NewYork-Presbyterian Hospital has amply demonstrated that Six Sigma works as a model for quality in a health care setting. By carefully selecting and supporting Black Belts and choosing projects aligned with the its strategic objectives, the hospital has made impressive improvements in clinical, operational, and service excellence—with a return on investment that would elicit envy in any industry. Just as important, the Six Sigma program has been a catalyst for creating a culture of continuous improvement and innovation.

Edward D. Craven, John Clark, Mary Cramer, Steven J. Corwin, M.D., and Mary Reich Cooper, M.D.

Much has been written about the use of Six Sigma and Lean tools, techniques, and strategies in business and manufacturing settings, but readers of this journal may be less familiar with their applications in the health care industry, which account for approximately one-sixth of the U.S. economy. Health care organizations, including hospitals, are learning what other industries have known for some time, namely, the power of Six Sigma as a business initiative to improve quality, efficiency, and productivity. NewYork-Presbyterian Hospital has embraced these tools to find new solutions to difficult-to-solve problems and set the stage for ongoing innovation.

The hospital’s investment in the people and the systems necessary to rigorously measure processes and improve quality has since not only paid for itself many times over but also helped this large and complex organization to better meet the ever-increasing demands of today’s health care delivery system. The launch of the Six Sigma program was the first step on the organization’s quest for breakthrough improvements that will take it to a new level of organizational and operational excellence.

Since its implementation in January 2004, Six Sigma has become a way of life at NewYork-Presbyterian. This article describes how we “hit the ground running” with our Six Sigma program, embraced its methodology from the top down, and implemented it in areas not traditionally considered to be amenable to its tools and techniques. Through brief case studies, we highlight some representative projects that employed Six Sigma tools, Lean...
thinking, and common sense to provide safe, consistent, efficient, quality care to our patients. The success of such projects points to considerable progress in fundamentally changing the organizational culture and translating innovation into practice at all levels of the hospital.

The new reality of health care delivery calls for measurable performance that only can be accomplished through a data-driven approach to quality.

THE VISION: QUALITY AS A DIFFERENTIATOR

NewYork-Presbyterian Hospital is a 2,224-bed academic medical center that provides inpatient, ambulatory, and preventive care at its five major campuses in the metropolitan New York City area: Columbia University Medical Center, Weill Cornell Medical Center, the Morgan Stanley Children’s Hospital of NewYork-Presbyterian, the Allen Pavilion, and the Payne Whitney Westchester Division. As a teaching hospital, it is affiliated with two of the nation’s leading medical colleges, the Columbia University College of Physicians & Surgeons and the Joan and Sanford I. Weill Medical College of Cornell University. The hospital employs a staff of nearly 15,000 (not including the physicians and residents employed by the two medical colleges). NewYork-Presbyterian Hospital is the flagship of the NewYork-Presbyterian Healthcare System, the largest nonsectarian, not-for-profit health care system in the United States, with approximately 58 member facilities in four states and three countries.

NewYork-Presbyterian is the result of a full asset merger in 1998 of the New York Hospital, founded in 1771, and the Presbyterian Hospital in the City of New York, founded in 1868. With the merger came a commitment from the board of trustees, medical board, and administration to invest in building a quality infrastructure, because it was viewed as critical to the success of the new organization. We integrated the two institutions and organized all of the specialized clinical areas such as cardiology, neurosciences, oncology, and geriatrics into 14 hospitalwide clinical service lines, with an overarching goal of achieving quality-driven performance. In tandem with this, we developed our performance improvement program within each of the 14 service lines to improve the way clinicians think about quality in their delivery of health care services. In 2002, the hospital made additional investments of capital towards its goal of improving the quality of service.

Just as many businesses have employed various models, such as Total Quality Management and Continuous Quality Improvement, to improve performance and production over the years and then went on to discover Six Sigma, our hospital has long drawn upon quality models to guide process improvements. For instance, in the past we used the PDCA (Plan, Do, Check, Act) model before adopting a unique homegrown model called PRIDE (Process, Relevant data, Interpret the data, Design a solution, Execute the plan). The PRIDE model offered a catchy acronym to which our staff could easily relate, and the theme was used in various ways, including a video shown to new employees at orientation. Although the use of these models produced results that led to improvements, the solutions often were short-lived because the models lacked a mechanism for ensuring that the improvements would be sustained over time. The need for a more effective approach was apparent.

Traditional quality methodologies were no longer rigorous enough in an evolving health care environment that demanded an ever-increasing amount of data within the context of what has come to be called evidence-based medicine. The new reality of health care delivery calls for measurable performance that only can be accomplished through a data-driven approach to quality. It is beyond the scope of this article to discuss the data-dependent demands faced by hospitals today, such as compliance with government and private payers, increasing regulatory requirements, burgeoning and costly technology, and how they all affect the growing need for access to care. But common to all of these elements is the need for data to validate our approach to the delivery of patient care.

To take a data-driven approach, we needed the ability to measure quality and to apply these measurements in a meaningful way that would have an impact on all aspects of care delivery—from patient safety, efficiency, and effectiveness to physician performance, and even employee satisfaction. The methodology of the Six Sigma model of DMAIC...
In 2003, NewYork-Presbyterian’s senior leadership expanded its vision for quality and raised the bar for clinical, operational, and service excellence, backing this up with a commitment to change the way the organization operates (see Exhibit 1) and selecting Six Sigma as the hospital’s approach to performance measurement and process improvement.

It is of note that even before launching a formal Six Sigma initiative, NewYork-Presbyterian had earned a place on the *U.S. News & World Report* Honor Roll of America’s Best Hospitals, ranking ninth in 2004 and seventh in 2005 in this annual survey of 6,007 medical centers to select the best in the nation. Based on the magazine’s evaluation of 17 medical specialties, NewYork-Presbyterian placed in all 17 categories, including second in psychiatry, third in neurology and neurosurgery, fourth in kidney disease, and fifth in both pediatrics and urology.1 Despite such recognition, senior leadership believed the hospital could do even more to distinguish itself on the basis of quality. Indeed, the transition to a Six Sigma model marked a turning point for the organization—a critical step in the evolution of a quality model and the transformation of the culture at NewYork-Presbyterian.

An important early step in this transformation was the appointment in 2003 of a new chief learning officer to reframe the Center for Organizational and Leadership Effectiveness. The center, known as COLE, integrates employee training and development, education on service excellence, change facilitation, rewards and recognition, and employee communications—all in direct support of key hospital strategies and initiatives. This integration helps employees better understand how they fit into the big picture and contribute to the hospital as a whole. COLE worked closely with the chief quality officer, who championed the Six Sigma program at NewYork-Presbyterian and oversaw its rollout as a hospitalwide initiative.

**SIX SIGMA TRAINING**

Many months were devoted to the logistics of setting up our Six Sigma program. The key components of the program launch were training people in Six Sigma methodology and selecting their initial projects. The first wave of training, conducted by GE Healthcare, began in January 2004 with 10 candidates who had been handpicked by senior management to be Black Belts (the individuals who agreed to work full time for at least a two-year period devoted exclusively to Six Sigma projects). As the six-month training regimen began, each Black Belt was assigned his/her first project. At the completion of training, each Black Belt moved on to a new project. Meantime, the next

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*Exhibit 1. NewYork-Presbyterian Hospital’s Performance Excellence Model*
wave of Black Belts entered training at three-month intervals, with four sequential waves producing a total of 40 Black Belts by the end of 2004.

During this same period, training began for Green Belts, the individuals who would learn Six Sigma concepts and techniques so that they could participate part-time on projects under the direction of a Black Belt. A total of 160 Green Belts were trained in the first year of the program.

The objective of the Six Sigma program is to increase consistency and reliability while reducing the variability of clinical and administrative processes.

The first wave of Green Belts included members of the hospital’s top-level management team, including vice presidents and physicians who wanted to learn the tools and techniques that their staff would be using in Six Sigma projects. They believed the training would enable them to make experience- and knowledge-based decisions in their own work as well as in deploying staff on future projects. Their participation was a valuable addition to the program startup. They asked excellent questions about the projects to which they were assigned and challenged the new Black Belts in training in regard to their projects. As they went further into the Six Sigma training, they also asked probing questions of the Master Black Belts from GE Healthcare who served as their trainers, even suggesting some program modifications—which ultimately were implemented—for the training of subsequent groups of Green Belts.

SIX SIGMA PROJECTS: GETTING THE RIGHT STRATEGIC FIT

The objective of the Six Sigma program is to increase consistency and reliability while reducing the variability of clinical and administrative processes. The end result of each project is intended to help advance patient-centered care to a new standard by encompassing quality on all levels—clinical, service, and operational. Toward this end, each Six Sigma project that we undertake is carefully selected for its fit with NewYork-Presbyterian’s five strategic initiatives: strategic growth, people development, performance excellence, information technology, and innovation.

These strategic initiatives in turn are aligned with the Institute of Medicine’s goals for quality health care, which include safety, patient centeredness, effectiveness, efficiency, timeliness, and equity.

At the launch of the Six Sigma program, projects undertaken by the first waves of Black Belts focused on five target areas: bed capacity, inpatient medical management, cardiology services, radiology services, and supply chain management. As improvement objectives were met in these areas, the focus for Six Sigma projects has now widened to encompass quality and patient safety (performance excellence), patient length of stay, and revenue enhancement (strategic growth).

Any employee or medical staff member of NewYork-Presbyterian can suggest a project. The hospital’s intranet features a form that can be completed online and submitted to our four Master Black Belts for consideration. All ideas are reviewed for their strategic fit, and then assigned a priority ranking based on project selection criteria, which was developed during a “Workout” with the hospital’s leadership. The weighted criteria reflect many factors, including:

- Clinical excellence
- Regulatory and safety
- Physician satisfaction
- Staff satisfaction
- Patient satisfaction
- Ease of implementation
- Financial benefits
- Time to complete
- Sustainability

The project descriptions and priority rankings are submitted to the hospital’s chief operating officers for consideration. The stakeholder in each proposed project area is interviewed, preliminary data are collected and evaluated, and if the findings support the need, a project is formally designated and an executive sponsor is appointed to oversee it through completion.

Oversight of the Six Sigma program was initially provided by the Performance Excellence Steering Committee, with the chief quality officer as chair. (The committee name reflected the program’s title.) The committee had responsibility for all aspects of the Six Sigma program, including project selection, recruitment and selection of Black Belts, and mon-
New York-Presbyterian Hospital Uses Six Sigma

SIX SIGMA AT WORK: SELECTED PROJECTS

More than 130 Six Sigma projects, some of which incorporated other improvement tools such as Lean, were conducted in the first year. These projects scrutinized all levels of numerous processes throughout the continuum of care—from supply chain management to meal tray accuracy and the use of information technology to enhance patient safety—and produced sustainable improvements. The projects described below illustrate the processes and the solutions that the staff of New York-Presbyterian—under the leadership of the Black Belts—has engineered.

Clinical Solutions: Isolation Management. Isolation management is a concern for hospitals because of the increasing prevalence of infectious organisms nationwide and their increasing resistance to treatment with antibiotics, as well as the growing complexity of the patient population. New York-Presbyterian has the challenge of meeting the need to isolate, often in private rooms, patients who have developed colonies of these organisms (colonization), while at the same time maximizing its bed capacity to care for all other patients.

A Six Sigma project was initiated to improve the utilization of isolation by identifying colonized patients entering the hospital during the admission screening process to ensure that there would be an accurate first bed assignment. Appropriate isolation reduces the risk of transmission of infection and enhances overall patient safety by avoiding transfers to another room after the first bed assignment. The team’s goal was improvement of the processes for identifying patients requiring isolation upon admission to the hospital and communicating that information to the admitting staff.

In support of the hospital’s strategic initiative of information technology, we created an interface between the epidemiology database and the admitting department’s registration software. This interface allowed us to identify patients who required isolation, to improve our first-bed assignment accuracy by 43 percent in the first year, and to better utilize our private isolation rooms.

The control phase of the project led to the design of automated reports that compare the requirement for isolation beds, as generated by the epidemiology database, with the initial bed assignments made by the admissions registration system. To sustain and institutionalize these important project results, the reporting mechanism is now being folded into the Executive Portal, a hospital intranet site, which managers and staff can access to view automated monitoring results for performance improvement initiatives.

The identification and removal of expired medications and products to improve patient safety was the goal of an inventory management project that used Lean methodology.

Inventory Management Solutions. The identification and removal of expired medications and products to improve patient safety was the goal of an inventory management project that used Lean methodology. Medications and other products, such as intravenous (IV) bags and catheters, are labeled with manufacturer expiration dates, just like perishable grocery items at the supermarket.

An initial inventory showed that there were more than 200 different medication storage areas throughout the hospital, from pharmacies and nursing medication supply rooms to computerized medication-dispensing machines. Two Black Belts were deployed to solve the problem and quickly identified the need for a uniform policy in the management of medications and medical products from the loading dock to the bedside.

Working with the three large departments through which most of the inventory flows—procurement and strategic sourcing, pharmacy, and nursing—the Black Belts studied a number of sites on all five campuses to better understand the problem. Employing a voice-of-the-customer tool, they developed a 47-question survey, tailored to each of the three departments, that enabled them to identify, count, catalog, and assess the processes the staff used for expired products. The Black Belts conducted hundreds of staff interviews over a two-month period. They visited the loading docks at dawn and questioned employees about date-checking the cartons of medical supplies they unloaded from delivery trucks. The Black Belts also observed how staff
stocked and removed products on shelves and in bins in patient care units and pharmacy locations.

The surveyed areas were scored on a three-point scale as follows: 1 = No expired product found; 2 = No expired products, but inventory management practices need improvement; 3 = Expired products found. The initial survey results indicated that two-thirds of the storage areas in the three departments needed better processes for managing their inventory of medications and products.

Monthly checks of the extensive network of storage areas now assure that medications and products with upcoming expiration dates are removed from inventory.

In addition to the survey, certain key findings emerged:

• No uniform or systematic inventory management process was in place, and accordingly, each staff member approached it a different way.
• Orders for more stock were often based on the amount staff felt comfortable with, rather than on par levels or actual need, resulting in overstocking and waste.
• Stock was not always rotated by date; in some cases newer items were placed in front of or on top of older items, which then stayed hidden and languished into expiration.

The Black Belts created a detailed process flow map and employed common-sense Lean techniques—sort, straighten, sanitize, standardize, and sustain—to put procedures in place to ensure proper product rotation. Monthly checks of the extensive network of storage areas now assure that medications and products with upcoming expiration dates are removed from inventory. Staff on the patient care units, in pharmacy storerooms, and in receiving areas—the front line for inventory quality control—are now held accountable for their role in this process. A follow-up assessment found 100 percent compliance with the new policy and processes, which has been sustained over time.

Reducing Patient Room Turnaround Time.
The moment a patient enters the hospital, the clock starts ticking on wait time and patient satisfaction. The hospital has a fixed complement of patient beds; once a bed is vacated, it must be cleaned for the next patient, thus making cleaning an integral part of patient flow. For instance, a lengthy cleaning time can add to a patient’s wait time in the emergency room and result in a backup that not only produces delay but also adds to patient, physician, and staff dissatisfaction. The Housekeeping Turnaround Time project was designed to help move the patient more efficiently through the continuum of care by finding ways to reduce bed-cleaning time.

The cleaning process includes three steps: (1) the patient care unit notifies housekeeping that the bed needs to be cleaned; (2) housekeeping cleans the bed; and (3) housekeeping notifies the unit that the bed is ready for the next patient. The Black Belt’s initial measurement found that the entire process took an average of 101 minutes. Step 2 in the process, a thorough cleaning, took an average of only 25–30 minutes, so why did the rest of the process take so long? The team analyzed the gaps in the timeline between the two notification points and found that the main reasons for the lengthy cycle time related to staff availability and communications. Housekeeping staff was not available during lunch breaks and shift changes, and no cleaning occurred during these periods. In addition, there was no systematic, consistent process for notifying housekeeping that a bed had just emptied and needed to be cleaned.

To improve the housekeeping turnaround time for patient beds, the team recommended—and the hospital implemented—a few simple changes. First, lunches and shift changes for housekeeping staff were placed on a staggered schedule to assure that coverage is available continuously. The second part of the solution entailed the creation of a new electronic bed-tracking system in which housekeepers carry a pager that allows them to be electronically paged as soon as a patient discharge is entered into the system, thus signaling that an empty bed needs immediate cleaning.

The result has been a 50 percent reduction in the average housekeeping turnaround time, from 101 minutes to about 50 minutes. This improvement has been sustained at this level for more than a year and has been valued at more than $700,000 annually, in addition to increasing bed capacity and improved patient satisfaction.
In the program’s first year, the Black Belts fanned out across the organization to lead more than 130 projects on the five campuses, drawing on more than 1,300 employees to participate as team members, and engaging the interest of staff throughout the hospital. In the targeted project areas, some managers worked on multiple projects in addition to their own responsibilities, and the demands generated by the growing pains that came with the Six Sigma program proved to be stressful. But the positive attention that the projects and their results received—along with the allure of the Black Belt cachet—had an astounding effect on the staff: Department by department, more and more employees began to ask what it would take to be a part of this team.

We built a strong support system for the Black Belts. Each was assigned a vice president or senior vice president who would serve as an executive mentor and help foster his or her career path. With subsequent waves of training, each newly graduated team has served as mentors for the next crop of Black Belts. In addition, weekly roundtable meetings were held by the department’s champion, the chief quality officer, to help each Black Belt navigate any sensitive project issues.

The visibility of the Black Belts soon led them to be seen as a highly regarded, high-caliber group of problem solvers. Many staff members had worked alongside the Black Belts and had direct experience with the Six Sigma projects in their patient care units. Employees who did not have the opportunity to be part of a Black Belt’s project team soon learned about them in hospital newsletters that carried articles about their projects. Storyboards in lobbies and on patient care units detailed the success of specific performance improvement projects. Slide presentations at meetings of our senior leadership, service lines, medical staff, clinical chiefs, and directors of service spotlighted the Black Belts’ work and contributions.

Our Black Belt recruitment process is rigorous and supports NewYork-Presbyterian’s strategic initiative of people development; it also has great appeal and is an event itself. When openings occur, information about the recruitment is printed onto posters that are placed all around the hospital. A series of open houses is held at all campuses to familiarize employees with the responsibilities and experience of being a Black Belt, including giving them the opportunity to speak with current Black Belts. Applicants represent a variety of health care professionals—physicians, nurses, laboratory technicians, speech therapists, pharmacists, dietitians, attorneys, and administrators. More than 100 candidates applied for 10 Black Belt openings in early 2006 (see Exhibit 2).

Exhibit 2. Black Belt Selection at NewYork-Presbyterian Hospital in 2006

For those who are selected, the move is both a risk and a potential opportunity. Each new Black Belt volunteer takes on projects outside his or her area of expertise in order to foster professional growth. By accepting and successfully meeting such a challenge, the Black Belts have found themselves stepping onto a genuine career track within the organization. The first team of 10 Black Belts was asked to make a two-year commitment to the hospital in their new capacity as Six Sigma problem solvers. (Today’s Black Belts make a three-year commitment to the organization.) At the end of their deployment, the first wave of Black Belts all received promotions back into the organization—including four Master Black Belts, one vice president, and some department directors. The Black Belts in the second wave also received promotions in recognition of their successes, and some, who said they thrived on the Black Belt experience, chose instead to continue another tour of duty in that position.
SIX SIGMA RESULTS: VALUE AND PROGRESS

From a broad, organizational perspective, we have seen impressive results from our Six Sigma program and our cultural transformation, and we offer some highlights of these below.

Reduced Operating Expenses. The hospital saw its initial investment of $8 million to set up the Six Sigma program generate a $47 million savings in bottom-line expenses in 2004 alone as a direct result of the initiative—an impressive 6-to-1 return on investment in its first 12 months. Significant financial benefits have continued since 2004.

A reduction in LOS represents an improvement in the quality of care because it allows the patient to move through the continuum of care in a safe and efficient manner.

Reduced Patient Length of Stay. For the last three years, we have consistently reduced the average patient length of stay (LOS) by 0.2 days annually. Our Six Sigma program has enabled us to measure and analyze processes that impact LOS and helped produce results that include increased efficiencies, reduced costs, and additional bed capacity—a target area directly aligned to New York-Presbyterian’s strategic growth initiative. A reduction in LOS represents an improvement in the quality of care because it allows the patient to move through the continuum of care in a safe and efficient manner.

When the hospital reduces LOS, it decreases costs. Because Medicare reimbursement is case-based rather than per diem, higher patient flow (throughput) generates additional revenues. For example, one Six Sigma project reduced LOS for craniotomy patients by 4.2 days, resulting in cost reductions valued at more than $500,000 annually. In another project, the reduction of LOS for hip fractures produced an annual cost savings of $355,000. These and other LOS reduction projects enable us to invest the savings in other clinical programs, as well as to reinvest in our ongoing drive to improve quality. Overall, reduction in LOS has allowed for the freed-up capacity of approximately 70 beds per day, thus allowing us to admit an additional 3,500 patients annually.

Improved Throughput (Patient Flow). Throughput, the term used to describe the flow of a patient through the continuum of care in the hospital, is affected by the wait times a patient encounters in the various service areas he or she visits—for instance, the Emergency Department (ED). Throughput is difficult to quantify globally. In order to achieve performance excellence, the hospital addresses throughput in all the steps of the health care delivery process, as opposed to focusing on one single area. Using Six Sigma tools, we have scrutinized patient flow for any bottlenecks in the system that could produce gridlock or lengthen wait times; this has included projects to reduce the cycle, or wait, times in such key areas as the ED, operating room, postanesthesia recovery unit, and ancillary testing, such as radiology and laboratories. As a direct result of improving throughput and reducing LOS, New York-Presbyterian has been able to increase patient volume and access to care.

Compliance and Full Accreditation. During two critical and rigorous external regulatory reviews in 2005, the results of Six Sigma projects provided clear illustrations of the success of performance improvement within the organization. During a comprehensive review by the Centers for Medicare and Medicaid Services (CMS), the hospital was able to demonstrate compliance with CMS regulations by providing information and data-driven solutions on multiple clinical Six Sigma projects. Later in the year, when surveyors from the Joint Commission on Accreditation of Healthcare Organizations began their scheduled review of the hospital, we presented Six Sigma and Lean project results as real-time examples of the process improvements New York-Presbyterian had implemented. The hospital earned full accreditation in this triennial review.

Extending Our Expertise. The New York-Presbyterian Healthcare System has begun to tap into the foundation of performance excellence expertise that we are building in our organization. New York Hospital Queens invited our core team to give a presentation of its results and then asked us to help train them in the use of Six Sigma. Black Belts taught, coached, and mentored their staff as they worked on their first projects. The facility has been operating a successful Six Sigma program for the last one-and-a-half years and has rolled out its second group of projects.
We would like to share three major lessons learned with those readers who may be contemplating a similar initiative in their own organizations:

- **The Necessity of Investment.** An effective program calls for an investment in the people who are being trained to do the job and in the process itself. Significant training for staff and a commitment from the entire organization from the top down is essential to ensure that the program succeeds.

- **Selective Use.** Once implemented, a Six Sigma program is not necessarily the best vehicle for every performance improvement project in the hospital; its power and potential are best reserved for complex problems that are narrow in scope. Structuring a Six Sigma project with too wide a scope can overwhelm the people doing the project and result in wasted time and money.

- **Demonstrating the ROI.** An important aspect of demonstrating sustainable results from a Six Sigma program is the ability to show a return on investment. There were many times when the question arose, Should we continue with this program? While some may have had second thoughts, our ROI showed tangible, irrefutable results and so the program has continued. And with a round of new investment, we recently rolled out our fifth wave of Black Belt training.

Our next steps can be summarized succinctly: Six Sigma works for NewYork-Presbyterian and we will continue to use its methodology to identify issues and problems that need to be solved.

In conclusion, we share the observation of one senior-level participant in the Black Belt/Green Belt training process about the effect of the program on him. “This is hands-on management,” he told us. “It’s better than any continuing education course or conference I have taken since I received my MBA.”

### NOTES