April 2011

Interim Cost-Effectiveness Estimates from the RTI Evaluation of the Smith Family and Fireman Charitable Foundations' Diabetes Initiative

Report

Prepared for

Richard and Susan Smith Family Foundation and
Paul and Phyllis Fireman Charitable Foundation
ATTN: Lynne Jones Doblin
1280 Boylston Street, Suite 100
Chestnut Hill, MA 02467
Via e-mail: ljdoblin@smithfamilyfoundation.net

Prepared by

Joseph Burton
Kevin Smith
Thomas Hoerger
Douglas Kamerow
Olivia Berzin
RTI International
3040 Cornwallis Road
Research Triangle Park, NC 27709

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EXECUTIVE SUMMARY

This report presents additional interim findings for RTI's evaluation of the Diabetes Initiative with a focus on estimating the cost-effectiveness of the programs.

- **Section 1** presents results from our recent analyses of clinical data, which now includes data from the Bowdoin Street Health Center.
- **Section 2** provides an overview of cost-effectiveness and presents results from our cost-effectiveness estimates.
- **Section 3** presents the results of the patient survey for Bowdoin Street Health Center and compares them with the results from other health centers.
- **Section 4** summarizes the accomplishments of the grantees.

The dataset includes information from the medical records of more than 5,000 patients, some of whom received "enhanced care" services. Enhanced care services include, among other programs, (1) group medical visits; (2) lay health worker visits; (3) individual visits with a nurse case manager, nutritionist, or other non-physician staff member; and (4) diabetes education sessions in various group or individual formats.

We compared persons receiving these enhanced care services with those who have not received enhanced care services, both at baseline (about the time patients were added to a diabetes register) and afterward. In general, those not receiving enhanced care services fared as well as those who did. This was not surprising to any of the health centers. They all describe the Initiative as catalyzing their abilities to improve several facets of their care processes, resulting in improved outcomes for all patients served. At all health centers, the average values for the three key clinical indicators (glycated hemoglobin [Hb_{A1c}] level, blood pressure, and total cholesterol) have improved over time:

- Hb_{A1c} levels improved, on average, 0.3 percentage points, from 7.9 percent to 7.6 percent.
- Systolic blood pressure improved by 4 mmHg, from 137 mmHg to 133 mmHg.
- Total cholesterol improved by 13 mg/dL, from 187 mg/dL to 174 mg/dL.

Hb_{A1c} values tend to increase before treatment, fall markedly in the first year after treatment, and then remain relatively flat or increase slightly. Systolic blood pressure values were essentially flat after an initial improvement. Cholesterol levels declined steadily.

Cost-effectiveness estimates are sensitive to the funding or reimbursement needed to sustain these kinds of programs over time. The information collected to date about the true costs of the programs leads to estimates that health centers spend about $250 per patient per year in improving general care processes and monitoring their diabetes patients and an additional $600 per patient per year ($850 in total) in providing extra services to a smaller group of patients who need them. This averages to about $400 per person annually, which is the number used in the cost effectiveness estimates. Extra services typically are provided for shorter periods (about a year) at the beginning of enhanced care. Under a bundled-rate reimbursement program, these amounts would be considered case management fees. They are substantially lower than the fees charged by large insurance companies or disease management companies for similar chronic illness programs.

We observed small or no differences in clinical values between persons who received extras services and those who did not. We did observe differences in the entire patient populations over time, however, and used these changes to estimate the cost-effectiveness of the care processes supported by the Initiative. Using those changes and the reported costs of achieving them, we find that the care processes in total delivered at the health centers are cost-effective compared to other health care services and programs offered as part of standard medical care.

The trends over the entire diabetes population served are difficult to interpret because persons with type 2 diabetes often improve to some degree after treatment, even in the absence of enhanced services. Few studies investigate longer-term trends in these clinical measures. The populations served by community health centers, however, are disadvantaged, generally have more difficulty accessing care, and have poorer health outcomes.

Improving average clinical measures over a large group of individuals can be considered a success. It is important to remember that average changes are not representative of all individuals. Portions of the populations improved by much larger amounts, and some persons did not improve at all. Disparities persist, and the Initiative has enabled these health centers to address them through innovative programs. Although we are not observing direct causal links between the set of enhanced services provided and improved outcomes, these efforts were part of an overall strategy to provide patient-centered health care. Individuals with type 2 diabetes require varying types of support to effectively self-manage their disease. Offering enhanced services that are not typical of the usual care process is one means of tailoring care processes to the needs of individuals. When serving a diverse population, as these health centers do, tailoring becomes essential.

Society has recognized the need to change primary care and chronic illness care, as have the Centers for Medicare & Medicaid Services and the Health Research and Services Administration (the agency that funds federally qualified health centers). Patient-centered medical homes are the new paradigm. The Affordable Care Act, passed in 2010, recognizes the importance of patient-centered medical homes and community-centered health homes by providing funding and incentives for the health care system to evolve accordingly. The health centers participating in the Diabetes Initiative are well-positioned for this transformation as a result of the resources and assistance provided by the sponsors.

In addition to identifying ways in which the Initiative has helped them become closer to becoming patient-centered medical homes, health centers have identified key shortcomings in the existing delivery system. For example:

- The Massachusetts Medicaid program does not pay for more than one service on a single day. This policy effectively limits payments for patients who wish or need to participate in multiple programs or see multiple providers, such as mental health specialists.
- Communication with area hospitals can improve; primary care providers should be routinely notified when their patients visit hospitals.

A bundled rate program in conjunction with patient-centered medical homes could address these shortcomings and enable the health centers to continue their efforts.

1. SUMMARY OF CHANGES TO CLINICAL INDICATORS

1.1 Review of Medical Records Received and Patients Included in the Analyses of Clinical Data

Data Received

The analyses in this report use data we received from Bowdoin Street, Codman Square, Dorchester House (DotWell), and Whittier Street in the fall of 2010 or in 2011; Mattapan's latest data are as of February 2010. As with previous reports, this one includes analyses of the three clinical indicators that are inputs to the cost-effectiveness simulation model:

- glycated hemoglobin levels (Hb_{A1c})
- systolic blood pressure
- total cholesterol

The clinical indicators form the basis for estimating future adverse events related to diabetes.

Methods

For these analyses, we applied two methods, consecutively, to assess changes in the key clinical indicators:

1. simple pre-post changes
2. changes over time, controlling for demographic characteristics and time

In the next sections, we review the details of each method and present results from the analyses.

Definitions of Participants and Nonparticipants

We defined participants as persons who participated in at least one additional diabetes intervention offered by the health center and were identified on the datasets received as having done so. The actual number of participants at each health center may be greater than the numbers reflected here because of some underreporting of participation. While the health centers offer many similar enhanced care interventions, there are differences in the programs and differences in the number of patients that each center is capable of serving. For example, the curricula used in the various educational components are not identical. This is partly due to the differing racial and ethnic characteristics of the populations served. **Table 1-1** presents participants' utilization of enhanced services for each site.

Table 1-1 Number of Participants in Group Visits and Community Health Worker Programs, by Health Center

Intervention	Bowdoin Street	Codman Square	Dorchester House	Mattapan	Whittier Street
Group medical visits	186	93	151	*	114
Community health worker visits		62	0	101	—
Other participants (case management and other program components)	186	320	769	—	259
Total†	**186**	**466**	**920**	**101**	**373**

* The intervention is offered, but currently we do not know which patients participated.

† The number of participants in each intervention does not sum to the total because some persons participated in more than one component.

Bowdoin Street Health Center. Bowdoin Street offers group medical visits, case management visits, and education visits.

Codman Square and DotWell. At Codman Square and DotWell, patients were considered participants if they took part in group medical visits or received community health worker visits, case management services, or diabetes education.

Mattapan Community Health Center. Mattapan offers multiple services, such as case management and group medical visits, as part of enhanced diabetes care. In this report, participants are those who participated in the lay health worker program, as they are the only ones identified in the current dataset.

Whittier Street. Enhanced care at the Whittier Street Health Center includes a weekly walk-in session know as Diabetes Clinic, group medical visits, and case management.

1.2 Methods: Comparing Baseline Values with Follow-up Values in the Period of the Initiative

This initial pre-post analysis is similar to what has been presented in previous reports. In this report, we present the results for both participants and nonparticipants by their baseline Hb_{A1c} levels:

- participants who began the Initiative in relatively poor control (Hb_{A1c} level of 8.5 or higher)
- participants who began the Initiative in relatively good control (Hb_{A1c} level below 8.5)

- nonparticipants who began the Initiative in relatively poor control (Hb_{A1c} level of 8.5 or higher)
- nonparticipants who began the Initiative in relatively good control (Hb_{A1c} level below 8.5)

Assignment of Baseline and Follow-up Measures

One of the challenges in analyzing data related to health care services is identifying baseline values for each measure so that we can understand how the values change after an intervention or enhanced care program, such as the Diabetes Initiative, begins. In a clinical trial, a new drug or procedure is initiated on a firm and unambiguous date, and relevant clinical measures are taken at fixed, regular intervals. In the delivery of medical care, clinical measures occur at irregular intervals and depend on whether patients attend visits; measures are not precisely timed with the delivery of additional services. Laboratory tests for cholesterol, for instance, typically occur no more than once annually and may occur several months before or after a group medical visit where providers offer instruction about managing cholesterol through diet. Consequently, we developed rules for identifying measures as baseline and follow-up measures.

Assigning a start date. We asked each health center to identify approximately when each patient began receiving diabetes care. This is often the date that an individual was placed on the center's diabetes register. If this date did not coincide with a visit to the health center, we adjusted the start date to be the next visit after this date. Clinical measures rarely occur on these start dates, however (as they would in a clinical trial), so we must assign a clinical measure that occurred at about the same time as the start date to be the baseline measure. These dates are approximations for a portion of cases.

Defining measures as baseline. In this report, we defined baseline measures for blood pressure as occurring within 6 months before the start date and up to 2 months after the start date. For Hb_{A1c} and cholesterol, we defined baseline measures as those occurring within 9 months before the start date and up to 3 months after the start date.[1] In cases in which there were multiple measures in this interval, we defined the one closest to the start date as the baseline.

Defining follow-up measures. After assigning a baseline measure for each person, we assigned follow-up measures to be any measure occurring after the start date (unless it was assigned as a baseline measure). For the statistical tests of differences between the baseline and follow-up measures, we used the last reported follow-up measure for any given patient, as long as that measure occurred at least 1 year after the start date. The

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[1] For blood pressure, we first looked for measures that were within 2 months before the start date. If no measure was available in that interval, our next choices, in order of preference, were measures within 1 month after the start date, within 2–4 months before the start date, within 1–2 months after the start date, and within 4–6 months before the start date. If no measure existed in any of these intervals, the person was excluded from the analyses.

purpose of applying this criterion was to include only patients who had received services over a longer period (at least 1 year) and exclude patients who were served for only relatively short periods of less than 1 year during the Diabetes Initiative.

Patients who did not have both a baseline and follow-up measure were excluded from all analyses. Patients whose follow-up measures were less than 1 year after their respective start dates are included in the multivariate statistical models but are not included in the simple tabular pre-post analyses. Because each individual has a different start date, the follow-up periods vary (that is, the interval between baseline and follow-up differs among the patients). In addition, the follow-up period is not standardized. For example, some patients have follow-up periods of 1 year; others have follow-up periods of 3 years.

1.2 Results

All Health Centers

As with prior reports, we conducted statistical tests (t-tests) of the differences between the baseline and follow-up measures in to see whether there were statistically significant differences. The net difference represents the effect that can be attributable to the enhanced care offered. It is important to note that in this report the intervals between baseline and follow-up vary among the individuals included.

Table 1-2 through Table 1-4 present the results of the pre-post analysis for the five health centers combined. Each table includes number of patients in the participant and nonparticipant groups, stratified by their baseline Hb_{A1c} value. The accompanying figures, **Figure 1-1 through 1-3,** present the trends in the clinical indicators for the results in graphic form. Using an Hb_{A1c} cut point of 8.5 resulted in about one-third of the patients being in the "High baseline Hb_{A1c} group," although the distribution varies across the measures and between participants and nonparticipants. Additional individuals are included in the analysis of blood pressure because blood pressure is taken more frequently and more persons have multiple blood pressure values in the data provided. Fewer people are included in the analyses of total cholesterol levels because full blood work-ups occur less frequently (annually, at most) and fewer persons in the dataset have multiple cholesterol values. In all analyses, we excluded individuals who do not have at least two measures.

Table 1-2 Unadjusted Pre-post Differences in Hb_{A1c}, Stratified by Participation Status and Initial Hb_{A1c} Level

	N	Baseline	Follow-up	Difference
Overall	2,999	7.9	7.6	−0.3
High Baseline Hb_{A1c}				
Participant	493	10.7	8.8	−2.0
Nonparticipant	350	10.7	8.9	−1.8
Difference				−0.2[2]
Low Baseline Hb_{A1c}				
Participant	1,099	6.9	7.2	0.3
Nonparticipant	1,057	6.8	7.2	0.4
Difference				−0.1[2]

Note. Hb_{A1c} = glycated hemoglobin.

All differences significant at the 5 percent level, unless noted.

[2] Not significant.

- ***Hb_{A1c}*** improved markedly (about 2.0 percentage points) among persons in the high Hb_{A1c} group, whether they were participants or nonparticipants; levels rose slightly (0.3–0.4 percentage points) for persons in the low Hb_{A1c} group. The difference between Hb_{A1c}s of participants and nonparticipants in the high Hb_{A1c} group was not statistically significant, nor was the difference in the low Hb_{A1c} group.

Figure 1-1 Unadjusted Pre-post Differences in Hb_{A1c}, Stratified by Participation Status and Initial Hb_{A1c} Level

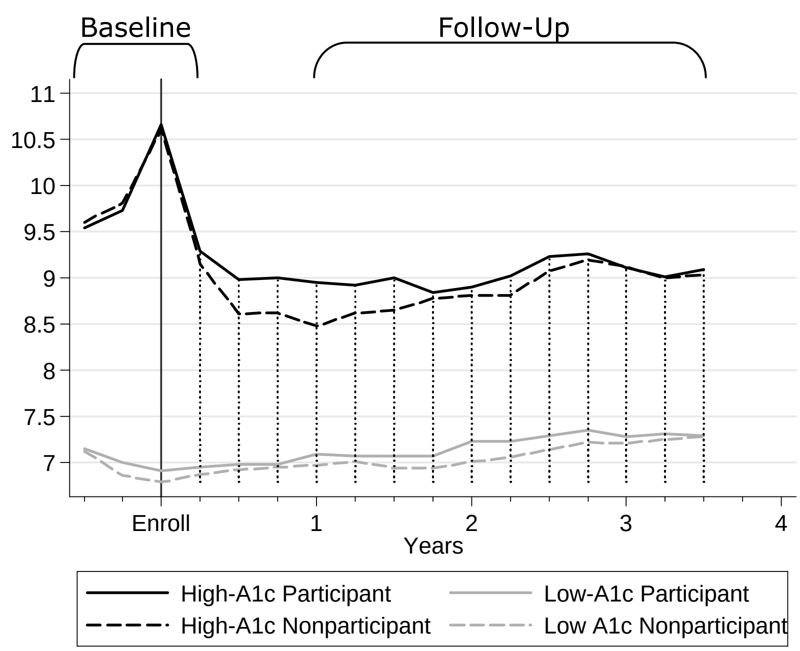


Table 1-3 Unadjusted Pre-post Differences in Systolic Blood Pressure, Stratified by Participation Status and Initial Hb_{A1c} Level

	N	Baseline	Follow-up	Difference
Overall	3,265	137	133	−4
High Baseline Hb_{A1c}				
Participant	518	138	134	−4
Nonparticipant	407	139	136	−4
Difference				0 [2]
Low Baseline Hb_{A1c}				
Participant	1,126	136	131	−5
Nonparticipant	1,214	137	133	−4
Difference				−1 [2]

Note. Hb_{A1c} = glycated hemoglobin.

All differences significant at the 5 percent level, unless noted.

[2] Not significant.

- ***Systolic Blood Pressure*** improved modestly—by about by 4 mmHg—in each of the four groups. The difference between participants and nonparticipants was not statistically significant in either the high-Hb_{A1c} or the low-Hb_{A1c} group.

Figure 1-2 Unadjusted Pre-post Differences in Systolic Blood Pressure, Stratified by Participation Status and Initial Hb_{A1c} Level

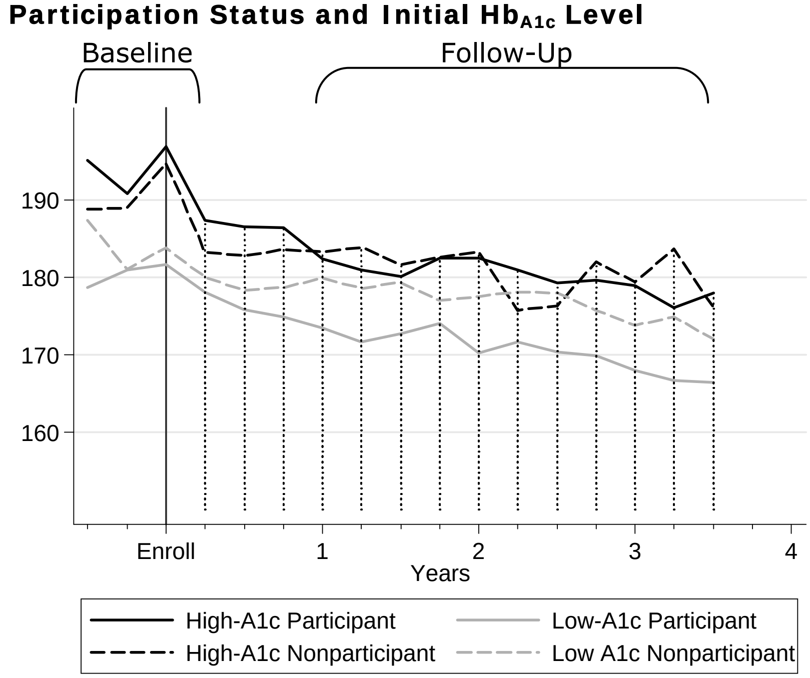


Table 1-4 Unadjusted Pre-post Differences in Total Cholesterol, Stratified by Participation Status and Initial Hb_{A1c} Level

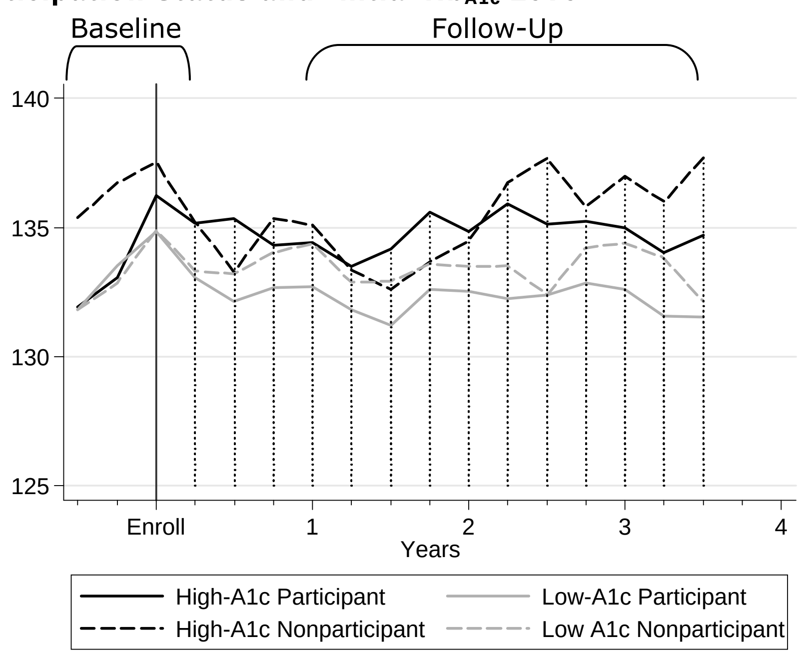
	N	Baseline	Follow-up	Difference
Overall	2,093	187	174	−13
High Baseline Hb_{A1c}				
Participant	322	198	176	−21
Nonparticipant	203	196	181	−14
Difference				−7 [2]
Low Baseline Hb_{A1c}				
Participant	830	183	169	−14
Nonparticipant	738	184	175	−9
Difference				−5

Note. Hb_{A1c} = glycated hemoglobin, Bowdoin Street not included in this table.

All differences significant at the 5 percent level, unless noted.

[2] Not significant.

Figure 1-3 Unadjusted Pre-post Differences in Total Cholesterol, Stratified by Participation Status and Initial Hb_{A1c} Level



- ***Total Cholesterol*** decreased substantially for all groups. Of note are the changes in the high-Hb_{A1c} group, where participants and nonparticipants improved by 21 mg/dL and 14 mg/dL, respectively. The net changes were not statistically significant in the high-Hb_{A1c} group, but they were significant in the low-Hb_{A1c} group.

Bowdoin Street Health Center

Table 1-5 presents clinical changes for persons served by the Bowdoin Street Health Center. Bowdoin Street reported lower density lipoprotein values instead of total cholesterol values. As with the other health centers, each of the clinical indicators improved during the period of the intervention.

- ***Hb_{A1c}*** decreased substantially among those in the high baseline Hb_{A1c} group (more than 2 mg/dL), although the difference between participants and nonparticipants is not statistically significant.
- ***Systolic Blood Pressure*** improved modestly in all groups (between 1 mmHg and 14 mmHg), although neither the differences between baseline and follow-up measures nor the differences between participants and nonparticipants were statistically significant.
- ***LDL Cholesterol*** decreased substantially for three of the four groups. The 13-mg/dL drop for both high-Hb_{A1c} participants and low-Hb_{A1c} nonparticipants was statistically significant at the 10 percent and 5 percent levels, respectively.

Table 1-5 Unadjusted Pre-post Differences in Clinical Indicators, Stratified by Participation Status and Initial Hb_{A1c} Level, Bowdoin Street

	N	Baseline	Follow-up	Difference
Hb_{A1c}				
Overall	276	8.1	7.7	−0.4
High Baseline Hb_{A1c}				
Participant	45	10.6	8.5	−2.1
Nonparticipant	37	11.0	8.8	−2.3
Difference				0.2[2]
Low Baseline Hb_{A1c}				
Participant	140	7.0	7.3	0.3
Nonparticipant	54	6.9	7.5	0.6
Difference				−0.3[2]
Systolic Blood Pressure (mmHg)				
Overall	113	132	127	−5
High Baseline Hb_{A1c}				
Participant	20	127	125	−2 [2]
Nonparticipant	19	140	126	−14 [2]
Difference				12 [2]

Table 1-5 Unadjusted Pre-post Differences in Clinical Indicators, Stratified by Participation Status and Initial Hb_{A1c} Level, Bowdoin Street (continued)

	N	Baseline	Follow-up	Difference
Low Baseline Hb_{A1c}				
Participant	47	129	128	−1 [2]
Nonparticipant	27	134	128	−7 [2]
Difference				6 [2]
LDL Cholesterol (mg/dL)				
Overall	195	96	88	−8
High Baseline Hb_{A1c}				
Participant	33	90	77	−13 [1]
Nonparticipant	27	123	99	−24 [2]
Difference				11 [2]
Low Baseline Hb_{A1c}				
Participant	89	86	86	0 [2]
Nonparticipant	46	106	93	−13
Difference				13

Note. Hb_{A1c} = glycated hemoglobin; LDL = low-density lipoprotein.

All differences significant at the 5 percent level, unless noted.

[1]Significant at the 10 percent level. [2]Not significant.

1.3 Assessing Changes in Clinical Values Using Multivariate Regression Analyses Compared with Pre-Post Changes

Overall, the comparisons between participants and nonparticipants revealed few differences between participants and nonparticipants over time. The tabular analyses are limited, however, because they do not account for important characteristics that can affect outcomes. Just as the data were stratified by baseline Hb_{A1c} level, the data could be stratified further—by gender or age group, for instance. Multiple strata, however, reduce statistical power and often render sample sizes too small for drawing conclusions. Multivariate regression analyses have several advantages over simple pre-post tabular analyses. First, it allows for investigating differences between participants and nonparticipants, while controlling for characteristics likely to affect outcomes, and without a loss of statistical power. Second, the analyses also do not require identifying baseline or follow-up values; each measure is used in the analyses, along with when it occurred. Third, it separates effects that are related to all persons over time from effects related to being in a particular group—like in the group of participants, being male, or being African American. The regression sample is the same as that used for the pre-post analyses.

Staff members from the health centers have said that the participant/nonparticipant distinction is misleading because they have improved several facets of their practices so that all patients served are receiving better care. They described the enhanced services offered as part of their efforts to tailor care to the needs of specific groups of individuals—typically those with poorer glucose control or individuals who had difficulties managing their diabetes. We thus used the differences over time for the entire populations served in our estimation of the cost-effectiveness of the Initiative. Our view is that the pre-post analyses represent the largest potential effect of the Initiative on clinical indicators, and the regression-based results represent the smallest effect. These are summarized in **Table 1-6.**

Table 1-6 Upper and Lower Estimates of Clinical Changes Attributable to the Diabetes Initiative

	N	Upper Bound (Pre-post)	Lower Bound (Regression-based)	Difference
Hb_{A1c}	2,999	−0.3	−0.3	0.0
Blood pressure	350	−4.0	−1.1	2.9
Cholesterol		−13.0	−4.3	8.7

Hb_{A1c} = glycated hemoglobin.

- Changes in Hb_{A1c} levels improved by an average of 0.3 percentage points.
- Changes in systolic blood pressure ranged from −1 mmHg to −4 mmHg.
- Changes in total cholesterol ranged from −4.3 mg/dL to −13 dL. These values are the basis for the cost-effectiveness simulation, described in the next section.

It is important to note that all individuals in this analysis had regular and consistent contact with their providers. We do not attempt to identify how much of these changes are a result of "usual" care, so some of the changes observed would have most likely occurred in the absence of the Initiative. Getting persons into regular care, however, is also an objective of the Initiative.

2. COST-EFFECTIVENESS ANALYSIS

2.1 Overview of Cost-Effectiveness Studies and How They Are Used

Keeping people healthy—through immunizations, medications, regular visits to doctors, life-saving surgeries, and rehabilitation after an accident or stroke—costs money. Pediatric immunizations for diseases such as measles, rubella, and mumps have effectively eliminated incidence of the disease and any of the associated costs for treatment. Administration of these vaccines have a positive returns on investment (Wright, 2008). Axioms like, "An ounce of prevention is worth a pound of cure" suggest that public health activities related to prevention, like vaccinations, have a return on investment that will save costly medical expenditures later in time. Outside of pediatric immunizations, however, it is rare that preventive services have the net effect of saving other health care dollars in the long term. Part of this is because the longer we live, the more we spend on our health. Furthermore, most preventive care and care for preventing secondary complications related to diseases—unlike vaccinations—are ongoing over multiple years. This means that costs of prevention and the costs of managing diabetes add up over time. Disease management interventions often do not have the potential to generate returns on investment in the strict sense, but may be worth the costs because of the high value we put on better health.

Cost-effectiveness analysis compares the costs and health outcomes associated with a health care intervention to the costs and health outcomes that would occur in the absence of an intervention. These analyses historically have been applied to discrete medicines or procedures. Outcomes can be closely tied to the drug or procedure because specific drugs have been through controlled clinical trials, and information on costs and efficacy can be determined with relative certainty. In general, demonstrating the effectiveness of public health programs is more difficult than for drugs and procedures because most programmatic studies are observational. Nevertheless, applying cost-effectiveness analysis to public health initiatives is useful, particularly because society is looking to support programs that have the best value.

For this project, we compare the costs and outcomes associated with the Diabetes Initiative with the costs and outcomes that would have occurred under "usual care" in the absence of the Initiative. The total costs associated with an intervention include both the costs of implementing the intervention (e.g., increased payments to health centers) and the costs of treating the disease (i.e., diabetes) targeted by the intervention. In some cases, the intervention will reduce the costs of treating the disease by, for example, reducing complications and hospitalizations. In rare cases, the cost of the intervention will be more than offset by reductions in health care costs. In this case, the intervention is called cost-saving; assuming that health outcomes improve, this outcome is clearly desirable.

Far more commonly, the intervention increases total costs and improves health outcomes. The question then becomes, "Is the improvement in health worth the increased costs?" This is a question that policy makers or society as a whole must answer, either explicitly or implicitly. We want to purchase the best value for our health care dollars. The cost-effectiveness ratio (defined as the difference in cost between the intervention and no intervention, divided by the difference in outcomes between the intervention and no intervention) can help decision makers determine the answer.

Table 2-1 provides an overview, based on current literature, of what amounts are considered cost-effective for reducing diabetes complications, heart disease, and stroke.

Table 2-1 Cost-effectiveness Ratios for Programs Related to Chronic Illness Care—Diabetes Complications, Heart Disease, and Stroke

Context	Cost-effectiveness ratio	Source
General overview	\$50,000–\$75,000 per LYG	(Woolf 2009)
Review of pharmacological hypertension therapies	Relative to no intervention, ranged from \$11,000 per LYG to over \$600,000 per QALY, with a mean ratio across studies of \$68,000 per LYG (2007 dollars)	(Brown and Garber 1998)
Intensive glycemic control or serum cholesterol control	\$41,384 per QALY and \$51,889 per QALY, respectively	(Hoerger, Bethke et al. 2002)
Diabetes self-management program	\$39,563 per QALY (main result)	(Brownson, Hoerger et al. 2009)
Lifestyle intervention to reduce risk of cardiovascular disease (CDC's WISEWOMAN program)	\$5,000 per LYG for a 10-year horizon and \$50,000 per LYG for a 1-year horizon (2007 dollars)	(Finkelstein, Khavjou et al. 2006)
Physician counseling smoking cessation strategies for women	\$2,900–\$5,000 per LYG	(Kupersmith, Holmes-Rovner et al. 1995); (Cummings, Rubin et al. 1989)

Note. LYG = life-year gained; QALY = quality-adjusted life-year.

Researchers sometimes suggest \$50,000/life-year or \$50,000/quality-adjusted life-year (QALY) as a useful benchmark for considering an intervention cost-effective or not cost-effective. With the latter benchmark, interventions with a cost-effectiveness ratio less than \$50,000/QALY are considered cost-effective, and interventions with a cost-effectiveness ratio greater than \$50,000/QALY are considered not cost-effective.

Table 2-2 shows the gains in life-years and cost-effectiveness ratios for selected health care interventions that are commonly adopted in the United States. The table shows that some common and widely provided preventive interventions (vaccination of infants and routine mammography screening) produce relatively small increases in average life expectancy; however, individuals who otherwise would have been afflicted by the disease may experience large gains in life expectancy. The table also shows that cost-saving interventions are rare.

Table 2-2 Life Expectancy Gains and Cost-Effectiveness Ratios for Selected Prevention Activities

Intervention	Target Population	Gain in Life Expectancy (months)	Cost-Effectiveness Ratios
Quitting cigarette smoking	35-year-olds	8–10	$6,400–$8,500/QALY
10 years of biennial mammography	50-year-old women	0.8	$16,000/LY
Measles, rubella, mumps, and pertussis vaccines	Infants	0.31	Cost saving
Reduction of cholesterol	35-year-olds with total cholesterol 200–239	5–6	$4,500/QALY (men with CHD); $40,000/QALY (women with CHD)
Coronary artery bypass surgery	Men with 2-vessel coronary heart disease	7.2	$40,000/QALY

Note. CHD = coronary heart disease; LY = life-year; QALY = quality-adjusted life-year.

SOURCE: Wright, J. C., & Weinstein, M. C. (1998). Gains in life expectancy from medical interventions—Standardizing data on outcomes. *New England Journal of Medicine*, *339*(6), 380–386.

2.2 Cost-Effectiveness Analysis Methods

The Cost-Effectiveness Model

In previous work for the Centers for Disease Control and Prevention (CDC), RTI developed the CDC-RTI Diabetes Cost-Effectiveness Model. The model has been used to (1) estimate the cost-effectiveness of intensive glycemic control, intensive hypertension control, and cholesterol reduction; (2) evaluate optimal resource allocation across intervention programs; (3) assess whether screening for diabetes is cost-effective; (4) show that lifestyle modification is cost-effective in delaying or preventing diabetes among persons with prediabetes; and (5) estimate the cost-effectiveness of screening for prediabetes. Briefly, the model is a simulation model of disease progression and cost-effectiveness for type 2 diabetes. To reflect the chronic nature of diabetes, the model follows patients from diagnosis to either death or age 95. The model simulates development of diabetes-related complications on five disease paths (nephropathy, neuropathy, retinopathy, coronary heart disease, and stroke). Model outcomes include disease complications, deaths, costs, and QALYs. A QALY measure can reflect death (QALY = 0), perfect health (QALY= 1), and the ranges of morbidity in between (0 < QALY <1), making it a more complete measure of health outcomes than life-years alone.

The model reflects several key characteristics of chronic diseases like diabetes.

- We adopt a long time horizon. This is important, because improvement in diabetes care may lead to improvements in major health outcomes years or even decades after the initial improvement in care.
- Because of the long time horizon, we simulate how changes in risk factors that can be observed in short studies affect long-term outcomes that will occur years later.
- In the model, interventions improve risk factors such as Hb_{A1c}, cholesterol, and blood pressure, and these improvements lead to fewer complications, fewer deaths, more QALYs, and lower medical costs in the long run.

Program Costs

Estimates of the true cost of running the diabetes programs offered as part of the Initiative are based on data received from the Codman Square Health Center. (We anticipate receiving additional cost information from other health centers for the final simulation) The costs are related to both (1) providing enhanced services (group medical visits, community health workers, and nurse case management) to a portion (about 25%) of the individuals served in a given year, and (2) managing the entire population of persons with diabetes and improving care processes in general. In the last 3 years of the project, Codman Square served about 1,500 patients each year. These were active patients, meaning they had at least one visit to the health center in that year or the previous year. (Numbers on the diabetes register were higher, but not all were active.) About 400 of the 1,500 received some type of enhanced services (group medical visits, community health workers, and nurse case management) in each year. We estimate that the Initiative costs $400 per patient, on average.

Assumptions

To obtain cost-effectiveness estimates, we applied the following key assumptions:

- The Initiative costs $400 per diabetes patient per year. This figure is based on the aforementioned estimate from Codman Square.
- The Initiative reduces Hb_{A1c} levels by 0.3 percent. This figure is based on analysis of the reduction in Hb_{A1c} from baseline to post-treatment for patients receiving Initiative services. Both participants and nonparticipants in the enhanced intervention are included in this calculation.

- The Initiative reduces total cholesterol levels by 4.3 mg/dL (2.7% relative to a mean baseline value of 187 mg/dL). This figure is based on analysis of the reduction in total cholesterol from baseline to post-treatment for patients receiving Initiative services.
- The Initiative reduces systolic blood pressure levels by 1.43 mm Hg (1.0% relative to a mean baseline value of 134 mm Hg). This is based on analysis of the reduction in systolic blood pressure from baseline to post-treatment for patients receiving Initiative services.
- The reductions in Hb_{A1c}, cholesterol and blood pressure will persist over time. To maintain these effects, the Initiative will continue to be applied at an annual cost of $250 per patient.
- The reductions in Hb_{A1c} and cholesterol will persist over time. To maintain these effects, the Initiative will continue to be applied at an annual cost of $250 per patient.

We calculated the cost-effectiveness of the Diabetes Initiative for a cohort of patients with demographic and baseline risk factors similar to the patients served by the Initiative (**Table 2-3**).

Table 2-3 Characteristics of the Study Population

Intervention	%
Gender	
Male	39.0
Female	61.0
Race/ethnicity	
White	8.8
African American	64.9
Native American	0.3
Asian/Pacific	10.2
Hispanic	15.8
Age Categories	
25–34 yrs	5.3
35–44 yrs	13.1
45–54 yrs	25.0
55–64 yrs	28.3
65–74 yrs	19.0
75+ yrs	9.3
Hypertension (>140/90 mm Hg)	
Yes	38.5
No	61.5
High Cholesterol (>200 mg/dL)	
Yes	30.2
No	69.8
Smoking Status	
Yes, smokes	20.3
No	79.7

2.3 Cost-Effectiveness Analysis Results

Based on the above assumptions, the preliminary cost-effectiveness results are shown in **Table 2-4**. The Initiative is projected to increase life expectancy by 0.196 years for each person served (about 2.4 months). The cost of implementing and maintaining the Initiative is $3,618 per patient over a lifetime, which is partially offset by a $956 reduction in diabetes-related medical costs. Overall, the Initiative increases costs by $2,662 and increases QALYs by 0.1218, producing a cost-effectiveness ratio of $21,322/QALY.

Table 2-4 Interim Cost-Effectiveness Results

	Initiative Costs	Diabetes-Related Medical Costs	Total Costs	Remaining Life-Years	QALYs	Cost-Effectiveness Ratio ($/QALY)
In absence of Initiative	$0	$53,499	$53,499	18.4050	12.6555	
With the Initiative	3,618	52,542	56,160	18.6007	12.7803	
Difference	3,618	−956	2,662	0.1248	0.1248	$21,322

Note. QALY = quality-adjusted life-year.

Three points about these results are worth emphasizing:

- The 0.196-year increase in life expectancy is an average increase and includes some individuals who live many more years as a result of the Initiative and others who do not receive any benefits because they die from causes unrelated to diabetes.
- The Initiative increases costs and improves outcomes. Thus, like most health interventions, the Initiative is not cost saving, but it does purchase improved health at a reasonable price.
- The cost-effectiveness ratio, $21,322/QALY, is less than the $50,000/QALY benchmark. This suggests that the Initiative is cost-effective and provides good value for the investment.

The cost-effectiveness model allows us to examine how disease management initiatives reduce disease-specific adverse events and total medical costs and utilization over time. In the case of diabetes, the goal is to reduce the following adverse events:

- chronic kidney disease and end-stage renal disease
- diabetic retinopathy and blindness
- peripheral vascular disease resulting in diabetic ulcers
- cardiovascular complications, including heart disease and stroke

Treatments for these adverse events can involve frequent and costly use of hospital services, as well as additional outpatient visits subsequent to treatments for acute problems or complications. Ideally, upfront costs associated with health care programs and additional routine treatment regimens ultimately reduce the long-term costs to stakeholders (MassHealth Program and its affiliates, those who pay for services for the uninsured). It is rare, however, that the additional, upfront costs are totally offset by a reduction in other health care costs over time. Both types of costs are included in the model. The estimated impact of the Initiative on adverse events is shown in **Table 2-5**. The table shows both the reduction in adverse events and the estimated number of complications that will be prevented in a center that services 1,500 diabetes patients for the remainder of their lives. The Initiative would lead to a projected reduction in all of the diabetes-related adverse events except stroke. Stroke increases slightly because patients live longer under the Initiative and therefore are at risk of developing stroke over a longer period.

Table 2-5 Cost-Effectiveness Results—Adverse Events

Adverse Event	% Without Intervention	% With Intervention	Reduction, %	Cases Prevented Per 1,500 patients
▪ End stage renal disease	2.55	2.24	0.31	4.7
▪ Blindness	13.75	11.79	1.96	29.4
▪ Lower extremity amputations	4.01	3.83	0.18	2.7
▪ Coronary heart disease	45.63	43.91	1.72	25.8
▪ Strokes	19.40	19.68	−0.28	−4.2

In addition to the diabetes-specific adverse events, health care interventions may also affect outcomes not specifically tied to diabetes. These kinds of effects are difficult to identify in any project or study. For instance, we do not know whether or how enhanced diabetes care may affect cancer. Also, in the traditionally underserved populations who use community health centers, reliance on emergency rooms as a usual source of care tends to be higher than in the general population. This is particularly true among uninsured individuals. Increased care under the initiative may decrease this over-use of the ER.

2.4 Sensitivity Analyses

Our analysis requires assumptions about the whether the impacts of the Initiativeare maintained in subsequent periods, and at what cost. In our base analysis, we assumed that the impact of the Initiative on Hb_{A1c}, cholesterol, and blood pressure is maintained in subsequent periods and that the intervention costs $400 in years 1 and 2 and $250 in subsequent years. **Table 2-6** shows how the cost-effectiveness ratio changes with alternative assumptions.

Table 2-6 Sensitivity Analyses

	Cost-Effectiveness Ratio ($/QALY)
Base analysis	$21,322
Maintenance cost is $400 in years 2+	$34,974
Maintenance cost goes to $0 in year 3; impact of Initiative begins to fade in year 3 and reaches 0 in year 7	$5,025

QALY = quality-adjusted life-year.

3. BOWDOIN STREET HEALTH CENTER SURVEY ANALYSIS

3.1 Bowdoin Street Survey Sample

After obtaining institutional review board approval, the Bowdoin Street Health Center administered the patient survey from November 2010 through March 2011. A total of 66 diabetes patients at the center completed surveys. The Bowdoin Street sample differed in several important ways from the samples at the other centers. First, all persons in the survey sample had made recent visits to the health center (within the previous 18 months); this contrasted with samples from other health centers where the samples simply included persons on the diabetes registers, regardless of whether they had recent visits. Second, about half of the individuals in the Bowdoin Street sample received expanded services programs, such as group medical visits, supported by the Foundations (participants); and about half of the persons received less intensive care regimens (nonparticipants). Third, all respondents completed surveys during visits to the center; none of the surveys were done by mail. Fourth, the expanded diabetes programs had been in operation for a longer time at Bowdoin Street than at the other health centers.

3.2 Comparison of Bowdoin Street Survey Reponses with Those of Other Centers

The goal of the cross-site evaluation is not to compare one health center with another. Nevertheless, we compare the results from Bowdoin Street to the other health centers here, not to compare the programs or the health centers, but to better understand the responses given the differences in the samples and in when the surveys were administered. From 2007 through 2009, 389 patients from these centers completed baseline surveys by mail or in health centers. Responses were weighted by center-specific response rates and combined to reflect the composition of all patients appearing in diabetes registries. Survey responses are summarized by seven multi-item scales (and one treatment categorization) that characterize a patient’s health status, as shown in **Table 3-1.**

Table 3-2 contrasts the mean scale scores for Bowdoin Street and for the other centers. The table reveals several differences between the mean scores for the two groups. To help interpret the magnitude of these differences, they are expressed in **Figure 3-1** in terms of relative effect size (group difference divided by the standard deviation of the outcome scale). Effect sizes of 0.20 or less are generally considered small; an effect size of about 0.5 is considered medium; and 0.80 is large.

Table 3-1 Survey Measures

Survey Section	Construct	Measure / Scale
A	Health utility	EQ-5D (0 = death, 1 = perfect health)
B	Treatment regimen	Insulin, oral medications
C	Symptom severity	Newcastle Diabetes Symptoms Questionnaire (NDSQ)
B, D	Self-care activities	Summary of Diabetes Self-Care Activities (SDSCA)
E	Physical activity	International Physical Activity Questionnaire (IPAQ)
E	Physical function	RAND-12 Physical Health Composite (PHC)
F	Depression	Patient Health Questionnaire (PHQ-9)
G	Support from health care providers	Resources and Support for Self-Management Scale (RSSM)

Note. EQ-5D is a five-dimensional standardized instrument for use as a measure of health outcome. It was developed by the EuroQol Group.

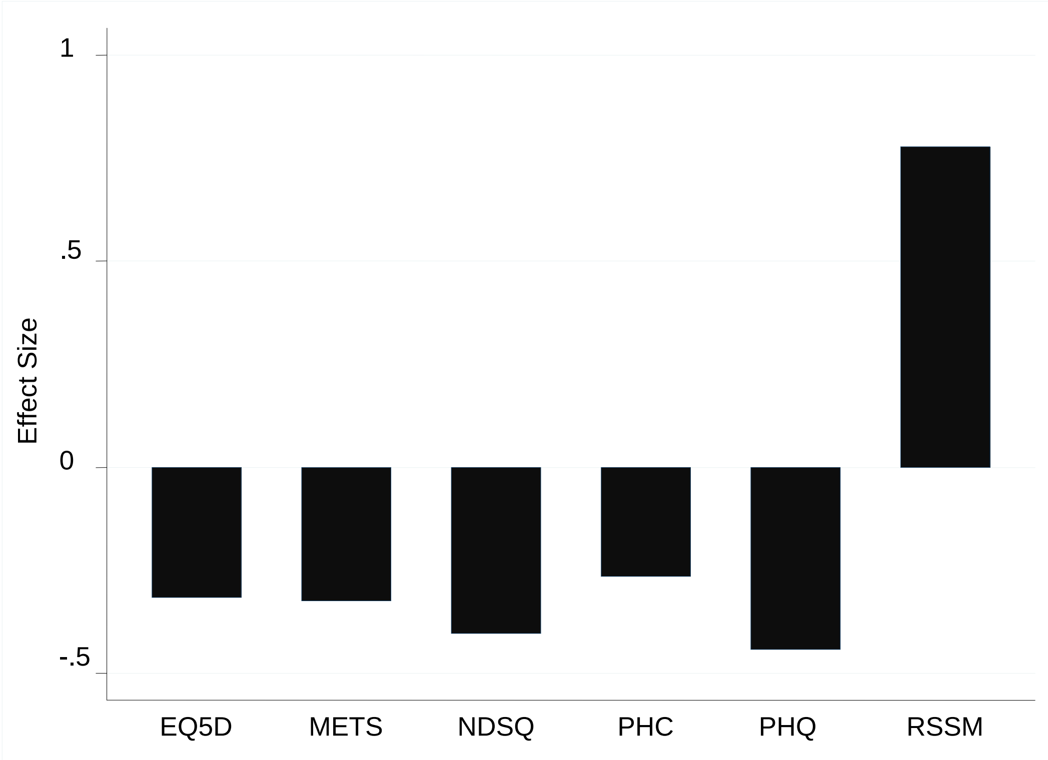
Table 3-2 Mean Scale Scores for Bowdoin Street and the Other Centers

Scale Name	Bowdoin Mean	Weighted Mean for Other Centers
EQ-5D	0.71	0.77
Metabolic equivalents	1,073.00	2,175.80
Newcastle Diabetes Symptoms Questionnaire	15.60	22.39
RAND-12 Physical Health Composite	37.40	40.26
Patient Health Questionnaire	3.00	5.15
Resources and Support for Self-Management Scale	3.82	3.09

Note. EQ-5D is a five-dimensional standardized instrument for use as a measure of health outcome. It was developed by the EuroQol Group.

The biggest difference in effect size between the groups was on the Resources and Support for Self-Management (RSSM) scale, which measures the perceived support (help, teaching, or other) from diabetes care teams. The Bowdoin Street sample reported receiving support from their health care teams considerably more often than those in the other centers (effect size 0.77). This finding is likely to have been influenced by the sample selection process at Bowdoin Street, where survey respondents would likely have had very recent contacts with their care team.

Figure 3-1 Effect Sizes for Bowdoin Street Diabetes Patients Compared with Patients at Other Health Centers



Note. EQ-5D is a five-dimensional standardized instrument for use as a measure of health outcome. It was developed by the EuroQol Group. METS = metabolic equivalents; NDSQ = Newcastle Diabetes Symptoms Questionnaire; PHC = RAND-12 Physical Health Composite; PHQ = Patient Health Questionnaire; RSSM = Resources and Support for Self-Management scale.

Two other outcomes had effect sizes of –0.40 or greater. Compared with those at the other centers, Bowdoin Street's patients reported lower levels of depressive symptoms according to the PHQ[2] scale and experienced common diabetes symptoms less frequently (Newcastle Diabetes Symptoms Questionnaire).

The effect sizes for the remaining three outcomes were all comparatively small, but all indicated less favorable health status for Bowdoin Street patients. The Bowdoin Street sample reported somewhat lower levels of physical functioning (RAND-12 Physical Health Composite), lower health utility scores (EQ-5D, a five-dimensional standardized instrument for use as a measure of health outcome, developed by the EuroQol Group), and only half of the amount of physical activity (International Physical Activity Questionnaire metabolic equivalents) reported by patients at the other four centers.

[2] Surveys administered at the other health centers used the full Patient Health Questionnaire (PHQ-9). We omitted the question related to suicide ideation on the Bowdoin Street version of the survey and used eight questions instead of nine. We did so because the question related to whether one has had thoughts about suicide does not affect the scale score and can pose operational challenges in survey administration when people respond affirmatively.

4. SUMMARY OF GRANTEE ACCOMPLISHMENTS

4.1 Improvements in Clinical Measures

Comparatively few intervention or quality improvement initiatives studies are assessed by analyzing clinical data such as Hb_{A1c} levels, blood pressure, or cholesterol levels over several years. It is much more common for outcomes to be assessed in the short run; most often, results are favorable. It is much more difficult to affect outcomes over longer periods, particularly for a progressive illness like diabetes. Thus, any sustained improvements in clinical values over longer periods are somewhat atypical. Collectively, the funded health centers were able to achieve improvements in each of the three clinical indicators, or at least maintain them.

- Both Hb_{A1c} levels and cholesterol levels tended to improve markedly soon after participation began in both enhanced care or usual care regimens; blood pressure improved marginally.
- After the initial year, Hb_{A1c} levels worsened slightly over subsequent years; cholesterol levels and blood remained relatively constant.
- Age tended to have a negative effect on Hb_{A1c} and a positive effect on blood pressure and total cholesterol.

The shape of the Hb_{A1c} trajectories for this population resemble that of the study population in the United Kingdom Prospective Diabetes Study, even though the characteristics of patients served in American health centers differ, and even though the respective study periods were more than two decades apart.

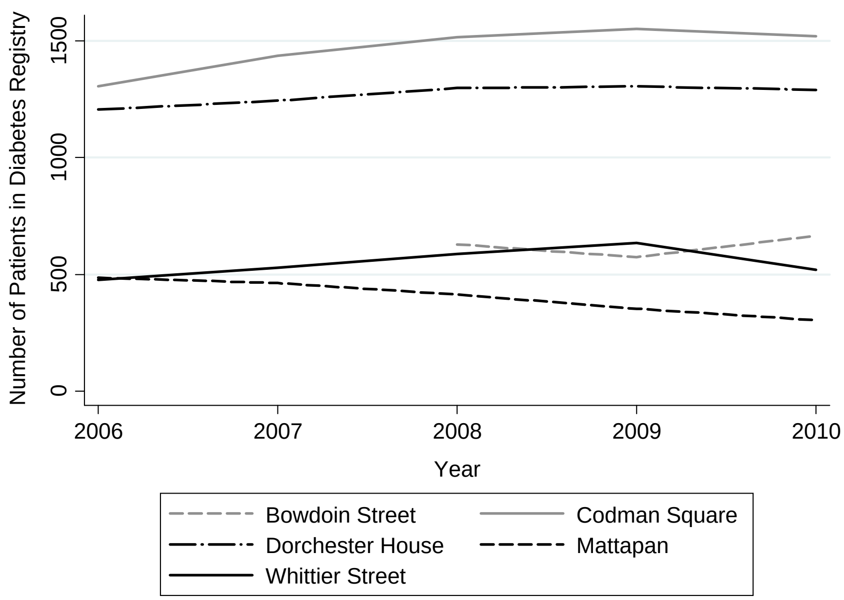
Published Results from Similar Initiatives

All of the health centers that were part of the Diabetes Initiative also participated in a national movement among all federally funded community health centers to improve chronic illness care—the Health Disparities Collaboratives. One recent study assessed the effectiveness of the Collaboratives in improving care and included an analysis of clinical indicators. Landon and colleagues (2007) compared clinical outcomes at health centers that were part of the Collaboratives to outcomes at health centers that were not part of the Collaboratives. The authors concluded that the Collaboratives significantly improved the processes of care (such as the number of individuals whose Hb_{A1c} levels were assessed) but did not improve the clinical outcomes studied.

4.2 Addressing Increasing Prevalence of Diabetes

Figure 4-1 illustrates the growth over time of the centers' panels of patients who have type 2 diabetes.[3] We see that Bowdoin, Codman, DotWell, and Whittier Street all experienced growth in the number of diabetes patients served from 2006 through 2010. This upward trend in the number of diabetes patients served demonstrates their ability to provide care to a growing population in need. In addition, all health centers reported that treating persons with diabetes requires additional time and resources and reported that state reimbursement and funding streams do not adequately cover the costs for treating persons with diabetes. In short, the health centers have been doing more with less. All of them reported that the Diabetes Initiative enabled them to provide better care to an increasingly larger number of persons throughout the period of the Initiative.

Figure 4-1 Patients on Diabetes Registers over Time, by Health Center



4.3 Preparing for National Changes in Health Care Delivery

The Affordable Care Act provides funding for the development, expansion, and support of the "medical home," which can be described as a system that improves care delivery in several ways by:

3 Registers always grow if patients are never dropped from them. For purposes of assessing the numbers of patients served over time, we counted only "active" patients. Patients were considered "active" for 1 year after their last recorded data point and inactive after that. That is, someone whose last data point was on November 1, 2008, would be counted on their center's diabetes registry for 2008 and 2009. Counts of active patients represent the true numbers served.

- providing comprehensive care management, care coordination, and health promotion;
- accommodating care during transition from inpatient to other settings;
- offering patient, family, and caregiver support and referrals to community and social support services; and
- using health information technology to link services.

One manifestation of the medical home is the community-centered health home (CCHH), which has the underlying values of the medical home model while also focusing on community involvement and advocacy. As a result of their involvement in the Initiative, the five community health centers in the Initiative are uniquely positioned to become (and in many respects already are) CCHHs. The use of community health workers by the health centers and the various community events that were implemented under the Initiative are features of CCHHs.

One overarching feature of the CCHH is its involvement in the community as a means of providing preventive services and care that are patient-centered and specific to individual preferences and needs. Patient-centered care is also a means for reducing disparities in health care.

Another aspect of the CCHH model is acknowledging and working to improve factors outside the health care system that affect patient outcomes. CCHHs are often allies in the eyes of their patients and are therefore privy to factors affecting patient health that might not come up during a visit in other practice settings. With this information, community health workers can refer their patients to in-house services that will address their needs and better help them keep their diabetes under control. This “finger on the pulse” of the community is consistent with a CCHH (Cantor et al., 2011).

4.4 Reducing Disparities in Diabetes Care

The population served by the Diabetes Initiative comprises entire panels of patients with type 2 diabetes served by five inner-city community health centers. The patients served are a racially and ethnically diverse group of more than 5,000 patients, almost half of whom are African American, who received diabetes care at the centers over multiple years. Within the health center population, differences among racial and ethnic groups in the three clinical indicators may represent important differences in physiological or social factors.

Table 4-1 shows the aggregate demographics of the health centers in the Initiative. Although this table does not capture the full stratification of racial and ethnic backgrounds, it nonetheless illustrates that these centers are serving a very diverse group of individuals. Our conversations with staff members at the centers made clear that staff work hard to tailor their care processes to the cultural needs of the communities they serve. The front-line staff members at the health centers often are themselves of the same racial/ ethnic group as the patients they serve or, at least, speak the primary language of their patients. They have a deep understanding of the cultures and traditions of their patients and how these are important to managing diabetes.

Table 4-1 Demographic Composition of the Populations Served with Type 2 Diabetes in the Initiative

Race/Ethnicity	Male	Female	M+F Total	% Total
American Indian or Alaskan Native	10	8	18	0.36
Asian or Pacific Islander	239	267	506	10.00
Black (not of Hispanic origin)	1,186	1,833	3,019	59.57
Hispanic	329	402	731	14.42
Mixed race or ethnicity	0	0	0	0.00
Other or not available	142	244	386	7.61
White (not of Hispanic origin)	192	216	408	8.05
TOTALS	**2,098**	**2,970**	**5,068**	**100.00**

Source: Data provided by participating health centers.

4.5 Community Health Centers Offer "Best Value" Care Teams

One strength of the funded community health centers is their extensive use of diverse teams of providers, which are needed to adequately address disparities and tailor care to individual needs. As part of the Diabetes Initiative, the health centers coordinated care among physicians, nurse practitioners, clinical pharmacists, registered nurses, medical assistants, nutritionists, and community health workers. The use of care teams is common among community health centers nationally: 90 percent of health centers employ nurse practitioners or physician's assistants to address their patients' needs, and one third of health center patients receive care from nurse practitioners or physician's assistants (Ku et al., 2010). This diversification in health center staffing models means that community health centers are less reliant on any one type of clinician and may be able to weather physician shortages better than their private practice counterparts. Perhaps more importantly, in an era in which all public and private payers are attempting to reduce health care expenditures, health centers are less costly.

Implementing the coverage expansions through the policy changes initiated by the Affordable Care Act over the next few years will be challenging because of the shortage of primary care providers. (Ku, et al., 2010) argue that the expansions will be less costly insofar as society relies on community health centers to handle the increased demand and use of primary care. They find that "the expansion of community health centers can reduce both federal and state Medicaid expenditures." Although Congressional Budget Office projections estimate that health center expansion would cost the federal and state government approximately $454 billion, others (Elmendorf, 2010; Ku, et al., 2010) find that the cost of health center and Medicaid expansion would be much lower than those projections and that states could actually reduce their overall Medicaid expenditures and save about $13 billion between now and 2019.

The Diabetes Initiative funding was used in part to expand the capacity of the health centers to build diverse care teams and optimize their use for diabetes patients. It fostered the health centers' progress and evolution toward becoming premiere, "best value" providers.

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