider bias may be an important contributor to health disparities (Beach et al. 2005; Bogart et al. 2000; Finucane and Carrese 1990; van Ryn and Burke 2000). Future diabetes disparities research targeting providers should include consideration of components that address patient/provider communication, cultural competence, and potential provider bias as means to reduce diabetes health disparities.

Health Systems Interventions

Health systems change (i.e., disease registries) is currently a major focus of QI initiatives seeking to improve health care quality and health outcomes. For example, New York recently began a citywide diabetes registry (via mandatory reporting of elevated HbA1c values) that allows a better coordination of diabetes services between health care institutions and represents true innovation in health system change (Steinbrook 2006). Other health system initiatives are discussed below.

Community-based partnerships and initiatives—Although our review focused on interventions that occur within the health care system or organization, there is a growing body of evidence that supports the role of community-based initiatives as being effective methods to improve diabetes health outcomes (Hendricks and Hendricks 2000; Lorig, Ritter, and

Gonzalez 2003; Rimmer et al. 2002; Rodondi et al. 2006; Two Feathers et al. 2005; Wang and Chan 2005; Wing and Anglin 1996). Programs that involve partnerships between communities and health systems and organizations may provide more promise at reducing health disparities than either strategy alone.

The REACH 2010 initiatives provide an excellent example of such promise. REACH 2010 was implemented as the federally funded mechanism to address the Healthy People 2010 goal of eliminating long-standing health disparities in diabetes and five other priority areas (Jenkins et al. 2004). Unfortunately, rigorous evaluation of REACH programs' outcomes has been lacking. Of the 17 REACH initiatives that address diabetes disparities, we were able to identify only two reports in peerreviewed journals that reported on changes in process and/or outcome measures (Jenkins et al. 2004; Two Feathers et al. 2005). To obtain information about lessons learned and essential programmatic components for successful interventions, more scientifically rigorous evaluation of these programs will be critical.

Strengthening the safety net—There is evidence that a majority of racial/ethnic minority patients may receive care from a relatively small number of providers (Bach et al. 2004; Forrest and Whelan 2000; Massing et al. 2003). A recent study of Medicare beneficiaries found that 80% of visits by African Americans were seen by 22% of the physicians in the study (Bach et al. 2004). These doctors were more likely to provide care to the uninsured and persons with Medicaid, practice in low-income neighborhoods, and report difficulty accessing high-quality specialists, diagnostic imaging, and nonemergency hospital admissions (Bach et al. 2004). Thus, the differential access of safety-net providers, who provide a disproportionate amount of care to racial/ethnic minorities, to quality health systems resources may be a crucial contributor to disparities in diabetes health outcomes.

A recent federal initiative to increase the number of community health centers will help to strengthen the safety net (U.S. Department of Health and Human Services 2006). Yet equally important is the provision of federal funds to safety-net hospitals and subspecialty clinics, which provide the secondary and tertiary care that are necessary adjuncts to community health centers. Future research should evaluate the impact of enhanced resources within the safety net on diabetes health outcomes and health disparities among racial/ethnic minorities.

National diabetes QI initiatives—Although the interventions that met our inclusion criteria were generally local in scope, it is important to acknowledge that there are ongoing national diabetes QI efforts that have the potential to improve health outcomes and reduce health disparities among racial/ethnic minorities. For example, the Diabetes Quality Improvement Project (DQIP) has been an important step in addressing deficiencies in quality of care. DQIP is a collaborative effort of diabetes health care providers, health care organizations, insurance organizations, researchers, diabetes organizations, and health services organizations (Fleming et al. 2001).

DQIP has provided a uniform set of diabetes performance measures that are used to assess, compare, and improve the quality of care (Hayward et al. 2004). Six of the original eight DQIP measures were adopted by the NCQA to use in HEDIS (Health Plan Employer Data and Information Set), a key component of the NCQA Quality Compass that allows businesses and consumers to compare the quality of health insurance plans quickly and easily (NCQA 2007b). Thus, the public availability of quality measures can motivate health care organizations to pursue QI initiatives because such information can be utilized by companies and individuals when purchasing health plans.

In addition to collaborating on the development of DQIP, the Centers for Medicare and Medicaid Services (CMS) has invested heavily in demonstration projects to evaluate whether disease management services can, as an adjunct to existing physician care, improve the management of chronic diseases such as diabetes (Casalino 2005). For example, in the Medicare Quality Improvement Organization Program, Medicare spends approximately $200 million annually to contract with networks of nonprofit quality improvement organizations (QIOs) that collaborate with hospitals, nursing homes, and outpatient practices to improve quality of care (CMS 2006, 2007; Massing et al. 2003). From 1999 to 2002, QIOs began 13 projects that focused on diabetes screening and prevention. The effectiveness of these QIOs has not been thoroughly evaluated, and early research reported that hospitals participating in QIOs have the same outcomes in 14 of 15 quality indicators as hospitals that did not collaborate with QIOs (Snyder and Anderson 2005).

Evaluation of federal initiatives such as the QIOs should include an assessment of their ability to improve health outcomes among racial/ethnic minorities and reduce health disparities. Since 1995, Medicare has funded nearly 50 different demonstration initiatives, only 1 of which specifically addresses health care delivery to racial/ethnic minorities (U.S. Department of Health and Human Services 2005). Such federal programs should integrate mechanisms that measure and reduce racial disparities; they currently represent a significant missed opportunity to learn more about the impact of national policy on the heath status of this country's racial/ethnic minority populations. Collaboration between initiatives such as REACH 2010, which seek to reduce health disparities, and general QI initiatives such as the Medicare-funded QIOs could provide an excellent opportunity to do just this.

Conclusions

Racial/ethnic minorities continue to suffer a disproportionate burden of disease from diabetes and its comorbid conditions. While the reasons for these disparities are multifactorial, the health care delivery system is most certainly a contributor. As such, health care interventions that target patients, providers, and the health care environment (e.g., payors, health organizations) have the potential to play a significant role in reducing racial disparities in diabetes outcomes. Our systematic review found support that each of these targets can serve as a potentially meaningful lever of change, particularly patients themselves through culturally tailored interventions. Much work remains to be done to better understand and address racial/ethnic diabetes disparities, including more rigorous evaluation of federal policy initiatives, but we currently have the collective knowledge and skills to make significant strides toward the goal of equity in diabetes care and health outcomes.

Acknowledgements

This project was supported by the Robert Wood Johnson Foundation (RWJF) Finding Answers: Disparities Research for Change Program, the Department of Medicine at the University of Chicago, and the National Institute of Diabetes and Digestive and Kidney Diseases Diabetes Research and Training Center (P60 DK20595). Dr. Peek was supported by an RWJF Harold Amos Medical Faculty Development award (53056) and a National Institutes of Health (NIH) career development award (K23 DK075006-01). Mr. Cargill was supported by the University of Chicago Summer Research Program, sponsored by the NIH; the University of Chicago Biological Sciences Division; and the Pritzker School of Medicine. Dr. Huang was supported by an NIH career development award (K23 AG021963).

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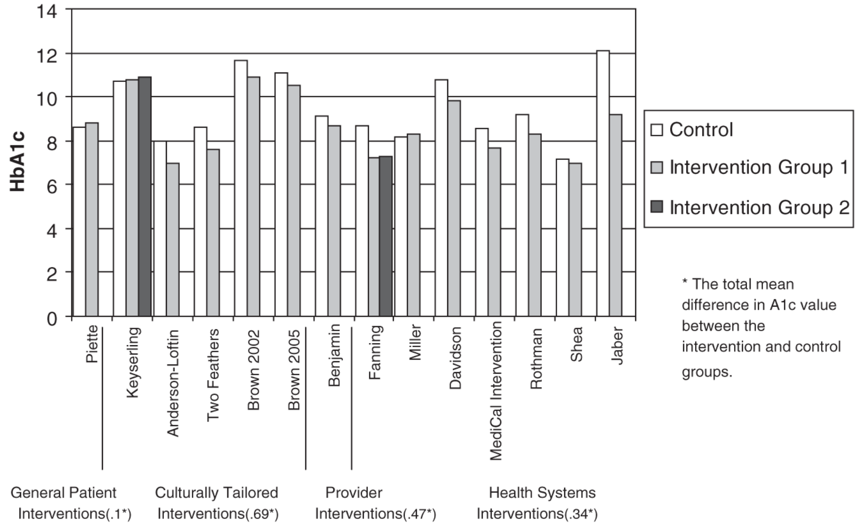

Figure 1.

Mean HbA1c Values for Control and Intervention Groups of Studies Included in the Meta-Analysis of Interventions to Reduce Diabetes Disparities

Table 1a

General Patient Interventions

Citation, Study Type	Intervention	*n*, Follow-Up, Racial/Ethnic Composition	Setting	Results: Process Measures	Results: Patient Outcomes	Summary	QS
Banister et al. 2004 B/A	I: 4 hr DSM education, dietician consults, and monthly support group meetings (with family members)	103 (70) 3-12 months 39% L 16% AA 11% W 4% Other	CHC		-1.5% HbA1c*** No Δ in mean body weight	DSM using support groups and family members is effective	15.5
Basch et al. 1999 RCT	I: Low-literacy booklet, video and telephone counseling, and education about importance of eye exams C: Usual care	I: 137 (134) C: 143 (139) 6 months 100% AA	Urban medical centers	4.3 OR for receiving a retinal examination 54.7% dilated retinal examination rate		Health educators can markedly increase the eye exam rate	23
Clancy et al. 2003 RCT	I: MD + RN group visits (health education, stress management skills, vaccinations, and one-on-one consultations) C: Usual care	I: 59 C: 61 3 and 6 months 78% AA 22% W	Primary care academic clinic	Improvements in: testing of HbA1c, LDL, and microalbumin; use of ACE inhibitors, ASA, statins; pneumococcal and influenza vaccination; foot and eye exams 76% had at least 9 of 10 process measures performed and 86% had at least 8 of 10	Increased trust in physician	Group visits can significantly improve diabetes quality of care and enhance physician trust	18
Erdman et al. 2002 B/A	I: Diet counseling, lifestyle modification, and DSM training	345 12 months 91% AA	Urban DM clinic		-1.1% HbA1c*** -7mg/dL TC*** -9 mg/dL LDL*** +3mg/dL HDL***	DM Rx and lifestyle changes can lower some lipids (HDL and TG), but LDL changes due to statins use only	18
Gerber et al. 2005 RCT	I: Computer training (information, skills, support) kiosk in waiting room C: Multiplechoice computer quiz about DM	I: 122 (94) C: 122 (89) 12 months 66% L 29% AA 5% Other	Urban health clinics		No significant changes in HbA1c, BP, weight, knowledge, or self-efficacy -0.2% HbA1c for study group members with low-literacy level and +0.3% HbA1c for study group with highliteracy level (neither statistically significant) Perceived susceptibility** to DM	No impact on health outcomes from computerbased patient education	20.5

Results							
Citation, Study Type	**Intervention**	***n*, Follow-Up, Racial/Ethnic Composition**	**Setting**	**Process Measures**	**Patient Outcomes**	**Summary**	**QS**
					complications: +0.95 (risk scale of 1-10)		
Piette et al. 2000 RCT	I: Biweekly automated assessment and self-care education calls with telephone follow-up by a nurse educator C: Usual care	I: 140 (124) C: 140 (124) 12 months 50% L 29% W 21% Other	County hospital GIM clinics		More frequent glucose monitoring, foot inspection, and weight monitoring, and fewer problems with medication adherence -41mg/dL glucose levels** Among Spanish-speaking patients, 6 × as many had normal HbA1c levels (18% vs. 3%)*	Automated calls with telephone nurse follow-up can be effective at improving DM self-care and glycemic control	22
Ziemer et al. 2003 RCT	I: Diet counseling using a simple HFC C: Diet counseling using EXCH	I: 289 (94) C: 359 (126) 6 months 90% AA	Urban academic DM clinic		Similar ↓ in fat and sugar intake (data not given)° -1.9% HbA1c in HFC and EXCH groups*** Similar ↓ in glucose levels (data not given)° +0.4 kg in EXCH group and 0.9 kg in HFC group, but no difference between groups at 6 months° No significant difference in lipids and BP between groups	HFC meal plan is easier to teach, easier to understand, and equally effective as the EXCH	17

Note: Effect is defined as the difference in the parameter change from baseline in the intervention group compared to controls, unless otherwise noted. Percentage changes reflect absolute differences (i.e., 75% to 85% = +10% change) in the values. AA = African American; ACE = angiotensin-converting enzyme; ASA = acetylsalicylic acid; B/A = before/after study; BP = blood pressure; C = control; CHC = community health center; DM = diabetes management; DSM = diabetes self-management; EXCH = traditional exchanged-based meal plan; GIM = general internal medicine; HbA1c = glycosylated hemoglobin; HDL = high-density lipoproteins; HFC = healthy food choices meal plan; I = intervention; L = Latino; LDL = low-density lipoprotein; OR = odds ratio; QS = quality score; RCT = randomized controlled trial; TC = total cholesterol; TG = triglycerides; W = white.

For numeric values without an indication of the *p* value, this information was not available.

* $p \leq .05$.

** $p \leq .01$.

*** $p \leq .001$.

° *p* value not significant.

Table 1b

Culturally Tailored Patient Interventions

Citation, Study Type	Intervention	*n*, Follow-Up, Racial/Ethnic Composition	Setting	Results: Process Measures	Results: Patient Outcomes	Summary	QS
Anderson-Loftin et al. 2005 RCT	I : Culturally tailored nutrition education by RN + DM educator C : Usual care	I : 49 (38) C : 48 (27) 6 months 100% AA	Rural primary care practices		-8.2 lb[°] High-fat dietary habits reduced to moderate No difference in HbA1c and cholesterol	Culturally tailored diet education can improve health outcomes for southern AA, especially those with BMI ≥ 35 kg/m^2	20
Brown and Hanis 1999; Brown et al. 2002 RCT	I: Culturally competent DSM education and support group by bilingual Mexican American nurses, dietitians, and CHWs C: Usual care	I: 126 (112) C: 126 (112) 3, 6, and 12 months >90% Mexican American	Primary care clinics and local sites (i.e., churches and schools) at Texas-Mexico border		-1.4% HbA1c level at 6 months, but still high (>10%)[***] Higher DM knowledge scores at 3 and 12 months	Culturally tailored DSM is effective at improving DM knowledge and health outcomes in Mexican Americans	19
Brown et al. 2005 RCT	I: 12 months of extended DSM education support/education (model in Ref. 32, 33); 24 hr education, 28 hr support groups C: 12 months of a compressed program (16 hr education, 6 hr support groups)	I: 102 C: 114 3 and 12 months 100% Mexican American	Primary care clinics and local sites (i.e., churches and schools) at Texas-Mexico border		No difference in FBS or HbA1c at 3 or 12 months I: -1.0 HbA1c at 12 months[**] C: -0.7 HbA1c at 12 months[*] No difference in DM knowledge at 3 or 12 months $384/p in extended group vs. $131/p in compressed group	A compressed culturally tailored DSM program is as effective as an extended program and ~1/3 the cost	20
Corkery et al. 1997 RCT	I: DM education (self-care skills and behavior change strategies) via bicultural CHWs + diabetes RN educator C: diabetes RN educator	I: 30 (24) C: 34 (16) Mean 7.7 months 75% Puerto Rican 25% Other Hispanic	Urban academic DM clinic		Significant difference on program completion rate Effect of CHW on knowledge, self-care behavior, and HbA1c outcome variables was not statistically significant	Bicultural CHW improved rates of program completion → improved patient knowledge and self-care behaviors	21
Keyserling et al. 2002 RCT	I1: Clinic-based, culturally tailored counseling (4 visits) with CHWs (3 group visits, 12 phone calls) to address diet/PA/DSM I2: Clinic intervention only C: Mailed pamphlets	I1: 67 (54) I2: 66 (59) C: 67 (58) 6 and 12 months 100% AA	Primary care academic clinics		I1: +44.1 kcal/day energy[**] expenditure (~15% increase) I2: + 33.1 kcal/day energy expenditure[*] No impact on lipids, glycemic control Small weight increases in each group	Clinic ± CHW intervention → modest increase in PA, but not in DM or lipid control	21

Results							
Citation, Study Type	**Intervention**	***n*, Follow-Up, Racial/Ethnic Composition**	**Setting**	**Process Measures**	**Patient Outcomes**	**Summary**	**QS**
Mayer-Davis et al. 2001; Mayer-Davis et al. 2004 RCT	I1: 12-month intensive diet/PA intervention I2: 12-month diet/ PA intervention based on Medicare reimbursement C: Usual care	I1: 62 (49) I2: 62 (47) C: 62 (56) 3, 6, and 12 months 82% AA 18% W	Rural primary care clinics		I1: -2.2 kg at 6 months** and -1.9 kg at 12 months,* -0.44 HbA1c at 6 months (not significant) I2: No difference from control group in weight loss, +0.28 HbA1c at 6 months (not significant)	Culturally tailored intervention → weight loss and trend for DM improvement, but no Δ from Medicarereimbursable intervention	19
McNabb, Quinn, and Rosing 1993 CT	I: 18-week culturally tailored patient education about diet/exercise C: Usual care	I: 13 (10) C: 10 (10) 4 and 12 months 100% AA	Urban academic DM clinic		-4.4 kg at 12 months** Within-group - 2.6 HbA1c Δ* at 4 months, but return to baseline at 12 months	Culturally tailored patient education can → sustained weight loss and short-term DM gains	15
Rosal et al. 2005 RCT	I: Culturally tailored, low-literacy diet, PA, and DSM education led by DM nurse, nutritionist, and CHW C: Usual care	I: 15 C: 10 3 and 6 months Low-income Spanish-speaking Latinos (80% Puerto Rican)	Local health center		-0.8% HbA1c at 3 months* and 0.85% at 6 months;** difference remained after adjustment for baseline levels Difference in depressive symptoms at 3 months but not 6 months Increase in selfmonitoring over time No Δ in physical activity	Culturally tailored, literacyappropriate education can improve health behaviors and outcomes among Latinos	22
Two Feathers et al. 2005 B/A	I: Culturally tailored DM lifestyle intervention by CHWs C: Usual care	151 (91) 5 months? 64% AA 36% L	Urban hospital clinics and local sites		Improvement in dietary knowledge and behaviors, and physical activity knowledge 0.8 in HbA1c level*** No Δ in cholesterol, BP, and weight	Culturally tailored DM lifestyle improvement in diet/DM knowledge and behaviors, and metabolic control	20
Vazquez et al. 1998 RCT	I: Culturally tailored nutrition program by nutritionists and psychologists C: Usual care	38 (36) I: 18 C: 20 3 months 100% Caribbean American Latinos	Hospital-based clinics and local health centers		-380 kcal from baseline** -25.4 g total fat intake*** -7.2% total energy intake** -6.5 g total saturated fat intake** +8.2% carbohydrate intake*	Culturally tailored diet program can favorably affect dietary behaviors	14

Note: Effect is defined as the difference in the parameter change from baseline in the intervention group compared to controls, unless otherwise noted. Percentage changes reflect absolute differences (i.e., 75% to 85% = +10% change) in the values. AA = African American; B/A = before/after study; BMI = body mass index; BP = blood pressure; C = control; CHW = community health worker; CT = controlled trial; DM = diabetes management; DSM = diabetes self-management; FBS = fasting blood sugar; HbA1c = glycosylated hemoglobin; I = intervention; L = Latino; QS = quality score; RCT = randomized controlled trial; W = white.

For numeric values without an indication of the *p* value, this information was not available.

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° p value not significant.

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Table 2

Provider Interventions

				Results			
Citation, Study Type	**Intervention**	***n*, Follow-Up, Racial/Ethnic Composition**	**Setting**	**Process Measures**	**Patient Outcomes**	**Summary**	**QS**
Benjamin, Schneider, and Hinchey 1999 CT	I: PBL methods to increase MD use of practice guidelines C: Usual care	I: 67 (54) C: 77 (52) 9 and 15 months 40% AA 36% L 24% W	Primary care academic clinic	Statistically significant improvements in annual eye and microalbumin exams; trends of improvements in annual lipids and influenza vaccines and diet/ diabetes education (data not shown)	-1.1 HbA1c at 9 months*** (-0.9 within-group Δ) and -0.68 HbA1c at 15 months (-0.62 within-group Δ at 15 months)**	PBL may be an effective method to increase MD adherence to diabetes practice guidelines and improve DM outcomes	16
Din-Dzietham et al. 2004 B/A	I: Provider education via CME and guideline distribution	47 providers 12, 24, 36, and 48 months "Primarily AA"	Primary care practices	+37% annual HbA1c tests +39% annual eye referral +14% microalbumin tests	-39% of patients with poor DM control (HbA1c 9.5%)** No improvement in SBP or DBP	Provider education can increase process measures and DM control	11
Fox and Mahoney 1998 B/A	I: Practice guidelines, chart audit with feedback, chart reminders	30 chart audits 12 and 24 months "Mostly AA"	Family medicine clinic	Improvements in diet and exercise counseling, foot care, HbA1c testing (+50%), eye exams (+55%), and pneumococcal vaccination at 12 months +30% compliance with all six measures at 12 months Overall compliance maintained at 70% for nine criteria	Improvements in HbA1c levels (data not given)°	CQI process can improve physician performance and DM control	10
Phillips et al. 2002; Phillips et al. 2005 CT	I1: Computerized, tailored decision-support reminders I2: Bimonthly in-person individualized feedback I3: Reminders + feedback C: Usual care	325 providers and 4,138 patients Mean 15 months 94% AA	Urban, public hospital academic GIM clinic		I3: 0.38 HbA1c,*** sign Δ in I1 [-0.15 HbA1c]* or I2 [-0.26 HbA1c]*** Within-group improvements for LDL in all groups; HbA1c for I1, I2, and I3; and SBP for I2 and I3	In-person MD feedback (especially with reminders) → modestly enhanced DM control and is more effective than reminders alone	22
Thaler et al. 1999 RCT	I : HbA1c results available at time of clinical encounter C: Conventional 24-hr delay in HbA1c results	I: 575 (278) C: 563 (296) 2-7 months >90% AA	Urban, public hospital academic GIM clinic		More appropriate Rx in study group (less frequent intensification for HbA1c < 7% and more frequent intensification for HbA1c > 7%) -0.4 HbA1c (study group)*	Rapid HbA1c results → more appropriate care and modestly improved DM control	19
Ziemer et al. 2006 RCT	I1: Computerized reminders to	345 MDs and 4,038 patients	Urban, public hospital academic GIM clinic	I2 and I3 had sustained provider behavior Δ: at 36 months, 52%	Multivariable logistic regression: adequate Rx	In-person feedback with or without	20

Results							
Citation, Study Type	**Intervention**	***n*, Follow-Up, Racial/Ethnic Composition**	**Setting**	**Process Measures**	**Patient Outcomes**	**Summary**	**QS**
	intensify medications I2: In-person feedback I3: Reminders + in-person feedback C: Usual care	6, 12, 24, and 36 months 94% AA		responded to elevated FBS with medication titration (I1 improvements returned to baseline)	intensification associated with 0.19 HbA1c Δ***	reminders can result in sustained reductions in provider "clinical inertia"	

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* $p \leq .05$.

** $p \leq .01$.

*** $p \leq .001$.

° *p* value not significant.

Table 3

Health System Interventions

				Results			
Citation, Study Type	**Intervention**	***n*, Follow-Up, Racial/Ethnic Composition**	**Setting**	**Process Measures**	**Patient Outcomes**	**Summary**	**QS**
Bray, Thompson, et al. 2005; Bray, Roupe, et al. 2005 B/A	I: 12-month RN case management, group visits, DM registry, visit reminders C: N/A	314 12 months 72% AA	Rural fee-for-service practices	Increased provider productivity on group visit days (20.17 to 31.55 average daily encounter rate) +21% lipid panel, +12% ASA Rx, +42% foot exam	-1.1 HbA1c* 61% of patients had a reduction in HbA1c, % of patients with HbA1c < 7% improved +13%° No significant difference in weight or BP	Multifaceted health systems change with RN case management can → increased revenue, and improved care processes and outcomes	12
California Medi-Cal Type 2 Diabetes Group 2004 RCT	I: 2-year mean RN dietician case management C: Usual MD care Culturally tailored interventions	I: 186 (171) C: 172 (146) Every 6 months for 36 months 39% L 35% W 16% AA 10% Other	Primary care clinics in low-income areas		Consistently, lower HbA1c (month 6: -0.65, month 36: -0.87);*** -1.88 HbA1c within-group change at 36 months** Other within-group changes: -2.9 mm Hg DBP,* -14.3 mg/dL LDL,*** +4.0 mg/dL HDL*	Culturally tailored case management can improve health outcomes in low-income mixed ethnic population	21
Davidson 2003 CT	I: RN-directed care with treatment algorithms C: Usual MD care	504 I: 252 (114) C: 252 (?) 6 and 12 months 86% L 11% AA	Urban, public primary care clinics	+64% biennial HbA1c tests +38% annual lipid tests +16% annual eye exams +14% annual renal tests +17% biennial foot exams +50% DM education +83% diet counseling	-2.0 HbA1c at 6 months (3.5 HbA1c within-group change)***	RN-directed care can → clinically important improvements in process and outcome	13.5
Fanning et al. 2004 CT	I1: RN case management and UC-TA I2: RN case management and CC-TA C: Usual MD care at a community clinic	I1: 204 (170) I2: 145 (106) C: 94 (82) 6 and 12 months 90% Mexican American	Local health center and academic GIM clinic		CC-TA: -1.4 HbA1c,*** -23 mg/dL LDL,*** 4 mm Hg SBP** UC-TA: -1.5 HbA1c,*** -34 mg/dL LDL,*** -2 mm Hg SBP** No change in body weight in any clinic	RN case management and use of Rx algorithms → equal, significant health outcomes in university and community settings	16
Gary et al. 2004 RCT	I1: RN case management and treatment algorithms I2: CHW (patient education, social support, and limited case management) I3: RN + CHW C: Usual care	186 (149) I1: (38) I2: (41) I3: (36) C: (34) 24 months 100% AA	Urban, academic primary care clinic		RN + CHW: -3.2 mm Hg* DBP and -35.5 mg/dL TG* No intervention effects seen on HbA1c levels, but withingroup Δ of 0.80 for RN + CHW (and nonsignificant within-group Δ of -0.31 for RN and 0.30 for CHW groups)	Culturally tailored RN + CHW interventions may improve health outcomes among urban AAs RNs and CHWs have similar effects	22

		Results					
Citation, Study Type	**Intervention**	***n*, Follow-Up, Racial/Ethnic Composition**	**Setting**	**Process Measures**	**Patient Outcomes**	**Summary**	**QS**
	Interventions were culturally adapted						
Hopper et al. 1984 RCT	I: 12 months of home health aide use (trained in PT, insulin delivery, glucose monitoring, nutrition counseling) C: Usual care	I: 114 (44) C: 113 (80) 18 months 75% AA	Urban, public hospital diabetes clinic	Eye clinic visits: +0.01 visits/year among those offered aides and +0.44 visits/year increase among those who accepted aides (vs. control)	-5.0 FBS (offered aides) * -8.8 FBS (accepted aides)°	Home health aides can → modest improvements in DM control and eye exam rates	20
Jaber et al. 1996 RCT	I: Pharmacist-led education (diet/PA/self-management), Rx counseling and management C: Usual care	45(39) I: (17) C: (22) 4 months 100% AA	Urban, academic internal medicine clinic		-2.1 HbA1c, -0.8 mmol/L FBS* Within-group Δ: -2.2 HbA1c*	Pharmacist-led Rx management and DM education can → significant improvements in DM control	21
Miller et al. 2003 CT	I: Same-day availability of HbA1c test results C: Traditional 24-hr availability of HbA1c results	I: 317 (141) C: 280 (134) 2 follow-up visits 96% AA	Urban, public hospital academic GIM clinic	+19% intensification of therapy (threshold: patients with baseline HbA1c 8%)	Rapid HbA1c results associated with 1.98 OR of treatment intensification* -0.3 HbA1c within-group Δ* in study group; no difference in HbA1c levels between intervention and control Rx intensification associated with 0.6 HbA1c* in study group and control group	Rapid HbA1c availability can lead to Rx intensification among patients with HbA1c > 8%; regardless of when HbA1c is available, Rx intensification → -0.6 HbA1c	20
Pettitt et al. 2005 RCT	I: 2-year mean RN dietician case management C: Usual MD care Culturally tailored interventions	I: 102 (48) C: 98 (34) Mean 23 months 42% W 38% L 14% AA	Primary care clinics in low-income areas		Retinopathy onset: OR = 5.35* No difference in the progression of retinopathy	Culturally tailored case management can reduce onset of retinopathy in low-income mixed ethnic population	21
Philis-Tsimikas et al. 2004 CT	I: RN case management/treatment algorithms + CHWs (patient education and limited patient navigation) C: Usual care Bilingual/bicultural staff for interventions	I: 214 (153) C: 76 (76) 12 months 72% L	Local health centers	100% compliance with ADA standards of biennial HbA1c, annual lipids, annual foot exam, and annual micro albumin (50% in control group)	Significant differences in HbA1c, TC, LDL, TG (numeric data not given) Within-group Δ at 12 months: -3.7 HbA1c,*** -0.98 mmol/L TC,*** -0.56 mmol/L LDL,*** -1.54 mmol/L TG,*** -4 mm Hg DBP** Within-group improvements in DM knowledge and self-efficacy	Marked improvements in process and outcome measures with culturally tailored RN + CHW intervention	17
Rothman et al. 2005 RCT	I: Intensive management by clinical pharmacists	I : 112 (99) C : 105 (95) 6 and 12 months 65% AA	GIM academic clinic	91% aspirin use at 12 months vs. 58% among controls	-9mm Hg systolic BP** -0.8% HbA1c*	DSM can ↓ BP and HbA1c levels among vulnerable	20

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Results

Citation, Study Type	Intervention	*n*, Follow-Up, Racial/Ethnic Composition	Setting	Process Measures	Patient Outcomes	Summary	QS
	and diabetes care coordinator C: One-time pharmacist management				Greater improvements in DM knowledge and satisfaction No difference in use of clinical services, adverse events, and Δ in total cholesterol level	patients with poor glycemic control	
Shea et al. 2006 RCT	I: RN telemedicine case management and treatment algorithms C: Usual care	I: 844 (700) C: 821 (717) 12 months 36% L 15% AA	Medicare patients in doctor-shortage areas in NY		-0.18 HbA1c** -3.42 mmHg SBP*** -1.94 mmHg DBP*** -9.50 mg/dL LDL***	Telemedicine can produce modest improvements in outcomes	20
Strum et al. 2005 B/A	I: Clinic-based medication assistance program	52 (52) 12 months 50% AA 48% W 2% Other	GIM academic clinic	+7% patients on lipid Rx, +0.3 mean number of DM meds used, +0.59 mean number of BP meds used	-0.8 HbA1c,* -16 mg/dL LDL,*** and 35 mg/dL TG*	Prescription assistance programs can lead to improved DM and lipid outcomes	16
Thaler et al. 1999 RCT	I : HbA1c results available at time of clinical encounter C: Conventional 24-hr delay in HbA1c results	I: 575 (278) C: 563 (296) 2-7 months 90% AA	Urban, public hospital academic GIM clinic		More appropriate Rx in study group (less frequent intensification for HbA1c 7% and more frequent intensification for HbA1c 7%) 0.4 HbA1c (study group)*	Rapid HbA1c results more appropriate care and modestly improved DM control	19

Note: Effect is defined as the difference in the parameter change from baseline in the intervention group compared to controls, unless otherwise noted. Percentage changes reflect absolute differences (i.e., 75% to 85% = +10% change) in the values. AA = African American; ADA= American Diabetes Association; ASA = acetylsalicylic acid; B/A = before/after study; BP = blood pressure; C = control; CC-TA = treatment algorithms at a community clinic; CHW = community health worker; CT = controlled trial; DBP = diastolic blood pressure; DM = diabetes management; FBS = fasting blood sugar; GIM = general internal medicine; HbA1c = glycosylated hemoglobin; HDL = high-density lipoprotein; I = intervention; L = Latino; LDL = low-density lipoprotein; OR = odds ratio; QS = quality score; RCT = randomized controlled trial; SBP = systolic blood pressure; TC = total cholesterol; TG = triglycerides; UCTA = treatment algorithms at a university clinic; W = white.

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Table 4

Multi-target Interventions

Citation, Study Type	Intervention	*n*, Follow-Up, Racial/Ethnic Composition	Setting	Process Measures (Results)	Patient Outcomes (Results)	Summary (Results)	QS
Chin et al. 2007 B/A with embedded RCT	I1: QI collaborative using PDSA cycles and chronic care model I2: I1 + MD communication training + patient empowerment	2,364, 2,417, and 2,212 charts reviewed (baseline, year 2, and year 4) 24 and 48 months 37% W 32% L 29% AA 4% Other	34 Midwest and central West CHCs 19 Midwest CHCs	OR at 48 months (total before vs. after): Biennial HbA1c test (4.45)*** Eye referral (2.37)** Foot exam (3.71)*** Dental exam (6.46)*** Lipid testing (2.13)*** Microalbumin testing (4.42)** OR at 24 months (I1 vs. I2): ACE inhibitor (1.47)* Aspirin (2.20)* Microalbumin testing (2.03)*	Total before vs. after: 0.03 HbA1c** (24 months) 0.45 HbA1c** (48 months) 11.8 LDL** (24 months) 19.7 LDL*** (48 months) 1.15 SBP* (24 months) 1.81 SBP (48 months) 0.48 DBP* (24 months) 0.79 DBP (48 months)	QI initiatives in CHCs can significantly improve DM care and longterm control of glucose and lipids High-intensity program with marginal benefit	20
Chin et al. 2004 B/A	I: QI collaborative using PDSA cycles and chronic care model	969 (chart review) 12 months	19 Midwest CHCs	OR: Biennial HbA1c testing (2.04) Eye referral (1.57) Foot exam (2.68) Dental exam (2.92) Lipid testing (1.58) Microalbumin testing (2.33)	0.12 HbA1c (nonsignificant)	QI initiatives in CHCs can significantly improve DM care/ process measures and may improve glucose control	20
Cook et al. 1999 B/A	I: 6 months of patient education, nurse case management, multidisciplinary DM team, treatment algorithms	698 6 and 12 months 88% AA 9% W 1% L	Urban, academic primary care clinic		1.4 HbA1c** 18% increase in patients with HbA1c values of 7.0%° +0.3 kg/m^2 BMI**	Improved DM control (but small weight gain) with multitarget intervention	18
Hosler, Godley, and Rowland 2002 B/A	I: Evidence-based guidelines, multidisciplinary DM team, minority outreach, community partnerships (i.e., CHWs), cultural competency, patient incentives	? 20 months 45% AA 25% L 7% Native Americans	6 hospital-based clinics and 12 community clinics	+10.5% annual HbA1c +15.3% annual lipids +8.4% annual eye exam +26.3% annual SBGM assessment +29.7% annual exercise assessment +15% annual diet assessment		Effective process measure improvement among medically underserved with modest input ($60,000)	15

Citation, Study Type	Intervention	*n*, Follow-Up, Racial/Ethnic Composition	Setting	Process Measures	Patient Outcomes	Summary	QS
			Results				
Jenkins et al. 2004 B/A	I: DM registries, audits with provider feedback, patient-held data sheets, community education, communitybased case management, CQI teams, CHWs, library-based Health Information Network	12,000 patients in DM registry; 270 (chart review) 24 months 158 AA 112 W/Other	REACH 2010 health systems partners	Elimination of process disparities in annual HbA1c, eye exam, lipid profile and microalbumin Within-group Δ: +11% HbA1c test +22% foot exam +20% eye exam +22% lipid profile +27% microalbumin	Elimination of disparities in BP control and diet/DM education, no disparities in HbA1c control or lipid Rx use, and an increased disparity for ASA Rx Within-group Δ: + 20% BP control° -5% HbA1c 7%° +16% on lipid Rx° -1% ASA Rx° +4% diet/DM education°	Multicomponent intervention targeting patients, providers, health systems, and community partners can reduce disparities in process and outcomes	18
Landon et al. 2007 CT	I: QI collaborative using PDSA cycles and chronic care model C: Usual care	9,658 12-24 months 35% W 24 % L 31% AA 10% Other	Community health centers	-1% ACE-inhibitor Rx° +10% ASA Rx* No-change eye exam° +21% foot exam*** +6% nephropathy screening° +5% influenza vaccination° +10% dental exam** -2% smoking cessation° +16% HbA1c testing*** +2% lipid testing°	-3% DM control° -1% BP control° +2% LDL control°	QI initiatives in CHCs can improve some DM care measures but no good evidence for improved health outcomes	17
Rith-Najarian et al. 1998 Obs	I1:Podiatric screening and patient education I2: Provider guidelines, multidisciplinary team, DM registry/ tracking system, flow sheets	639 Variable follow-up 100% Native Americans	Rural primary care clinic of the Indian Health Service		-28% amputation with I1 (not significant) -48% amputation rate with I2*	Provider guidelines and DM can improve patient outcomes (reduce amputations)	15
Sequist et al. 2006 B/A	I: diabetes registries, automated patient reminders with lab orders, electronic chart reminders	7,088 (chart review) 48 months 72% W 28% AA	14 New England academic ambulatory health centers	32.2% increase in LDL testing among AA -3.7% LDL testing disparity 14.5% increase in statin use among AA +2.3% statin disparity increase (p = .23) No change in HbA1c testing	29.9% increase in LDL control*** -2.4% LDL disparity reduction*** No change in HbA1c control	QI initiatives in academic outpatient practices can improve process and outcomes for lipids, but not DM control	18

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* $p \leq .05$.

** $p \leq .01$.

*** $p \leq .001$.

° *p* value not significant.