Effects of Quality Improvement Strategies for Type 2 Diabetes in Bronx, N.Y.

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Improving care of people with diabetes has become a major goal for many institutions. This is particularly important in the Bronx because we deal with a large underserved population of ethnic/racial minorities that is susceptible to more diabetes and further complications. Montefiore Medical Center already has in place many resources, such as multidisciplinary diabetes workgroups committed to implementing quality improvement (QI) projects. To carry on such endeavors, a complex and well-designed administrative support system is required from the executive office. The QI committees rely on step-by-step methodologies to define a series of factors that occur systematically and result in improved care. The large population with diabetes is cared for mainly by primary care physicians (PCPs) that are part of a large sophisticated health care system. Because of both the complexity and diversity of the population, several programs are tailored to the needs of specific subgroups. The implementation of different interventions and their effectiveness and cost must be properly assessed. Thus, QI projects are necessary to provide meaningful information that can be used for improving these health care systems and the patient care they provide.

In this article, we describe the population of the Bronx, the structure and programs that are dedicated to diabetes at Montefiore, and our information technology (IT) system and how it can be used for QI programs. We also provide an example of how the system is being used.

Patient Population in the Bronx

Although the Bronx is only one borough in New York City, its population is larger than all but five U.S. cities. This is a vibrant and younger population of diverse racial/ethnic backgrounds. Data from the U.S. Census Bureau, year 2000, illustrate how the Bronx statistics compare to national statistics. Average population age in the Bronx is 33.27 years versus 36.22 years nationally (71% are < 44 years of age, versus 65.5% nationally). The white population is only 29.9% in the Bronx, versus 75% nationally, with blacks or African Americans composing 35.6% versus 12.3% nationally, and Hispanic or Latinos composing 48.4% versus 12.5% nationally.

Albert Einstein College of Medicine is the only medical school in the Bronx, and Montefiore is the largest health care provider in the Bronx and its contiguous Westchester County. Montefiore is a not-for-profit integrated health care delivery system, a major academic clinical center serving patients referred from throughout the New York metropolitan area. It consists of:

- 1,060 total acute care beds on two campuses
- A network of 19 primary care centers providing 750,000 visits/year
- Two specialty ambulatory care centers near Montefiore's hospitals
- A 420,000-visit home health agency providing short- and long-term care to home-bound patients
- A unified, enterprise-wide clinical and business information system connecting all of the above components
- More than 800 house staff members and > 800 full-time academic faculty in all clinical specialties

Diverse Programs, Integrated Care

Montefiore has built one of the nation's largest, most successful integrated delivery systems, with an extensive network of primary and specialty care. The institution has been accepted to manage fully capitated risk contracts for > 150,000 people. During the past decade, Montefiore investments in programs of QI and health IT have gained national recognition for their achievements in patient safety, implementing "best practices," and improving clinical outcomes. Montefiore was among the first hospitals to establish departments of social services (1914), home health care (1947), and social medicine (1950) and to connect with the community, an essential element in the management of chronic conditions such as diabetes.

Because the Bronx is a "hot spot" for diabetes, with a prevalence of close to 12% in the adult population, the institution has established diabetes as a priority disease, making a full commitment to developing resources and a strategic plan to improve the lives of individuals with this disease. The long-term commitment, investment, development of integrated processes, cooperation, and creation of diverse programs that work under one umbrella are already bearing fruit. Following are some examples.

The Montefiore Clinical Diabetes Center. Established and certified by the American Diabetes Association (ADA) for more than 10 years, the diabetes

center is an integrated clinical program staffed by two endocrinologists, five registered nurses and two registered dietitians (all certified diabetes educators), and administrative personnel. Small practices provide care for patients with type 1 diabetes who need intensive insulin regimens. However, a major goal has been to implement innovative programs dedicated to providing support for patients with type 2 diabetes, the majority of whom are cared for by PCPs.

Among these initiatives are a novel program for high-risk patients and an inpatient intensive insulin program. The former, known as Proactive Managed Intervention System for Education in Diabetes (PROMISED), serves > 300 high-risk patients per year through 10-hour group workshops focusing on patient empowerment and diabetes self-management education. This program differs from other education programs by providing individual multidisciplinary evaluations and consultative reports for participants' PCPs. Developed for type 2 diabetic patients who receive care from PCPs, it emphasizes improving cardiovascular disease outcomes. By creating a team approach involving patients, their PCPs, and the diabetes specialty team, this program has achieved short- (1-year) and long-term (4-year) improvements in hemoglobin A_{1c} and other disease process goals. An inpatient program has provided intensive intravenous insulin therapy protocols for intensive care units and guidelines for managing more stable hospitalized individuals with hyperglycemia. This program provides professional education for a system-wide intervention and emphasizes continuity of care during the transition from hospital management to outpatient care. The QI project described later in this article pertains to assessment of inpatient management throughout the hospital.

Care for high-risk pregnancies. The Montefiore Diabetes in Pregnancy program offers an integrated approach to care for pregnant patients with diabetes. With a grant from the New York State Department of Health, this program takes a novel whole-family approach. Patients with gestational diabetes are viewed as conduits providing an opportunity for evaluation of entire families for cardiovascular risk factors such as obesity, diabetes, hypertension, and dyslipidemia, all of which are silent conditions that prevail in relatives of people with gestational diabetes.

Community-based primary care. During the past 5 years, Montefiore has implemented a successful diabetes QI and care management program in its federally funded health centers. This program builds on Wagner's Chronic Care Model to improve diabetes outcomes by redesigning the diabetes care delivery system to support patient self-management using clinical information and decision support. Originally funded as part of the Diabetes Breakthrough Collaborative Program, this endeavor includes ~ 4,000 patients. Other primary care programs were also developed in other health care facilities, featuring a dedicated team formed by a "nurse champion," a nutritionist, and a social worker, who provide resources to improve adherence to standards of care and better patient outcomes.

Chronic disease management program. This program, for patients with type 2 diabetes, was developed by the Montefiore Clinical Diabetes Center for the capitated patients followed by the Contract Management Organization, a fully owned subsidiary of Montefiore that now serves > 1,000 patients with diabetes. This program has also recruited three registered nurses to serve as diabetes case managers.

Collaboration with the Diabetes Research and Training Center (DRTC). Collaboration with the Albert Einstein College of Medicine DRTC has been very productive. Established in 1977 by the Diabetes Research and Education Act (Public Law 91-354), the Einstein DRTC is one of six centers supported by the National Institute of Diabetes and Digestive and Kidney Diseases. Through the Prevention and Control Division, which focuses on diabetes translation issues such as diabetes education, professional training, and community outreach, several innovative approaches have been developed to improve the quality of diabetes care. Seamless collaboration between Montefiore's Clinical Diabetes Center and the DRTC has resulted in several highly successful programs.

Collaboration with the Albert Einstein College of Medicine Institute for Community and Collaborative Health. A collaborative relationship between Montefiore and Albert Einstein has permitted bridging between the medical school, clinical networks, and Bronx communities. Two centers of excellence that have led major diabetes initiatives are the Bronx Center to Reduce and Eliminate Ethnic and Racial Health Disparities and the Hispanic Center of Excellence. This collaboration has made possible community involvement and outreach, clinical research, and improvement in cultural competency and health care disparities throughout Montefiore clinical systems.

IT Systems

During the past decade, Montefiore has invested more than $125 million in information systems, making it a national leader in implementing novel medical IT programs. It is one of the few hospitals in the United States to have achieved the goal of having a network of integrated outpatient and inpatient clinical information systems between two major hospitals and 19 community primary care centers. All prescription writing, test-ordering, and test-result reporting are computerized. There are > 1 million patients in the electronic medical record system, which allows clinicians to share information about patients across institutional and geographic boundaries (an ability often called "connectivity" or "interconnectivity"). These systems have significant implications for the day-to-day delivery of health care services; the electronic health record can electronically collect and store data about patients,

supply that information to providers on request, permit physicians to enter patient care orders on the computer (known as "computerized physician-order entry"), and provide health professionals with advice for making health care decisions about individual patients.

A user-friendly interactive software application system called Clinical Looking Glass was developed to evaluate health care quality, effectiveness, and efficiency. This versatile system communicates with the clinical information system and integrates clinical and administrative datasets, allowing nonstatisticians to produce epidemiologically cogent self-documenting reports. It globally assesses care quality while identifying specific patients in need of clinical remediation. The system is capable of producing immediate results for queries such as inpatient length of stay, readmission, mortality, and glycemic control. It identifies patients meeting specific criteria and can create self-documenting output with graphics and meaningful clinical summaries or a work list for targeted remediation of failing patients. This system has allowed several analyses for QI, including the one described later in this article.

A regional health information organization (RHIO) facilitates this exchange by bringing together the groups that must participate to make the exchange effective. The Bronx RHIO is one of the few central regional information organizations in the country dedicated to improving the quality and efficiency of health care delivery by facilitating the secure and portable electronic exchange of health information.

QI Programs

QI programs are complex and require serious, long-term organizational commitment and widespread, multidisciplinary efforts. At Montefiore, this has been the case, and a multitude of QI programs have been developed to assess different interventions and measure performance.

Major advantages of this novel methodology include enabling the organization to remain continuously data driven, standardization in quality-related institutional reporting, and enhanced information systems capabilities. These QI measures are intended primarily to facilitate providers in tracking the management of individual patients with clinical recommendations and treatment goals. The term "performance improvement" is a holistic term that describes all institutional improvement activities relating to clinical care processes. Performance improvement and quality improvement are not exclusive terms, but instead are complementary.

At Montefiore, the integration of QI is made through different components. The Quality Council is primarily responsible for alignment and coordination of performance improvement activities, an institutional strategy that oversees initiatives with specific indicators that assess the quality and safety of patient care. The Quality Improvement Committee ensures consistent, impartial, and professional evaluation of care. The Department of Risk Management is responsible for surveillance, investigation, and analysis of patient care and other occurrences to identify potential liability risks. The Division of Outcomes Analysis and Decision Support enables quality improvement and patient safety activities and helps convert computerized data into accessible information for use by clinical and administrative leadership. The Patient Safety Committee supports a coordination and integration function for institutional activities that affect the institutional patient safety program. The Environment of Care Committee oversees and manages the development, implementation, and ongoing evaluation of care activities across the integrated delivery system. Although the organizational structure is complex, development of QI projects can be simplified through the following steps:

- Identify the population with diabetes.
- Become familiar with guidelines.
- Review the essential diabetes care guidelines and the continuous QI guidelines with the diabetes workgroup.
- Clarify measurement issues and review criteria.
- Collect baseline data.
- Analyze baseline data to determine how the practice compares with the guideline recommendations to identify problems that need improvement.
- Set priorities for improving identified problem areas.
- Design strategies for improving performance in the problem areas.
- Implement strategies.
- Measure the progress and evaluate the success of interventions.
- View QI as a continuous process.

QI: A Sample Program

According to a report issued by the American College of Endocrinology/ADA Task Force on Inpatient Diabetes, poor glycemic control is a marker for inferior quality of hospital care. Given the fear of hypoglycemia and the lack of established algorithms to manage patients, many hospitals continue to rely on outmoded insulin sliding scales, and poor glycemic control in hospitalized patients remains common. Stress hyperglycemia, defined as hyperglycemia without a history of diabetes, is also a common condition associated with increased risk of in-hospital complications, multi-organ failure, longer lengths of stay, and higher inpatient mortality rates than patients with known diabetes.

To address these concerns, Montefiore provided new guidelines to replace regular insulin sliding-scale coverage. These guidelines entailed ongoing professional education mainly in the Department of Medicine. The protocol consists of a more proactive approach using an aggressive regimen of basal insulin in patients with type 2 diabetes and a basal-bolus approach for individuals with type 1 diabetes or those with type 2 diabetes who are acutely ill. Also, a protocol for intensive intravenous insulin therapy was developed and implemented for patients in the intensive care units with ischemic coronary disease and those undergoing

Table 1. Admission CBG Levels Divided Into Quintiles

	CBG (mg/dl)				
	< 50	**51–70**	**71–180**	**181–300**	**> 300**
Total cohort [*n* (%)]	678 (8.5)	1,186 (14.8)	5,787 (72.28)	330 (4.12)	25 (0.3)
Diabetes subgroup [*n* (%)]	538 (10.8)	886 (17.8)	3,288 (66.1)	249 (5)	15 (0.3)
LOS total cohort (days)	9.22	7.74	5.79	3.73	3.77
LOS diabetes subgroup (days)	8.96	7.3	5.07*	3.0*	3.33
Mortality total cohort (%)	24.5	14.6	9.0	10.4	20.8
Mortality diabetes subgroup (%)	19.2	11.7	6.7*	8.3	20.0

*$P < 0.001$.

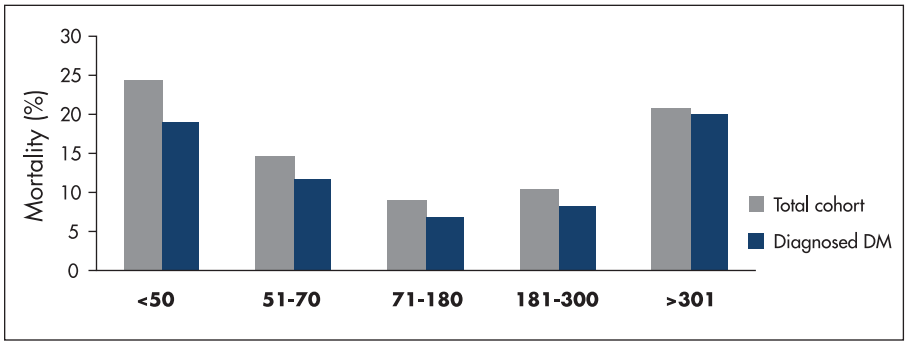

Figure 1. Distribution of mortality related to glycemic levels.

coronary bypass procedures. However, little information is available about how these recommendations have been implemented or the relationship between inpatient glycemic levels and mortality.

As part of a QI project, the impact of admission capillary blood glucose (CBG) was assessed on inpatient and outpatient mortality (as per death certificates) within 6 months after discharge. Also, a correlation between medications used for glycemic control and mortality and length of stay (LOS) was investigated.

The patients were representative of the Bronx population described above. Using the Clinical Looking Glass program (also described above), a cohort of inpatients was selected for having at least one CBG determination on admission between 1 January and 30 May 2006. The cohort included patients with diabetes and with stress hyperglycemia admitted to the general wards and acute medical and surgical units. The diabetes subgroup included patients with type 1 or type 2 diabetes. The patients' admission glucose levels were arbitrarily divided into quintiles: severe hypoglycemia (CBG < 50 mg/dl), hypoglycemia (CBG 51–70 mg/dl), euglycemia (CBG 71–180 mg/dl), hyperglycemia (CBG 181–300 mg/dl), and severe hyperglycemia (CBG > 301 mg/dl). LOS, all-cause mortality rate, and medication profiles were analyzed.

Results. A total of 8,006 patients were identified with a median age of 62 years. The analysis included only individuals with a CBG determination within the first 5 months of 2006. There were 3,337 males and 4,669 females, for a male-to-female ratio of 1:1.4. A large percentage of patients had stress hyperglycemia on admission. The distribution of admission CBG values, along with the LOS and mortality for both the total cohort and the diabetes subgroup is shown in Table 1 and Figure 1.

Patients with extreme hyperglycemia (CBG > 301 mg/dl) or hypoglycemia (CBG < 50 mg/dl) had a three- to four-times higher mortality rate than the general population. Patients with stress hyperglycemia had a longer LOS and higher mortality than those with established diabetes across all categories. Patients with either diabetes or stress hyperglycemia had a higher mortality than the overall nondiabetic population (6.2%). From 56,407 CBG determinations, the majority (52.5%) had glucose levels between 71 and 180 mg/dl, without antidiabetic treatment (Table 2). A large percentage of patients (24%) had severe hyperglycemia (CBG > 301 mg/dl) and apparently remained untreated. Oral agents, although not generally recommended for in-hospital glycemic control, were equally prescribed across all categories. Both basal insulin and regular insulin sliding scales continued to be used and were found to be associated with hyperglycemia and hypoglycemia (Table 2).

Discussion. A cross-sectional analysis showed that a large percentage of hospitalized patients had stress hyperglycemia. This may be because of a lack of proper diagnosis coding, unrecognized diabetes, or a high prevalence of new-onset diabetes in a hospital serving a high-risk population. This is significant because morbidity and mortality in individuals with stress hyperglycemia is even higher than those of patients with diagnosed diabetes. Severe hyperglycemia and hypoglycemia on admission are associated with increased inpatient and outpatient mortality rates compared with the general population.

Although hyperglycemia associated with an increased morbidity and mortality rate has been well established, hypoglycemia has not (Figure 1); the high mortality rate could be related to

Table 2. Distribution of Medication Use Across All Quintiles

	CBG (mg/dl)				
	< 50	**51–70**	**71–180**	**181–300**	**> 300**
Total cohort CBG [*n* (%)]	1,790 (3.17)	3,222 (5.71)	49,870 (88.41)	1,448 (2.57)	77 (0.14)
Diabetes subgroup CBG [*n* (%)]	1,440 (3.88)	2,458 (6.64)	31,836 (86)	1,232 (3.33)	56 (0.15)
Medications					
No therapy [*n* (%)]	162 (24)	345 (29)	3,040 (52.5)*	90 (27)	6 (24)
Antidiabetic oral agents [*n* (%)]	112 (16.5)	202 (17)	1,003 (17)	83 (25)	3 (12)
Basal insulin [*n* (%)]	433 (64)	657 (55.4)	1,699 (29)*	175 (53)	15 (60)
Regular insulin sliding scale [*n* (%)]	339 (50)	535 (45)	1,474 (25.5)*	152 (46)	14 (56)

*$P < 0.001$

multi-organ failure, but this needs further investigation.

The reduction in LOS by almost 1 day in patients with diabetes compared with the total cohort is exceptional; in most hospitals the LOS is longer for patients with diabetes. This can be explained by the role of the diabetes team and the function of the clinical diabetes nurse specialists who often expedite discharge by providing counseling and continuity of care to ensure outpatient follow-up.

We found that many patients with hyperglycemia remain untreated during their hospitalization and that, across all glycemic levels, oral antidiabetic agents continue to be prescribed. Also, the inappropriate use of basal insulin and regular insulin sliding scales leads to extreme hyperglycemia or hypoglycemia. This QI project includes the baseline characteristics that are being used to conduct newer interventional projects with a goal to improve glycemic control in hospitalized patients.

Summary. Periodic appraisal of the QI plan is a key component of the evolution of the integrated delivery system's organization. It is based on achievement of, or progress toward, key quality and performance objectives and evidence that performance improvement methodologies are being used effectively day to day. Data collection can be performed through abstracting of paper medical records, completing paper flow sheets prospectively, or using electronic data systems. The latter is faster and cost-effective and is the one more frequently used by our QI programs. With this system, it is now possible to monitor and learn the impact and cost of different interventions.

Barriers to QI include resistance of personnel to adjust to these new policies in spite of professional education; there is need for constant surveillance of the proposed interventions, and there is inability to retrieve important quality indexes because of poor documentation. Despite the advanced technology available, analyses can be skewed or inaccurate. It is, for instance, difficult to track patient medications, which often change in the course of a hospital stay. Although this is a cross-sectional analysis of all patients, analysis of individual patients may yield different information.

One of the new projects based on this data will be to post glycemic quarterly performance data by unit, with the goal of providing a more updated glycemic control profile in each unit and also creating an incentive for competitive practice towards improvement. With enhanced electronic data and continuous improvement of software technology that adapts better to physicians' needs, these QI projects will provide new and superior information to improve patient care.

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