HARVARD | BUSINESS | SCHOOL

9-609-109
REV: APRIL 25, 2011

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Dr. Uma Kotagal, Senior Vice President (SVP) of Quality and Transformation, reflected on the beehive of improvement activity under way in 2009 at the Cincinnati Children's Hospital Medical Center (CCHMC). The enthusiasm was palpable. The hospital had seven strategic initiatives and 28 official projects ranging from a new process to deal with scarce parking in the hospital garage to initiatives to eliminate adverse drug events. Still, despite the spread of CCHMC's standardized method for implementing process changes, Kotagal wanted to increase the rate and impact of improvement. But *how* was a big challenge. For instance, she wondered whether the hospital should be driving the strategic selection of improvement projects centrally or allowing motivated individuals in various work areas to select their own initiatives. Also, should the organization's quality improvement specialists be embedded in the medical divisions under the supervision of the division director, or work out of the centralized Quality and Transformation Department? Similarly, how much formal training was needed to accelerate improvement? These questions consumed Kotagal, whose years of medical education and experience did not reveal any easy answers.

Background

CCHMC, a not-for-profit, pediatric academic medical center, was established in 1883. The organization had over 40 medical divisions, each headed by a director who was a physician. The divisions encompassed physicians' research, clinical care, and education programs. To illustrate, the Pulmonary Division had 17 faculty members for five clinical programs and the Neonatology Division comprised 45 faculty members and the Regional Center for Newborn Intensive Care (RCNIC). The hospital employed its physicians, which was unusual. Most hospitals granted admitting privileges to physicians, but lacked formal authority over them.

Historically, the hospital had three aims: research, education of new physicians, and patient care, with an emphasis on research and teaching. However, in 1994, senior management created a radically new vision: CCHMC would be the leader in improving children's health. This meant a dramatic shift in focus to excellence in patient care by improving the hospital's delivery systems.

By 2009, CCHMC had made progress. The organization had grown from a regional hospital serving greater Cincinnati's 2.2 million people to an internationally recognized 475-bed facility. In 2008, *U.S. News and World Report* ranked the hospital third among pediatric hospitals. In 2006, CCHMC was awarded the "American Hospital Association-McKesson Quest for Quality Prize," which honored innovation in quality and commitment to patient care. It had over 93,000 emergency department visits and 27,000 hospital admissions per year, a substantial increase from 2003. Over this period, the number of patients treated in the hospital's emergency department increased by 11%,

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Professors Anita Tucker and Amy Edmondson prepared this case. HBS cases are developed solely as the basis for class discussion. Cases are not intended to serve as endorsements, sources of primary data, or illustrations of effective or ineffective management.

inpatient admissions increased by 33%, and length of stay simultaneously increased 7%. Net operating revenue increased 235% from 2006 to 2008, to $66 million on $1.3 billion in revenue. (See **Exhibits 1a** and **1b** for the hospital's operating revenues and patient visit data.)

Dr. Frederick Ryckman, a transplant surgeon, clinical director of the Division of Pediatric Surgery, and VP of System Capacity and Perioperative Operations at CCHMC, had worked at the hospital since 1982. He recounted, "The philosophy has dramatically changed from when it was a community hospital. It has truly transformed itself over the last 15 years."

Delivering care to hospitalized patients was a complex business. Patients entered the hospital through several routes: the emergency department, planned surgical procedures, or referrals from physicians. While in the hospital, the care process often shifted patients to different locations. For example, a patient might enter the hospital through the emergency department for diagnosis and stabilization, be transferred to the intensive care unit, and then to a medical unit, perhaps with side trips to radiology or other specialized departments, before discharge. The complexity was further heightened by the variety of caregivers involved: treatment plans were orchestrated by one or more physicians and involved pharmacists, nurses, physical therapists, respiratory therapists, dieticians, and others. Coordinating care across multiple units and professionals required extensive verbal and written communication. While some aspects of hospital operations were routine and predictable, most were not, and the care process for an individual patient could change at any time. Finally, medical knowledge changed frequently, and some diseases were still not well understood.

Overall, the hospital's work was both varied and complex. Most caregivers provided care for multiple patients at the same time, which required continual reprioritization as patients' conditions changed during the course of a shift. Vigilance was required to prevent medical errors, such as giving a patient the wrong dose of medication or allowing an infection to develop. Individual patients with the same medical condition might respond differently to treatments because of inherent variations in physiology. Further, hospitals kept track of every procedure performed, medication administered, and supply used, and had to submit detailed reports to payers—whether private insurance companies, the government, or the patients themselves. Finally, medical research had historically focused on discovering treatments for diseases, but these were not implemented consistently. In many settings, patients received treatments based on historical practices rather than proven methods. The complexity of patient care and the prevalence of system failures created opportunities to improve the reliability and efficiency of the systems through which care was delivered.

History of Process Improvement at CCHMC[1]

Kotagal joined CCHMC in 1975 as a fellow in neonatal physiology[2] and continued to work as a neonatologist, eventually becoming director of the Neonatal Intensive Care Unit. By early 1996, Kotagal had become concerned that, despite the hospital's emphasis on medical research to discover new treatments, known best practices might not always be used for current patients. She started investigating whether patients were receiving the care best supported by clinical evidence.

Together with a team that included primary care physicians from the surrounding community, Kotagal searched the medical literature for the most effective treatments for bronchiolitis. In past winters, CCHMC's intensive care units (ICUs) often became full because primary care physicians

[1] This section draws on Charles Kenney, "The Cincinnati Children's Triumvirate: Uma Kotagal, Jim Anderson, Lee Carter," in *The Best Practice: How the New Quality Movement Is Transforming Medicine* (New York: Public Affairs, 2008).

[2] Fellows were physicians in the highest level of postgraduate medical specialty training.

referred patients with bronchiolitis to the hospital for complex respiratory treatments. To its surprise, the team discovered that the most effective treatments could be performed in primary care physicians' offices and patients' homes. Seeking to avoid unnecessary procedures, the team changed the recommended guidelines for primary care physicians, reducing hospitalizations while simultaneously providing better care. The team went on to develop evidence-based guidelines for 11 other common conditions. Use of these guidelines dramatically reduced hospitalizations.

Later in 1996, Kotagal's quest for improvement was bolstered by the arrival of Jim Anderson as CEO and Lee Carter as chairman of the board. Although a long-time CCHMC board member, Anderson was an unusual choice for CEO because he was a practicing attorney not a physician. He was also well versed in quality improvement methods historically used by manufacturing firms. Carter, a firm believer in focusing on patient care, supported transparency about improvement opportunities. Carter articulated his vision for CCHMC as "We will be the best at getting better." With two strong allies, Kotagal continued investigating other medical conditions that might benefit from an evidence-based approach. Not everyone in the organization, however, immediately accepted her passion for evidence-based medicine. The chief financial officer and SVP of Finance, Scott Hamlin, recalled his early encounters with Kotagal:

> Dr. Kotagal informed me that much of our protocol for liver transplant was not scientifically proven to impact outcomes for the patients. My response was, "We make a margin on every one of those treatments you want to discontinue. Your plan would reduce the amount of money we make on liver transplants."

In 2001, as part of the organization's strategic planning process, Kotagal, Anderson, and Carter listened to a report from the head of radiology about the quality of outpatient care. Although clinicians strived to do their best for patients, the work pressure kept them from engaging in spontaneous improvement efforts when they encountered process problems. Kotagal recalled:

> He reported back saying, "We have very talented physicians, but a system that is broken and full of workarounds. We think we need to fix the system." Jim could barely contain his enthusiasm. He had come from the industrial sector and thought that most managers would get fired for the performance that CCHMC was turning in. He was delighted that there was a group of senior clinicians saying, "Fix the system."

Anderson captured this energy in the strategic planning effort. Instead of setting typical financial goals such as growing revenues by 15%, the new strategic plan called for a dramatic improvement in the delivery of care. Strategic initiatives included incorporating systematic approaches to quality, service, and process improvement into their management systems and developing scorecards to measure the performance of their delivery system and patient care. Anderson also convinced Kotagal to leave her position in the neonatal ICU to lead CCHMC's improvement efforts. Kotagal recounted the daunting task. "The weight of the new strategic plan to dramatically improve the system fell on my shoulders. I thought, 'Okay, that's great, but how?'"

Building Momentum: The "Pursuing Perfection" Grant

In early 2002, with the backing of Anderson and Carter, Kotagal competed against 200 other organizations to become one of several winners of a $1.9 million grant funded by the Robert Wood Johnson Foundation, with technical guidance from the Institute for Healthcare Improvement (IHI). The grant, "Pursuing Perfection," was a program to help health-care organizations transform the quality of their care from good to perfect by implementing a series of improvement projects.

Winning the award enabled Kotagal to take five physicians and one nursing leader to Intermountain Hospital's four-week-long training on improvement science. The course had been developed by Brent James, a physician and statistician who had spent the prior decade using W. Edwards Deming's industrial quality improvement techniques in health care. In addition, CCHMC was able to learn from the other grant-winning hospitals. For example, one of the other hospitals had achieved 95% reliability in administering antibiotics to surgical patients before their surgery to prevent surgical site infections (SSIs). Kotagal asked someone from that hospital to teach CCHMC how to achieve this high level of reliability. As Kotagal explained:

> They built a "forcing function" into their operating room process. Patients couldn't enter the operating room until they had received their antibiotic. Learning about forcing functions and how to use them was our biggest breakthrough on process reliability.

Improving Outcomes for Cystic Fibrosis Patients[3]

The Pursuing Perfection grant required CCHMC to undertake two improvement projects initially. For the first project, Kotagal worked on developing and implementing treatment protocols with proven efficacy—what was known as evidence-based medicine. Finding a second project, however, had not been easy. She ultimately picked cystic fibrosis (CF) because the head of the pulmonary division (which treated CF patients) was the only division leader who expressed interest in participating. Another benefit of working on CF was that the Cystic Fibrosis Foundation (CFF), a national nonprofit organization, collected patient outcome data from CF centers throughout the U.S., analyzed it, and provided standardized reports to the centers on their individual and aggregated performance. CF became a defining project for the hospital because their CF patient outcomes for lung function skyrocketed from being in the 20th percentile compared to the other CF centers in 2001 to being in the 95th percentile by 2008.

CF was a genetic, chronic disease that caused the body to make thick mucus secretions that clogged the lungs, resulting in infections that destroyed lung tissue. Most children with cystic fibrosis were able to participate in most activities and attend school as young children, but their disease worsened with age. In the 1950s, most patients with CF died before they reached their fifth birthday. By 2009, treatment advances had increased patient life expectancy to 35 or 40 years. While medications helped, quality of life and life expectancy greatly relied on daily vigilance in diet and physical therapies. Therefore, CF treatment centers such as CCHMC worked closely with parents to help them provide the daily care their children needed.

Transparency Two key outcome measures for CF were lung functioning and nutritional status as measured by body mass index (BMI). The Pursuing Perfection grant required CCHMC to agree in advance to disclose their performance to patients. Lee Carter recounted that, when they agreed to transparency, they were naïve about how difficult it would ultimately prove to be.

> In reviewing our data from the CFF, we learned that our patients' lung functioning was at the 20th percentile, and our BMI results were below average compared to other centers. We knew that we would have to tell the families what our performance was, but we did not know the courage such transparency was going to require.

[3] For more information about CCHMC's and Minnesota's cystic fibrosis performance as well as the Cystic Fibrosis Foundation, see Atul Gawande, *Better: A Surgeon's Notes on Performance* (New York: Henry Holt, 2007), pp. 201–230.

The performance of the CF Center was much worse than CCHMC leadership had expected. Like many large research hospitals, CCHMC had believed itself among the best hospitals in the country, despite having little data with which to make comparisons. Clear evidence of their mediocre performance convinced clinicians to change practices that, despite beliefs to the contrary, had been ineffective. Jim Anderson recalled:

> We talked with one of the CF doctors who had been at this for 30 years. By the fourth or fifth rendition of the data he finally accepted that the way they had been treating CF patients was yielding poor outcomes. He said, "We have been wrong." And he was close to tears. He realized that they had been doing things that got their patients to the 20th percentile when they thought they were at the top.

CCHMC's CF physicians informed all of their patients' parents of the hospital's performance on lung functioning and nutritional status. Despite the fact that there were three other CF clinics within a 100-mile radius of Cincinnati, everyone kept their children in CCHMC's CF clinic. After much discussion of how to best incorporate the patients' perspective into their improvement efforts, the CF team decided to invite 20 parents to participate directly as full-fledged team members. Seventeen agreed. One such parent, Kim Cook, recalled her response.

> Our numbers were not good at all. But I think we all reacted in the opposite way to what the staff thought we would. They thought we would be angry. But we respected them on a new level. They were being totally honest. They were saying, "We want to be number one, and we want you to help us get there." I was so motivated. I thought, "We are going to do it. We are going to get there!" I think their nervousness went away after we reacted that way.

The parents and clinicians were committed to working together to improve CCHMC's outcomes. They wanted to use a "positive deviance" approach of identifying the CF centers with the best performance and replicating what they did to achieve superior performance. CCHMC asked the CFF for the names of the top five centers. It took several months for CFF to comply with this request because they had not previously ranked the centers. They first analyzed several years of data to identify consistently high performing centers. After identifying the top performers, CFF obtained permission from those centers to share the information with CCHMC. Kotagal recalled, "Once CFF revealed the top five hospitals in the country, we visited Minnesota and some others and talked with the remaining ones on the phone.[4] We learned a lot that we applied."

In 2006, CFF made all CF centers' data available to the public on their website. Bruce Marshall, vice president of clinical affairs at CFF and leader of the CFF quality improvement initiative, recalled the difficult, two-year journey to full transparency.

> We knew that we needed to achieve a stronger partnership with families to get better faster, and that required sharing performance data, but we needed to convince the care center community. It took a lot of courage for them to be transparent with their performance. People told us that it would be the biggest mistake that CFF ever made because lawyers would be circling with lawsuits and patients would switch to better performing centers. These things didn't happen. I believe transparency helped accelerate improvement across the country.

[4] At the time the Minnesota hospital was called Fairview Hospital.

CCHMC also changed their processes based on family input. Tracey Blackwelder, a mother of eight children, four of whom had CF, was a CF improvement team parent member. Later, CCHMC hired her as a Parent Program manager. Blackwelder recalled the families' contributions:

> The parents were asked to come up with a list of perfect care. Our top three items were completely different from what the clinicians thought was perfect care. Their top item was reducing the time required for clinic visits. They thought we wanted to get in and out fast. We didn't care about the time. We wanted to talk to them and spend as much time as necessary.
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> We also developed new language for describing patient conditions. They had labels for children's nutritional status, with the worst category labeled "nutritional failure." This really bothered us. We thought, "We are not failing. Don't call my kid a failure!" So the group came up with different labels, with Level 1 being nutritionally at risk. These labels didn't make you feel like you failed. It's not always *you*; it's the disease. You don't have control over everything.
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> Instead of a grandiose plan, we started with the Level 1 kids, and tried our hardest to bring them all up to the next level. Two of my children were in Level 1. After we had no one left in the risk category, we worked on the next level. We were successful because we made a series of incremental changes. There was no way to do it all at once with over 200 families.

The CF team made many other process changes over the next several years. For example, to improve lung functioning, they focused on airway clearance, the daily techniques patients performed to clear mucus from their lungs (such as breathing into a device that vibrates the large and small airways). The team asked patients to bring their airway clearance equipment to the clinic and demonstrate usage. They discovered that although most patients were diligently performing the exercises, their equipment was often so worn out they weren't getting any benefit. The clinic also hired a full-time respiratory therapist to focus exclusively on airway clearance, including teaching parents and patients new, more effective techniques that better fit into each individual patient's daily routine. The CF clinic also changed the timing of their chart reviews to the week *before* patients came to the clinic. The care team jointly reviewed each patient's progress and developed a coordinated plan for each patient, including which specialists needed to see the patient during the upcoming visit. They created a check sheet to ensure that patients didn't leave the clinic until all required caregivers had met with the patient. When patients left the clinic, they were given personalized written care plans and treatment goals for the next three months. The team worked directly with the children to set treatment goals and to teach them to self-manage more aspects of their medical condition. Honor Page, a parent, recalled the impact of seemingly small changes on the quality of her daughter's experiences:

> Small changes can mean a lot to patients and family. For example, they purchased carts to help patients transport their belongings out of the hospital at the end of inpatient stays. The carts eliminated the balancing and juggling on the wheelchair when we are trying to get everything out. That change is probably not going to move a data point, but it is a tremendous improvement for quality of experience.

(See **Exhibit 2a** for Minnesota's and CCHMC's absolute performance on lung functioning and **Exhibit 2b** for body mass index from 2001 to 2008. For their percentile compared to the other CF centers, see **Exhibit 2c** for lung functioning and **Exhibit 2d** for body mass index.)

Moving Forward: The Improvement Science Program

CCHMC continued its improvement efforts after the grant ended. The number of projects increased, as did the number of people educated in the principles of improvement. Over time, improvement was becoming part of daily clinical work. Meanwhile, the hospital's leadership team expanded transparency to disclose performance on a number of key measures.

Spreading Improvement Efforts throughout the Medical Divisions

Initially, Kotagal did not expend time convincing reluctant leaders, such as division directors, to engage in improvement. Instead, she worked with clinician leaders lower in the hierarchy who were passionate about transforming patient care. These people were able to influence the division directors over time. Kotagal recalled, "We ignored people such as some of the division directors. Eventually they asked, 'Why are you ignoring us?' I told them, 'I have a lot of people to work with. If you are interested, I am happy to work with you, but I don't want to convince you to do this.'"

Even within clinical units committed to improvement, Kotagal's approach was controversial. She pushed for a fast pace of improvement. Stephen Muething, VP of patient safety, recalled:

> For a while, people thought Uma pushed too hard and that she was expecting the impossible. They asked her, "Don't you ever stop?" In fairness, she pushes at a pace that makes the weak buckle. Ironically, I would say we are doing more now than we were before, but we don't hear that complaint much anymore.

Kotagal acknowledged that she did not accept excuses.

> Clinicians would say to me, "What do you want me to do, take care of patients or do improvement?" I would reply, "Your job includes improvement." They would complain that it was too much work to do both. And I would say, "You are a leader. Why are you whining? I really like you. But I don't see you in an improvement group. So when you say how hard you are working and how busy you are, what do you mean? Many other hospitals don't have as many people to help them as we have."

Quality Improvement Consultants To help busy clinicians implement change, Kotagal's group employed 16 quality improvement consultants (QICs) and several analysts. The QICs were quality improvement experts, typically with more than six years of experience implementing change prior to joining CCHMC. They were well versed in CCHMC's standard approach to improvement. Their job activities included coordinating information flow among clinicians involved in a project, implementing change, tracking measurements, and communicating results. Most QICs were managed by the Quality and Transformation Department and were available on an as-needed basis to work on projects throughout the hospital. However, four of the QICs, such as Amrita Chima in the Pulmonary Medicine Division, were either assigned to or employed full time by a single division, which enabled intensive learning about that division's needs.

Dr. Raouf Amin, director of the Pulmonary Medicine Division, commented on the value of a person in the division being dedicated full time to quality improvement:

> Ten years ago or so, the clinical effectiveness group [CE] and hospital administration would say, "You don't need permanent additional resources to support quality improvement initiatives." But it definitely doesn't work this way. There is a need for resources to have sustained effort dedicated to Quality Improvement [QI]. The QIC person helps staff integrate QI projects into their daily schedule. To do that well requires a full appreciation of the

environment in which the team works. Thus, we feel that the QIC has to be a full member of the division. Over time, CE and Pulmonary Medicine reached an arrangement where the QIC is fully dedicated to the different programs within Pulmonary Medicine, but maintains a close professional relationship with CE.

Chima herself appreciated having the opportunity to be fully integrated into the division:

> I have a portfolio of projects all within pulmonary. I have a desk in the clinical effectiveness department and I go there for meetings with my QIC colleagues, so I still have that network. However, I am never there because I am interacting here in pulmonary. I personally think that has made a big difference. Unless you understand your client's environment, understand their concerns, you can't be as effective. A lot of divisions like the concept of having their own QIC.

Improvement Science Training and Projects

CCHMC developed an in-house education program called "Intermediate Improvement Science Series" (I2S2). I2S2 consisted of six two-day sessions spread over six months. Physicians, clinicians, and administrative leaders learned a hospital-specific, standardized approach for implementing change. Students learned through extensive reading on process improvement as well as by conducting their own improvement project during the course. The purpose of I2S2 was twofold: to get results from the projects and to develop people who could lead improvement efforts back in their departments after graduation. By early 2009, 140 people had completed the I2S2 training program.

The I2S2 curriculum was built around the conceptual framework of Deming's system of profound knowledge, which emphasized four topics: appreciation of a system, the impact of variation on performance, the theory of knowledge, and the psychology of change. Topics included the Toyota production system, microsystems, managing variability, high reliability, and managing teams.

CCHMC's model for improvement answered three questions: (1) What do you want to accomplish? (2) How will you know a change is an improvement? (3) What changes will you test? The four steps in a test of change were Plan (the change), Do (implement the change), Study (if the change made a difference), and Act (adopt, adapt, or abandon the change). (For a more detailed overview of the Plan–Do–Study–Act (PDSA) steps, see **Exhibit 3a**. For a model of how PDSA cycles move toward improvement, see **Exhibit 3b**.) I2S2 emphasized rapid cycles of small-scale tests of change, which enabled quick learning and avoided resistance to larger scale, more permanent changes that often required extensive approval processes. Gerry Kaminski, the course developer and primary instructor, explained this philosophy:

> In a traditional large-scale improvement project, you check after two months whether it made a difference. We're asking people to do rapid testing on a much smaller scale. A small enough scale so that it won't do any damage. We encourage people to think about some intervention that might fail, but will yield learning about where the system breaks down. They build learning through a test that lasts a day. Then they debrief to find out if it works and what suggestions people have. Those ideas are built into the next cycle, which might be larger scale and longer. Small tests slowly change culture because you engage more people as you scale up.

The standard template for documenting improvement projects had a smart aim on the left, key drivers in the middle, and design changes on the right. It was called a "smart" aim because the project's goal was specific and measurable. Key drivers were hypotheses about what could influence the aim. Finally, the project included design changes or interventions that would move key drivers in the direction necessary to improve performance on the aim. The course emphasized measurement, which enabled project participants to test whether a change had the desired impact.

The I2S2 program taught the Pareto principle as a technique for selecting which problem to address. The Pareto principle, also known as the 80/20 rule, was popularized by the quality pioneer Joseph Juran in the late 1940s. It was based on the notion that 20% of the problems caused 80% of the quality costs or incidents. Thus, process improvement efforts would achieve the greatest impact by focusing on these "vital few" problems while safely ignoring the "useful many." Histograms were used to plot the frequency of each problem class in descending order. (See **Exhibit 4** for an example of a project that used a histogram to track adverse events in pediatric cardiac surgery.)

I2S2 graduates became enthusiastic supporters of improvement science. Javier Gonzalez del Rey, director of the residency program that oversaw the clinical training of recent medical school graduates, commented on how effective the program had been at changing his thinking. Deming's famous red bead experiment,[5] which showed that people tend to interpret random variation in a process as a meaningful difference in performance, was especially powerful:

> The red bead experiment really opened my eyes to the concept that unless you understand what your system can give you, you will never be able to create true change. You may think you created change by asking people to "work harder," or by educating, or creating more policies, when in reality the change you observed was just normal variation from your system, not the result of an intervention.
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> After graduating from I2S2, I've been interested in applying improvement science to everything. It's what we need in medicine. For example, we had a problem with residents (physicians in training) working longer than the maximum allowed by the Accreditation Council for Graduate Medical Education. Prior to the training, I would have just said, "Fix it"—in essence, "squeeze the system." But now I know that the system is only going to give you as much as the system is designed for. We have to change the system to solve the problem.
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> You have to get away from the belief that *you* know everything about the situation. Instead, the people doing the work have the answers. Ninety percent of the changes came from them. You can guide them, but they are the ones who need to figure it out. Also, I learned that it works well to say, "We are going to try this for one week and see if it works. And, if it doesn't work, no big deal. Doing small changes avoids huge fights."

Goal of Zero

The hospital's senior leadership team set a goal of zero serious safety events (e.g., death from a medication error) and for other life-threatening medical errors, such as ventilator-associated pneumonia (VAP) and SSIs. CEO Anderson commented on the importance of having a target of zero serious incidents:

> There is power in changing the way people think by having the goal be perfection—zero. No matter what your current level of performance, your mindset is "It can be improved." Take our experience reducing VAP to zero. Before we started our improvement efforts, we had

[5] In Deming's red bead experiment, participants ("workers") were asked to draw a 50-bead sample from an urn filled with white and red beads. White beads represented products of acceptable quality, while red beads represented defective products. Workers were told to put forth their best effort to draw the fewest possible number of red beads. Over the course of the experiment various worker-centered performance improvement measures were introduced, including rewards for high-performing workers, punishment for low-performing workers, performance appraisals, quality control inspections, and motivational posters. None of them had an effect on the overall defect rate; variability was not a result of the workers' skill or diligence but random, and therefore unresponsive to training or incentives. The only way to consistently reduce the defect rate was to fix the system by removing more red beads from the urn.

about 80 cases of VAP per year. And one of our physicians, an extraordinary doctor, said, "This is the best we can do." If you legitimize that line of thinking, your aspirations flatten.

Anderson felt that without a clear goal of zero, caregivers would not make appropriate decisions:

> As leaders we say to clinicians, "We will invest whatever you need to provide the best care and get this metric to zero." Once you interject a financial analysis you start confusing caregivers. They think, "What am I supposed to do? Am I supposed to take care of kids to the extent it maximizes profitability? Or am I supposed to take care of kids to the extent it maximizes the quality of the outcomes?" Our original pitch for improvement was "We need to take cost out of the system and run a more efficient operation." Caregivers just glassed over. So, we made a very deliberate decision to not talk about money anymore. We believe—and now can prove—that financially we'll do better by focusing on quality.

Carter and Anderson felt strongly that transparency was necessary to improve their performance. The hospital had run charts in the hallways outside the units where patients and employees could see performance on relevant safety measures, such as VAP and SSI. On their website, the hospital posted all 385 of its performance measures.[6] Serious safety events decreased from a baseline of one event per 1,000 adjusted patient days in 2005 to around 0.3 by 2009. (See **Exhibit 5a**.) Ventilator-associated pneumonia decreased from a baseline of around 7 infections per 100 ventilator days to less than one. (See **Exhibit 5b**.) Surgical site infections decreased from 1.1 infections per 100 procedure days to just over 0.6 infections. (See **Exhibit 5c**.) It was unclear what effect, if any, transparency had on patient satisfaction. (See **Exhibit 5d**.)

Collaboration

Collaboration between units and between medical specialties played a large role in the hospital's approach to improving patient outcomes. Pattie Bondurant, senior clinical director for the Regional Center for Newborn Intensive Care, was part of the across-ICUs team that worked on reducing VAP in the ICUs. She saw respiratory therapists (rather than physicians) leading the project as a key driver of success.

> The turning point for us was when our respiratory therapy clinical managers in all three of the units said, "With all due respect doctor, this is our expertise and you need to let us do our job." It was a really defining moment for this group. The doctor sat back and said, "I believe you're right." I think it speaks to the transformation of the organization that those doctors were open to say, "Yes, you're the experts and we're going to let you do your job."

Business Case for Quality

The hospital tried to align incentives to facilitate collaboration. For example, streamlining the flow of patients through the hospital was enabled by rewarding overall hospital performance rather than the performance of individual departments. Ryckman commented:

> We have embraced the philosophy that profitability comes from doing the right things in the right way. Our goal is not "I want to keep my ICU full all the time." Our goal is to get patients in here for the right period of time and to put them where they need to be for their care. Then we can fill the empty bed with a new patient because we have unmet demand for our services. If we can do this efficiently, we are going to make money.

[6] See http://www.cincinnatichildrens.org/about/measures/default.htm.

CFO Scott Hamlin agreed that providing quality care resulted in strong financial performance. To illustrate, he explained that a surgical patient without an infection generated average total revenue of $50,000 and stayed in the hospital 5 days, while a surgical patient who got an infection had average total revenue of $103,700 and stayed in the hospital for 16 days. See **Exhibit 6** for a graph of average length of stay and average daily charges for the two types of patients. Hamlin commented on how he used to think that reducing infections meant lower revenue:

> We pursue a "Do the right thing for kids" model. This wasn't always easy. Take SSI, for example. We billed around $11.2 million per year for SSIs. I used to focus on the revenue we would lose if we eliminated infections and thought that there was a disincentive to do quality improvement. Now I think about it differently. We can re-fill the beds freed up by reducing infections with new patients. What is most important is that by eliminating infections patients are satisfied, doctors are happier, and payers are happier. It's a win, win, win.

Similarly, Ryckman explained how faster throughput rates reduced the need for expensive new facilities:

> We have assumed in the past that any patient placement problems were capacity problems. So the recommended solution was always, "We need to build more ICU beds. Or, I need more operating rooms (OR)." By smoothing our OR flow and dedicating different ORs for scheduled surgeries versus unscheduled emergency surgeries, we were able to increase throughput by 5%. This doesn't seem like a big deal, but we run 20 operating rooms, so a 5% increase equals one additional OR being available. It costs $2.5 to $3 million to build a standard OR that can do typical procedures. If you can manage it better, you won't have to build a new room. The same relationship exists with hospital beds. It costs $200 M to build 50 or 80 new beds.

The same thinking was used by Rebecca Phillips, VP of education and training:

> My staff repeatedly told me we didn't have enough room for training. I didn't believe it, so we did an analysis of every conference room in the hospital to find out how they were equipped, when they were used, and by whom. We found the equivalent of 36 rooms of classroom space, based on compressed scheduling of available space and on adding a handful of rooms to the scheduling system. We also learned that if administrative and business staff, people like me, avoid using space from 10 A.M. to 12 P.M. which is when it is needed by clinicians, we had enough room capacity for our training needs.

Culture of Improvement

CCHMC leaders believed that they had developed a culture of improvement in the organization. Thomas Cody, who succeeded Carter as the chairman of the board, commented:

> I asked a physician, "Why are you here when you could work at any hospital?" And she answered, "I love it here. I'm not a customer, I am an owner." In other hospitals physicians ask, "How do I maximize the hospital's value to me?" Here at CCHMC physicians ask, "How do I maximize the hospital's value?"

Dee Ellingwood, SVP of planning and business development, concurred:

> I know our focus on quality improvement will continue after Jim [Anderson] retires. The culture is there. We have a large base of human capital at the intermediate level, which will continue to expand. Those people are the change agents who will keep the path moving, and who will help us spread improvement throughout the hospital.

Kotagal also felt the culture had become solidly ingrained:

> If you look at the surveys, what people say works well is their trust of leadership. People really believe that this leadership cares about kids, and that is saying a lot for a group of researchers who think about process improvement as the dark side. I've had prominent researchers come up to me and say, "When Jim steps down, I hope we're going to look for somebody like that and not go back."

Challenges

The hospital faced several challenges in its quest to become the leader in children's health. Most pressing, the key leaders of the improvement effort were all retiring within a few years. Carter had already retired as chairman of the board, Anderson was retiring as CEO at the end of 2009, and Kotagal might follow within five years. Cody expressed the need to find another person who shared Anderson's mind-set on transparency and improvement:

> The thing that scares me the most is the search for a new CEO. It's absolutely critical that whoever succeeds Jim understands and has an absolute commitment to the underlying culture of this organization.

Similarly, Ellingwood was anxious about Kotagal's central role:

> I am anxious about leadership succession. It is not about senior leadership. It's about Uma and the people below her. How do you broaden that base of improvement experts? Who is the next Uma? Who is the next Fred? For me, it's anxiety producing.

Another challenge was developing a strategy for project selection and management of improvement resources. Kotagal wondered about the right balance between having hospital-wide improvement projects driven centrally by the organization, such as the project to improve patient flow, and department or unit-level projects chosen and driven by passionate individuals. Similarly, she wondered whether she should keep the quality improvement specialists embedded in her department, or allow more to be placed full time in the divisions.

Maria Britto, assistant VP of chronic care systems, and Kotagal's close collaborator, explained that there was more demand for quality improvement resources than they had the capacity to support:

> As our improvement process matures, we are transitioning from focusing our efforts opportunistically on motivated teams who want to improve their performance on a particular disease to more strategically embedding improvement into the daily work of entire clinical divisions. We don't have enough resources to continue supporting all of the existing disease-based teams and to simultaneously ramp up divisions that want to start improvement. One thing we are not very good at is focusing and making hard decisions to stop doing things. We are phasing out teams that are in divisions that aren't ready to do this work. We are phasing out projects in juvenile idiopathic arthritis, autism, and school-based asthma.

Kotagal pondered these difficult trade-offs and decisions as she made her way home after a long day at work.

Exhibit 1a Operating Revenues and Expenses (dollars in thousands) for Years Ended June 30

Operating Revenues	**FY 2008**	**FY 2007**	**FY 2006**
Net Patient Services Revenue	$893,712	$787,132	$657,491
Research Grants	126,302	119,508	120,832
Other Operating Revenue	313,591	301,198	231,210
Total Operating Revenue:	1,333,605	1,207,838	1,009,533
Operating Expenses			
Salaries and Benefits	766,396	670,614	594,085
Services, Supplies, Other	406,598	377,659	313,460
Depreciation	80,222	75,794	70,508
Interest	14,099	11,945	11,668
Total Operating Expenses:	1,267,315	1,136,012	989,721
Net Operating Revenues:	$66,290	$71,826	$19,812

Source: Cincinnati Children's Hospital, 2008 Annual Report.

Exhibit 1b Statistical Highlights for Years Ended June 30

Patients	**2008**	**2007**	**2006**	**2005**	**2004**	**2003**
Admissions *(includes short stay)*	27,392	26,804	25,813	23,633	23,820	20,574
Average Length of Stay *(days)*	4.5	4.5	4.4	4.6	4.5	4.2
Emergency Department Visits	93,456	93,416	91,172	89,953	89,773	84,436
Patient Encounters	925,944	917,204	842,822	799,917	761,482	711,290
Outpatient Visits *(includes neighborhood locations)*						
Primary	61,788	44,110	43,589	42,196	33,926	34,075
Specialty	693,636	703,859	638,175	602,962	554,925	507,103
Test Referral Center	31,941	31,025	29,728	27,737	27,538	26,195
Surgical Procedures						
Inpatient	6,323	5,892	5,282	5,336	5,092	4,012
Outpatient *(includes neighborhood locations)*	22,845	23,069	22,638	21,871	21,971	19,747
Surgical Hours	43,325	42,834	39,425	34,881	33,878	30,315
Transplants						
Blood and Marrow	81	72	68	64	50	45
Heart	4	4	8	6	5	4
Liver and Small Bowel	37	27	39	25	33	28
Kidney	10	18	13	11	13	12
People						
Active Medical Staff	1,292	1,258	1,078	1,134	1,113	1,018
Total Employees	10,680	9,760	9,050	8,469	7,782	7,207
Full-Time Equivalents	9,104	8,225	7,659	7,167	6,940	6,019

Source: Cincinnati Children's Hospital, 2008 Annual Report.

Exhibit 2a Improvement in Cystic Fibrosis Outcome Data: Lung Functioning

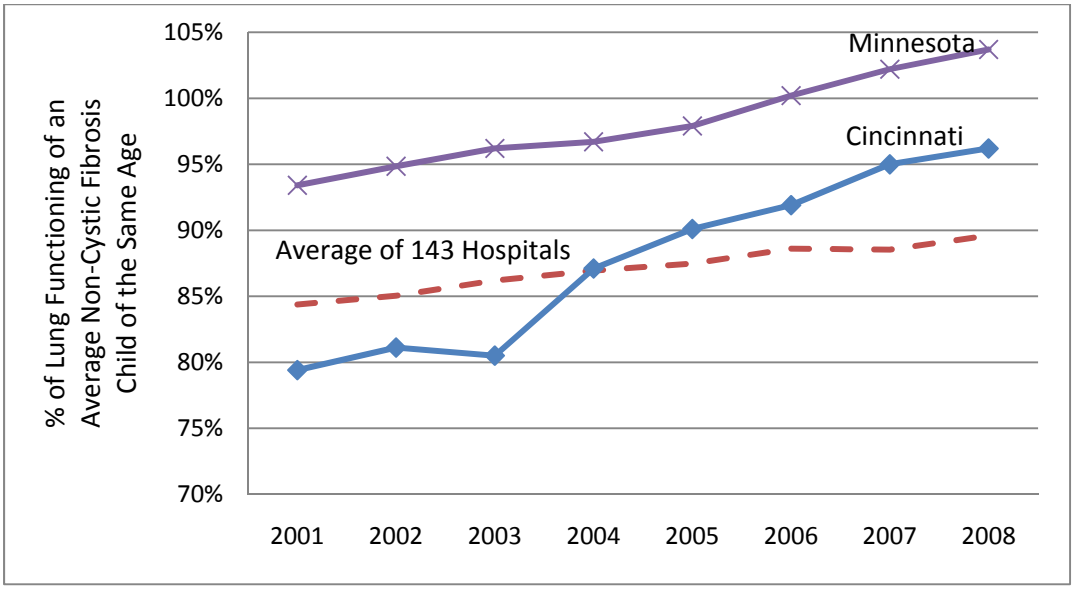
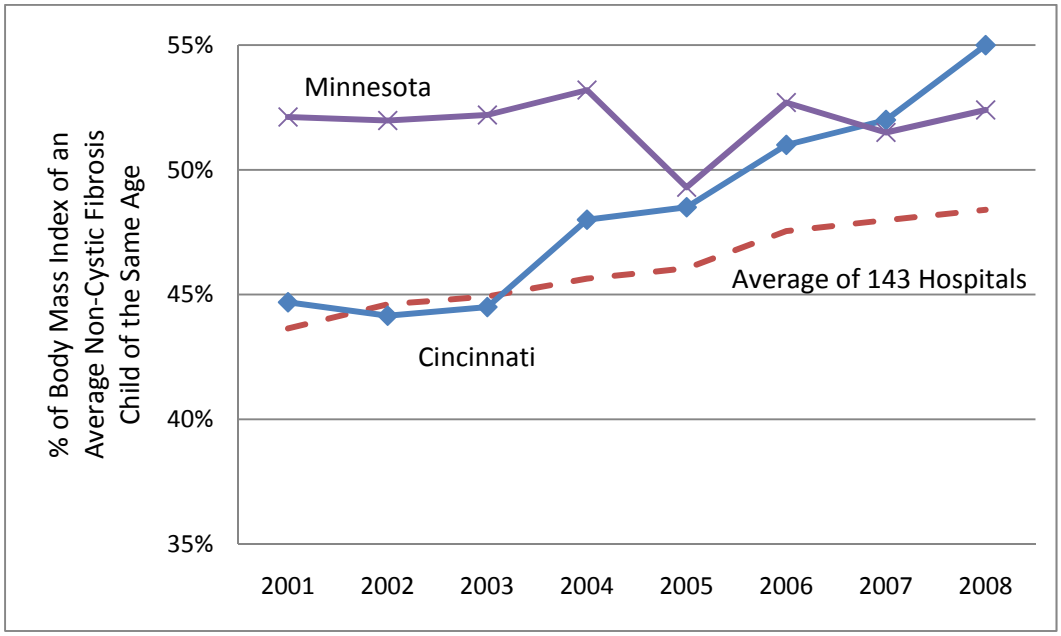


Exhibit 2b Improvement in Cystic Fibrosis Outcome Data: Body Mass Index



Source: Cystic Fibrosis Foundation.

Note 1: Cystic fibrosis patients struggled to maintain high levels of lung functioning and body mass index. To track progress, hospitals that treated CF patients compared a CF patient's lung functioning and BMI against that of an average child without CF. In this exhibit, the average non-CF child is represented as having a lung functioning level of 100% and a BMI of 100%. In 2001, the average CF patient at CCHMC had a lung functioning score of approximately 80% of that of a non-CF child of the same age. By 2008, CCHMC had improved such that their average patient had a lung functioning score of 96%. Similarly, the average CCHMC CF patient had a BMI score 45% of that of a non-CF child in 2001; that improved to 55% by 2008.

Exhibit 2c Percentile Performance on Lung Function Compared to Other Cystic Fibrosis Clinics

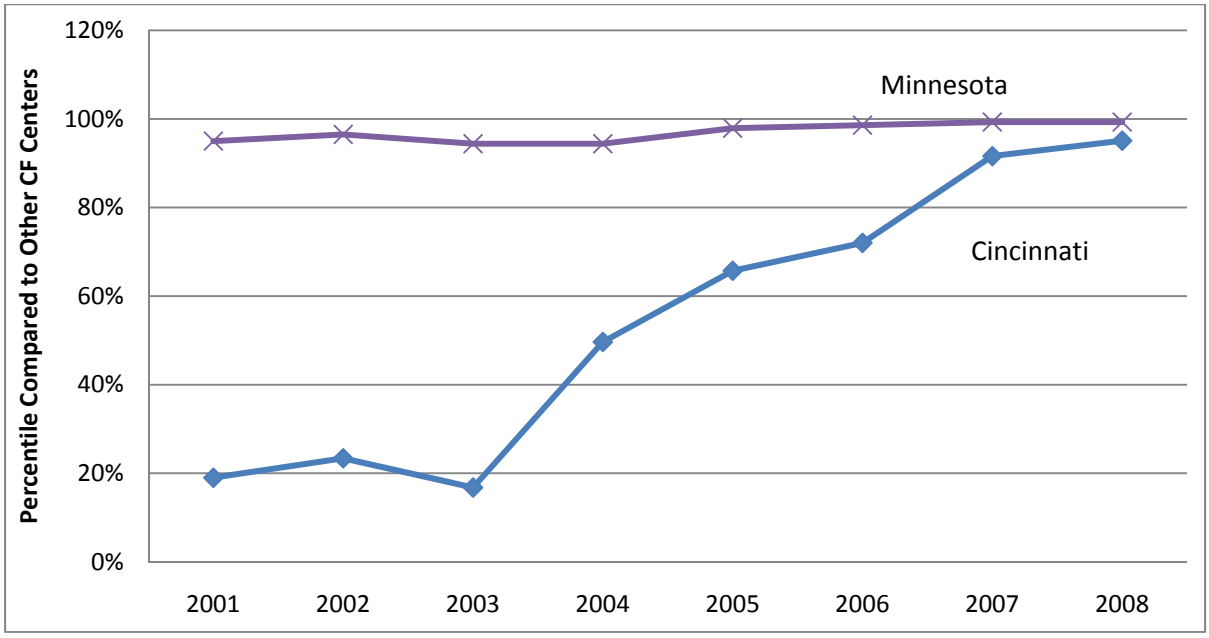
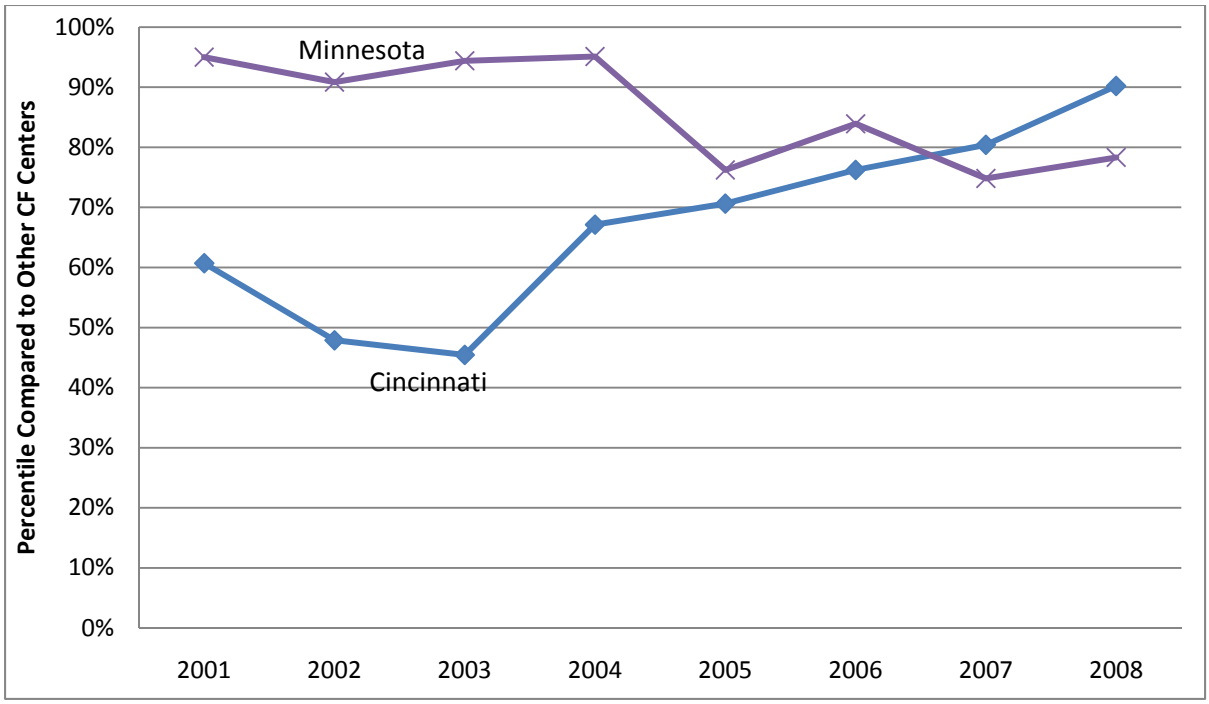
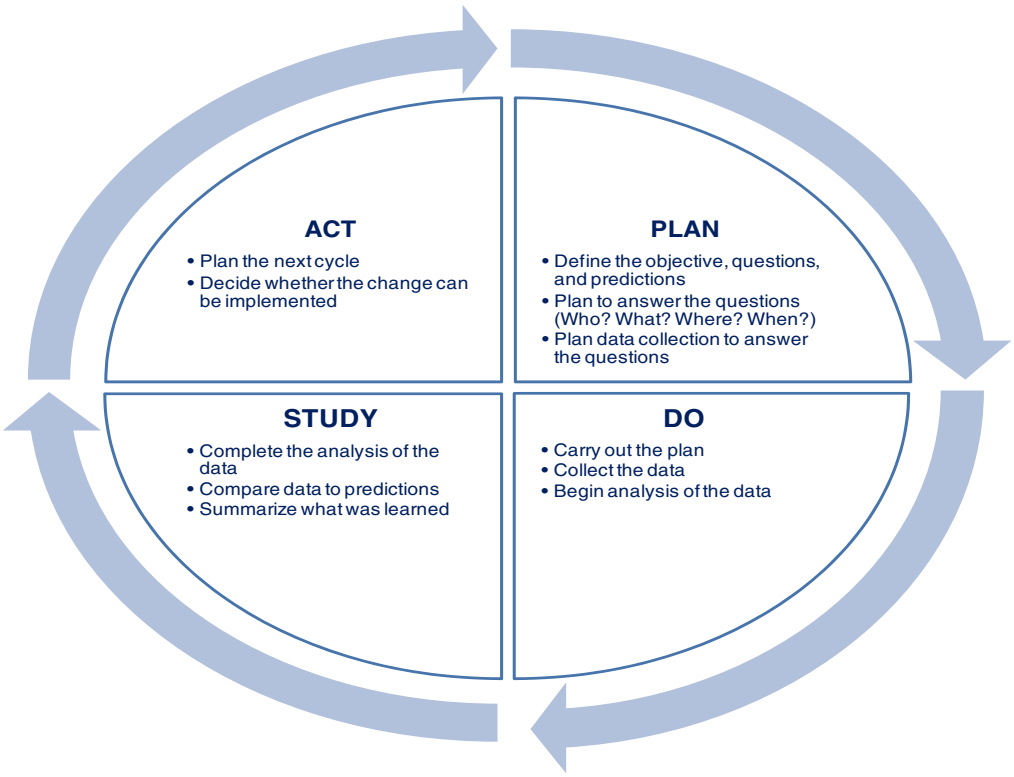


Exhibit 2d Percentile Performance on BMI Compared to Other Cystic Fibrosis Clinics



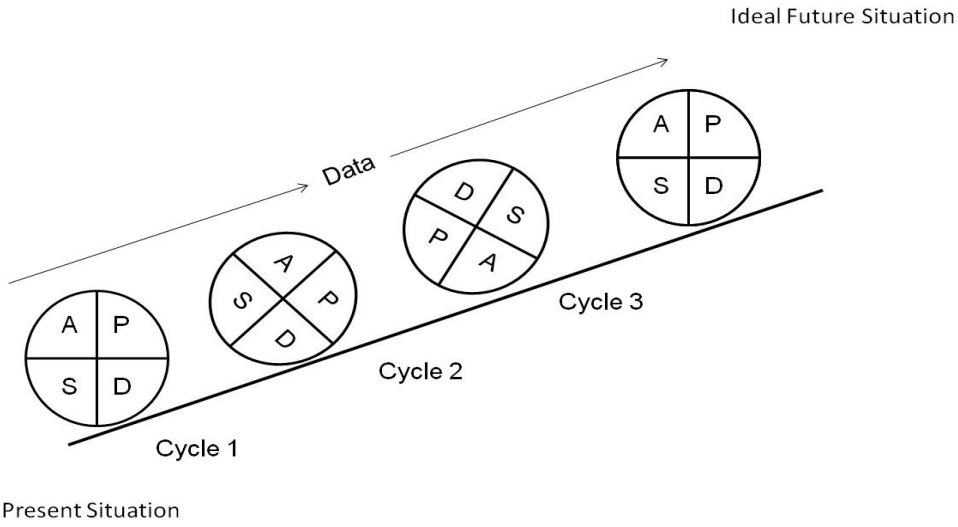
Source: Cystic Fibrosis Foundation.

Exhibit 3a Individual PDSA Cycle



Source: G. Langley et al., *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance* (San Francisco: Jossey-Bass, 1996), p. 97.

Exhibit 3b Series of PDSA Cycles Leading to Improvement



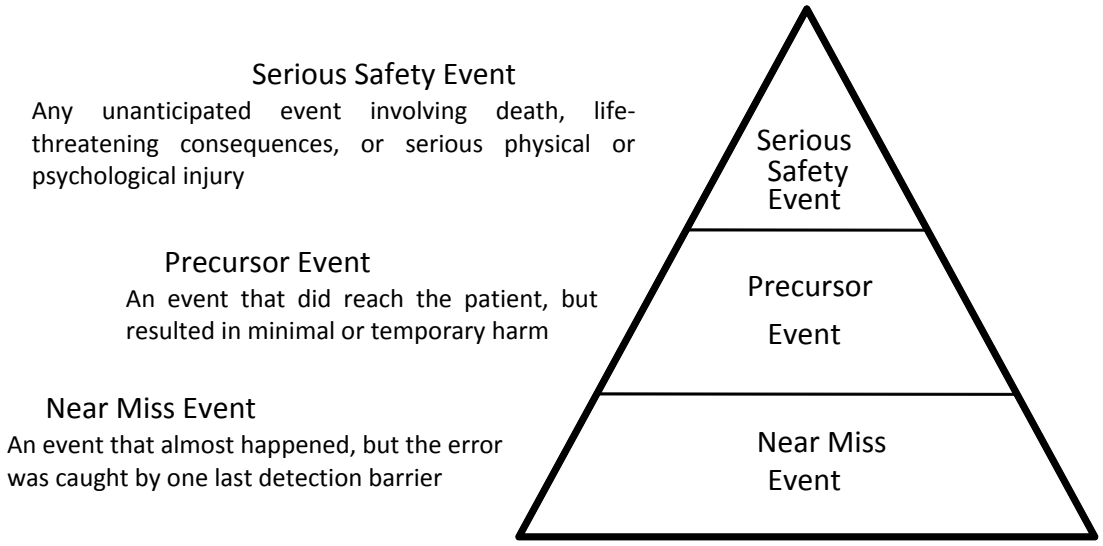
Source: G. Langley et al., *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance* (San Francisco: Jossey-Bass, 1996), p. 103.

Exhibit 4 Adverse Events in Pediatric Cardiac Surgery

The CCHMC pediatric cardiac surgery team, led by surgeon Pirooz Eghtesady, worked on reducing adverse events in the operating room (OR). Eghtesady had completed the I2S2 training and was eager to teach his staff the concepts so they could begin improving the OR. He commented:

> In April 2008, I had the idea of collecting data on issues that happen in the OR and making the data transparent to use as a learning tool. The current focus was preventing serious safety events, which are at the top of the safety pyramid. We decided to take the reverse approach and start at the base of the pyramid to eliminate near misses. The theory was that we would have nothing to percolate to the surface to cause serious safety events. (See **Figure A**.)

Figure A Pyramid of Safety Incidents



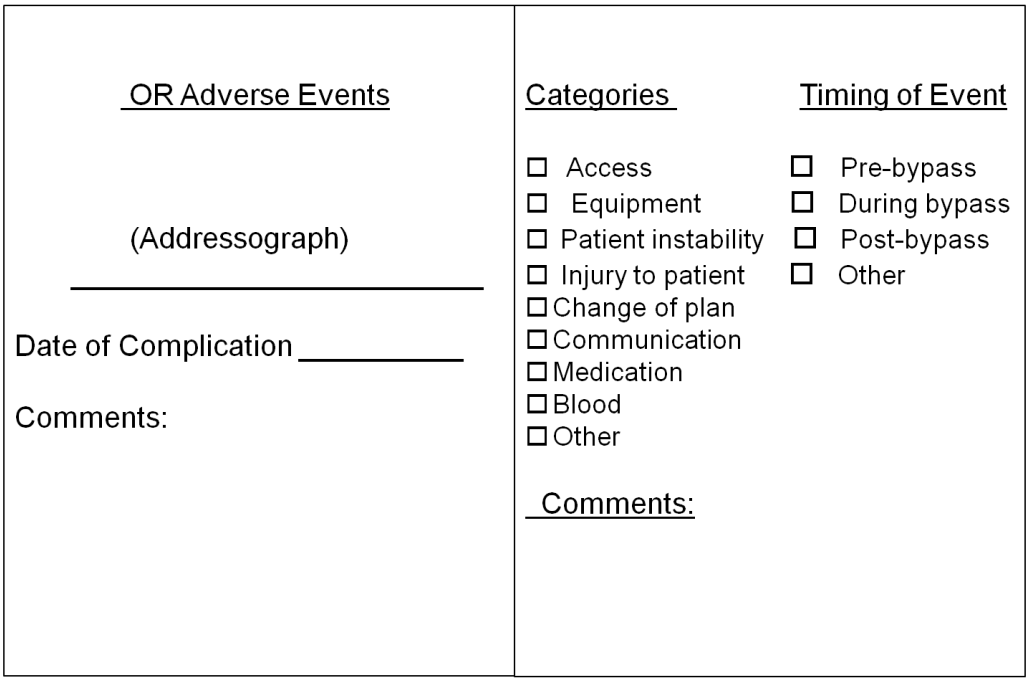
Source: Cincinnati Children's Hospital.

The team began recording events that occurred during surgery. At the end of each operation, following a checklist, the physician assistants asked: "Were there any patient injuries? Was there any patient instability? Did we have any medication-related events?" (See **Figure B** for a blank adverse events data collection card.) Categories such as patient instability and communication were broad and encompassed several different underlying problems that often were complex. Blood product–related incidents were more homogenous. (See **Figure C** for a description of the types of incidents.) Eghtesady recalled:

> In the past, we discussed adverse events at the end of each operation, as part of our post-brief. We would say we were going to do this or that, but nothing ever happened because the process was not formalized and the information was not captured. With the new process, we constructed a histogram of the frequencies of types of incidents and met monthly to discuss the events. With this information in front of our faces, we were motivated to improve our

processes. We set a goal of reducing the number of near miss events by 50% by December 2009. (See **Figure D** for a histogram.)

Figure B Adverse Events Data Collection Card



Source: Cincinnati Children's Hospital.

Figure C Explanation of the Types of Near Misses in the OR

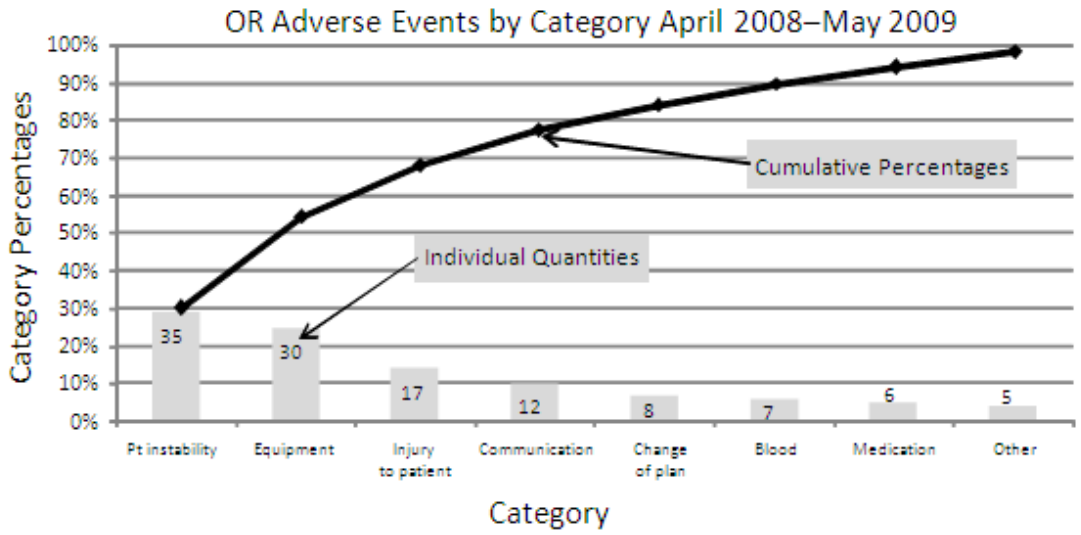
Type	Definition	Example
Equipment Misuse or Malfunction	Any event related to improper *use* or actual *malfunction* of equipment or devices; includes any event caused from misuse or inappropriate function related to monitoring and access lines.	X-ray/fluoroscopy table was not working when patient brought in and anesthetized.
Patient Instability	Any event requiring pharmacological or mechanical support to maintain age- and/or disease-appropriate hemodynamic, respiratory, and metabolic stability. All events requiring external cardioversion, administration of	Patient's blood glucose level was extremely low (20 mg/dL) and unstable throughout the operation even with close monitoring.

	antiarrhythmics, temporary pacing, institution of inotrope infusion beyond initial plan, or emergent institution of bypass are automatically considered in this category. Parameters for blood glucose level, blood pressure, saturation of peripheral oxygen, and electrolytes are used to identify other events that result in instability for at least 5 minutes.	
Injury to Patient	Any physical injury occurring to a patient that results in temporary or permanent physical harm (severity level of harm classification 5 or greater) and further is attributable to a specific organ system injury (dermatology, cardiovascular, pulmonary, ENT, etc.).	Pressure ulcer formed due to IV positioning. The back wall of the superior vena cava was punctured during cannulation.
Change of Plan	Any unplanned or deviation from original/initial surgical plan as stated in the prebrief; includes "return to bypass" events and surgical modifications.	Return to bypass to augment superior vena cava baffle of Senning after transesophageal echocardiogram showed significant gradient.
Communication Failure	Any event during which failure to communicate properly or thoroughly concludes in an interruption or loss of information between two or more parties and thus causes deviation from routine or expected care.	Nitric oxide was not available immediately after coming off bypass (ANESTHESIA-SURGEON-RESPIRATORY). Pericardium treatment time incorrect due to no feedback communication between circulator and scrub nurse (NURSE-NURSE).
Medication-Related Event	Any event with which a patient has any adverse side effect or reaction due to administration of medication; furthermore, any improper dosing or improper preparation of medication.	Protamine sulfate reaction, patient with bronchospasms and loss of pulmonary blood flow.
Blood Product–Related Event	Any event that occurs with the use, misuse, handling, or processing of blood-related products.	Took 20+ minutes for blood to be delivered from the blood bank to the operating room refrigerator, making it unusable.

Other	Any event that is a deviation from the expected and not meeting criteria for above categories.	

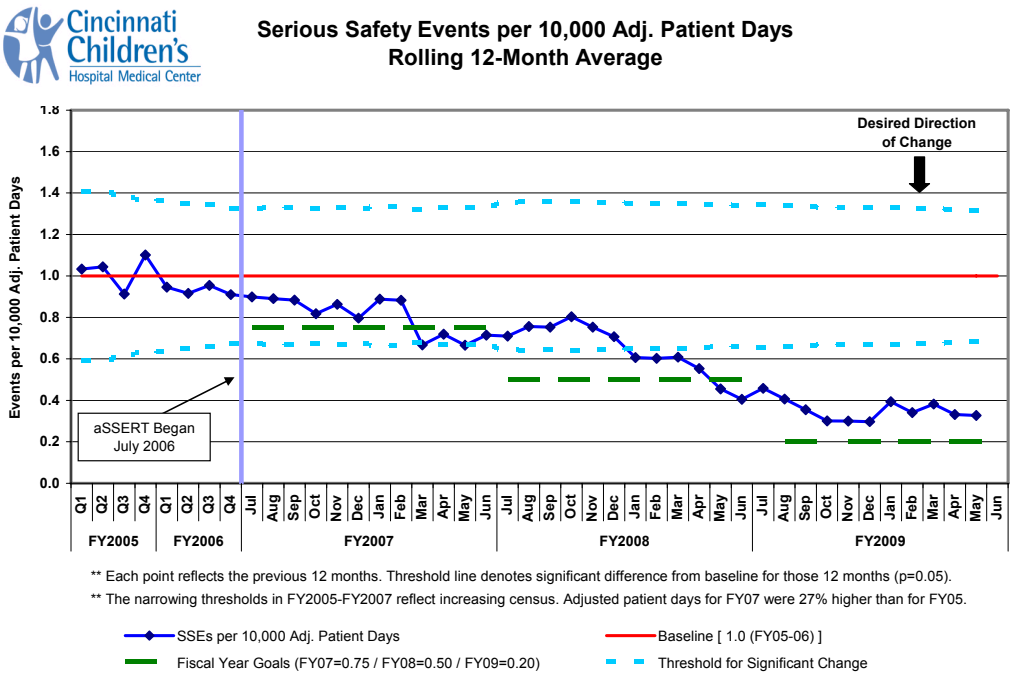
Source: Cincinnati Children's Hospital.

Figure D Pareto Chart of the Types of Near Misses in the OR



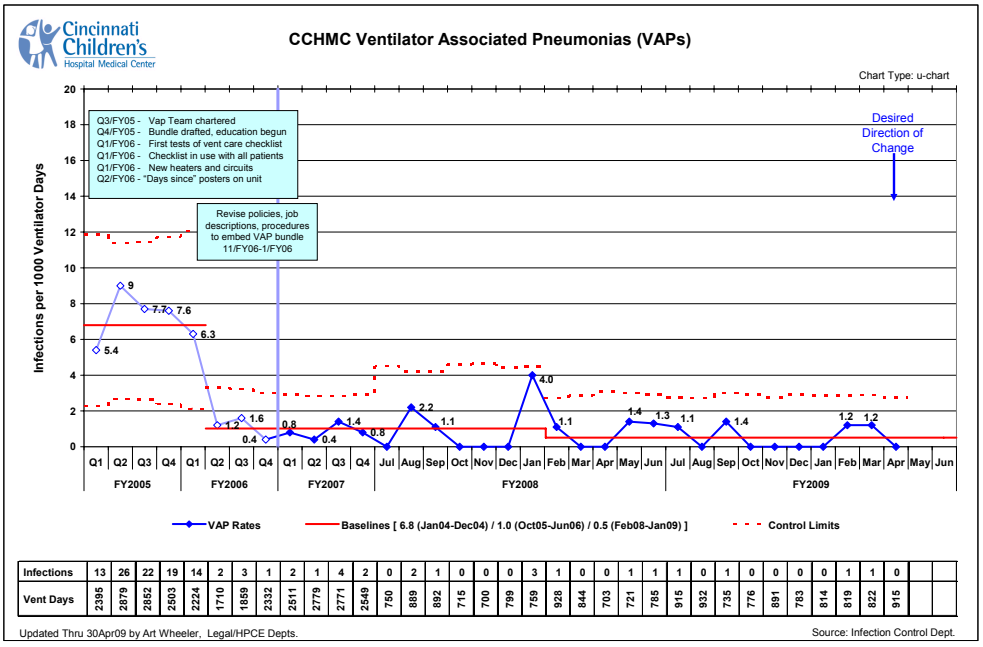
Source: Cincinnati Children's Hospital.

Exhibit 5a Run Chart of Serious Safety Events



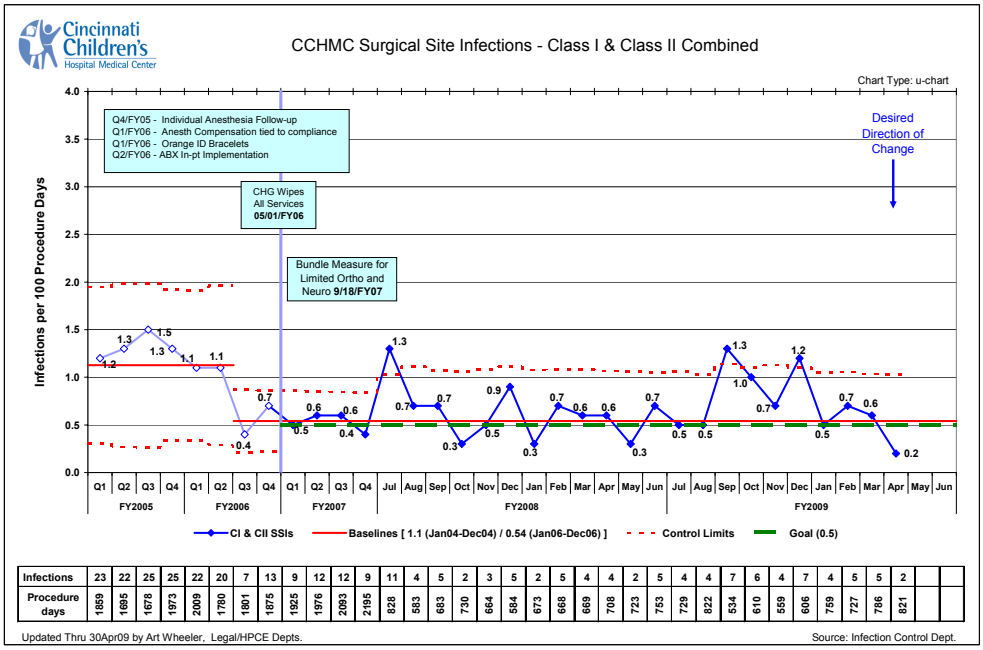
Source: Cincinnati Children's Hospital.

Exhibit 5b Run Chart of Ventilator-Associated Pneumonias



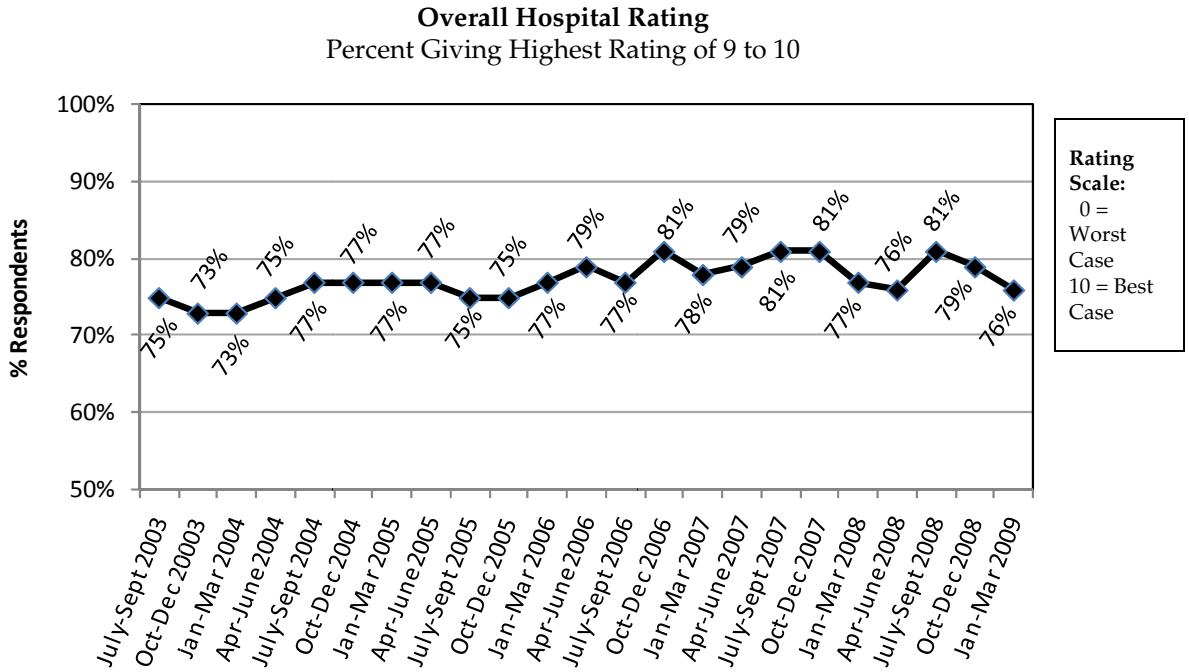
Source: Cincinnati Children's Hospital.

Exhibit 5c Run Chart of Surgical Site Infections



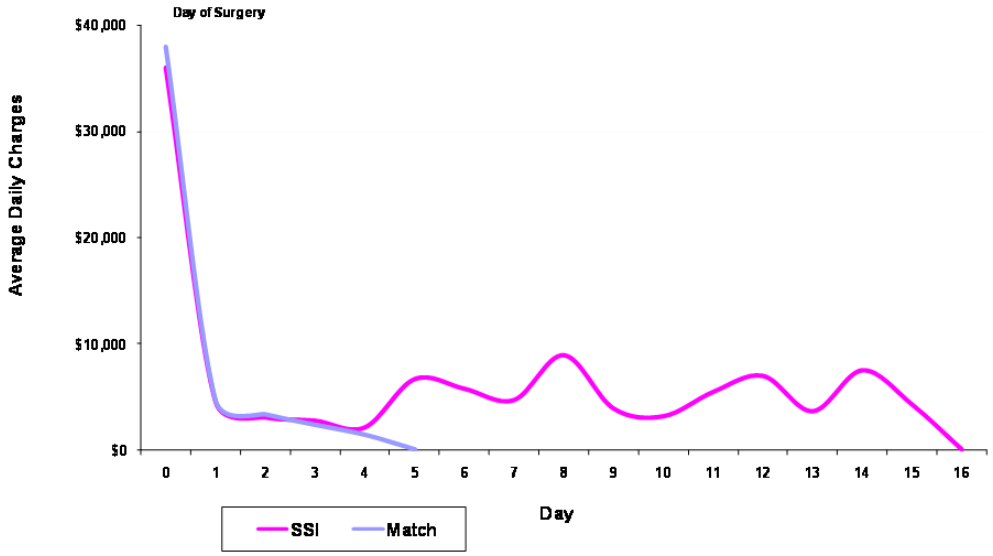
Source: Cincinnati Children's Hospital.

Exhibit 5d Hospital Survey Results



Source: Cincinnati Children's Hospital.

Exhibit 6 Average Length of Stay and Daily Charges for Patient with a Surgical Site Infection (SSI) and a "Matched" Patient without a SSI



Source: Cincinnati Children's Hospital.