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“For too long, doctors and other health care professionals have regarded the need to ‘reduce the cost of health care while maintaining or improving quality’ as someone else’s problem at best, and a professionally illegitimate notion at worst... One root of the problem is that ‘delivering value’ is not a traditional professional value.”
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The Joint Commission Journal on Quality and Patient Safety (ISSN 1553-7250) is published monthly (12 issues per year, 1 volume per year) by Joint Commission Resources, One Renaissance Boulevard, Oakbrook Terrace, IL 60181. Third-class nonprofit postage paid at Oakbrook Terrace, IL, and at additional mailing offices. POSTMASTER: Send address changes to The Joint Commission Journal on Quality and Patient Safety, Superior Fulfillment, 131 W. 1st Street, Duluth, MN 55802-2065. Annual subscription rates for 2010: United States/Canada, $319 for print and online, $299 for online only; ROW, $299 for print and online, $299 for online only. For more information, visit our Web site at http://www.jcrinc.com/journal. Printed in the USA. Copyright © 2011 by the Joint Commission on Accreditation of Healthcare Organizations.

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The John M. Eisenberg Patient Safety and Quality Awards

Introduction

The John M. Eisenberg Patient Safety and Quality Awards program was launched in 2002 by the National Quality Forum (NQF; http://www.qualityforum.org/) and The Joint Commission, in honor of John M. Eisenberg, M.D., M.B.A., director of the Agency for Healthcare Research and Quality (AHRQ) at the time of his death in March 2002. Dr. Eisenberg was one of the NQF’s founding leaders and sat on its board of directors. In his roles both as AHRQ administrator and chair of the federal government’s Quality Inter-Agency Coordination Task Force, he was a passionate advocate for patient safety and health care quality and personally led AHRQ’s grant program to support patient safety research.

The recipients of the award were recommended by the award panel, which was jointly appointed by The Joint Commission and NQF and chaired by Norma Lang, Ph.D., R.N., University of Wisconsin-Milwaukee. “The innovative and exemplary work of these individuals and health care organizations hopefully will not only inform but also inspire others to become champions of patient safety and quality improvement. Their achievements make it clear that substantial improvements can be made in patient safety,” says Mark R. Chassin, M.D., M.P.P., M.P.H., president, The Joint Commission. “We applaud their commitment and courage in pursuing changes that have improved the lives of many.” Janet Corrigan, Ph.D., M.B.A., president and CEO, NQF, says, “This year’s recipients have all made significant contributions to improving patient safety and the quality of health care. As organizations and as individuals, they have challenged the status quo and achieved meaningful results that can be replicated not just in the United States but around the world.”

The 2010 awards were presented on February 25, 2011, at NQF’s Annual Conference in Washington, D.C. The honorees in each of the award categories are as follows:

Individual Achievement (two recipients): John H. Eichhorn, M.D., University of Kentucky, Lexington, Kentucky. Dr. Eichhorn was recognized for his work in improving the quality of anesthesia care and patient safety through the development and application of practice standards and protocols. His contributions have led to dramatic and sustained reductions in catastrophic intra-operative anesthesia accidents, as well as improved anesthesia patient safety and quality of care overall.

James L. Reinertsen, M.D., The Reinertsen Group, Alta, Wyoming. Dr. Reinertsen was recognized for his life-long leadership in improving health care quality and safety in medical groups, hospitals, and health systems. His teaching and guidance have stimulated the leaders of scores of health systems in the United States, Canada, and Europe to achieve and sustain dramatic improvements in mortality rates, nosocomial infections, serious harm events, and other important measures of safety.

Innovation in Patient Safety and Quality at the National Level: Washington State Hospital Association, Seattle. This organization was recognized for its Safe Tables Collaborative program, which provides the fundamental infrastructure for Washington hospitals to share their experiences and learn from each other and from patient safety experts at the local and national levels.

Innovation in Patient Safety and Quality at the Local Level: The Children’s Hospital at Providence Newborn Intensive Care Unit, Anchorage, Alaska. This organization was recognized for its multiyear quality improvement project to eliminate catheter-related bloodstream infection (CR BSI) in the neonatal intensive care unit. Improvement was accomplished incrementally over several years, beginning with the elimination of CR BSI associated with umbilical catheters in 2007 and the near-elimination of CR BSI associated with peripherally inserted or surgically placed catheters. The organization achieved and sustained success through implementing best practices in conjunction with using clinical microsystems principles and creating a learning culture within the context of clinical practice.

Additional information about the Eisenberg Awards can be found at http://www.jointcommission.org/topics/eisenberg_award.aspx.
An Interview with James L. Reinertsen

2010 John M. Eisenberg Award Recipient for Individual Achievement

Interviewed by Penny Carver, M.Ed., Senior Vice President, Institute for Healthcare Improvement, Cambridge, Massachusetts, and Marcia L. Delk, M.D., M.B.A., Senior Vice President for Medical Affairs and Chief Quality Officer, WellStar Health System, Marietta, Georgia

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Penny Carver: It has now been a decade since you contributed to the Institute of Medicine’s reports To Err Is Human and Crossing the Quality Chasm. Since those landmark publications, you have been working tirelessly with senior leaders across the world to improve safety and quality in health care. Can you reflect on what you feel has changed during the past decade?

In the past 10 years, governing boards and senior executive teams have become much more aware of clinical quality and safety issues. A decade ago, they thought that their role was all about finances and facilities; they presumed that doctors and nurses—and perhaps the quality staff—could take care of clinical matters. But today, they’re more likely to understand that trustees and administrators are not just the stewards of physical assets, they are the leaders of a clinical care system. They are responsible for everything in the organization—especially what goes wrong clinically. Many factors have brought about this awakening, such as publicly reported quality and safety data, pay-for-performance plans, and regulatory pressure to meet safety standards. Yet no factor has been more powerful than front-page media coverage of major safety mishaps, particularly if it’s your hospital’s name on the front page. The good news in all of this is that many boards and clinical executives now realize that safety is their job, not just the doctors’, and that they need to learn how to do that job.

Another very positive development in the past decade is that board and executive leaders now have numerous examples of care systems that are getting the job done—where real improvements in hard measures of clinical quality and safety have been achieved and sustained at scale. They can learn from a variety of organizations, such as Cincinnati Children’s in Ohio, the George Eliot Acute Trust in the English NHS (National Health Service), WellStar in Atlanta, Immanuel St. Joseph’s Mayo in Minnesota, the 70-plus hospitals in the Ascension system, McLeod Regional in South Carolina, the Delnor Community Hospital in Illinois—and collaboratives, such as the Keystone Project in Michigan—how to reduce preventable harm and deaths. This collective experience has shown that it is possible to reduce mortality rates by 20% to 30%, as measured by actual “hearse counts,” not just coding-dependent risk-adjusted rates; to decrease the number of serious safety events by up to 80%; and to reduce the overall risk of health care–associated infections by 50% or more. Although these pioneers might not have achieved the theoretically ideal level of performance in every instance, for many safety risks they have shown us that “zero” is in sight.

Of course, the third trend in the past 10 years is actually the absence of a trend—the disappointing realization that despite awareness of the safety problem, and despite a growing number of breakthrough safety achievements in leading-edge organizations, not enough hospitals and care systems are making progress, so that the overall level of safety across the health care system in the United States has not improved.

Marcia Delk: So it seems that some hospitals and systems are getting significantly safer, but many are not. In your view, what distinguishes those that are making real progress from those that are just trying hard?

According to the Institute for Healthcare Improvement (IHI) Leadership Model, leaders of improvement must develop the will to make changes, generate good ideas about what changes to make, and then execute the changes. In my view, the difference between organizations that achieve results and those that don’t is not that the successful organizations have better ideas. For example, evidence-based bundles that reduce the risk of central line infections and implement preprocedural check-
lists to reduce surgical harm and death are not some sort of proprietary secret. They're widely known to everyone. What separates organizations that get results from those that don't is that the boards and senior leaders of successful systems have developed and sustained the will to make necessary changes in structures, processes, and, most importantly, patterns of behavior, and they have then executed those changes with skill and persistence. Marcia, your own organization, WellStar Health System, provides a very good example of this. In the course of the last four years or so, your board and medical staff leaders developed the will necessary to push through major changes in the culture, such as a serious increase in accountability for safety behaviors. The leaders of your five hospitals had the backbone to stand behind these expectations, even if it meant that some staff members lost their privileges to practice at WellStar. And your administrative team executed needed improvements in measurement, process reliability, and many other changes, with skill and persistence. The result has been a 78% reduction in safety events; near elimination of health care–associated infections such as central line bloodstream infections, ventilator-associated pneumonia, and those caused by Clostridium difficile, and a 23% reduction in overall mortality.

All the ideas and knowledge that you used—human factors and safety science, high-reliability organizations, culture of safety, and so on—are widely available. What sets WellStar, as well as other organizations that have achieved and sustained similar results, apart from those organizations that just spin their wheels and don't get any results is the combination of fierce will and competent execution. And that has to start at the top.

Penny Carver: Speaking of the top—you, as a consultant, often have only a few hours with a health care organization’s board or corporate (C-) suite team, in which to activate them to take a leadership role in safety. You seem to have a remarkable rate of success. What do you actually do when you get behind closed doors with senior leaders?

When I have only a few hours with a hospital’s leadership team, I usually start with Paul Batalden’s first law of improvement, “Every system is perfectly designed to produce the results it gets.” Drawing on the hospital’s own data and reports, in terms of the annual number of deaths, serious harm events, nosocomial infections, and defects in evidence-based care delivery, I show them what their hospital is perfectly designed to produce in terms of simple counts of these events—without any complicated risk-adjusted rates, rankings, or other coding-dependent measures that are principally designed for comparisons with other hospitals. I call it “eliminating the denominator.” A common response of board members is, “We’ve been looking at our quality numbers for years, and we had no idea that we were harming that many people.”

The next step is to ensure that the stories behind their data are brought out so that the board and executives can see the impact of surgical complications, diagnostic delays, C. difficile infections, and so forth, on their own patients. It is unfortunately not difficult to find recent examples of these stories—the chief medical officer’s (CMO) office, the quality department, and risk management staff are generally my best sources.

Then, to make it clear that a large proportion of the harm that the hospital is “perfectly designed to produce” is preventable, I share specific examples of proven methods, such as infection control bundles and surgical checklists, as well as examples of organizations whose leaders have implemented those methods with stunning success.

And just in case they aren’t moved by the data, the stories, and the examples of others, I also make sure they know the regulatory and legal risks that they face if they fail to improve safety problems. For example, I tell them that if leaders know (or should have known) about problems such as physicians who are not meeting safety standards or following key safety policies, and if the leaders then do nothing about those problems and merely continue to send out bills as if their services were meeting standards, those leaders—the board, CEO, and others—are at risk of prosecution for “false claims” fraud by the U.S. Department of Justice. I then provide a few specific, recent examples of such prosecutions. If all else fails, that gets their attention.

In essence, I get the board and CEO to see the problem and to own the problem. And that usually leads them to ask the key question, “OK, how do we solve the problem?”

Marcia Delk: In helping leaders to learn how to improve quality and safety, you’ve often used the Seven Leadership Leverage Points model, which has been used to develop the capability of senior executives not only in the United States but in Canada and Europe. What has been so powerful about the Leverage Points framework?

The history of quality and safety improvement has largely been a history of projects, in which a team is formed around a specific improvement opportunity for a unit, clinic, disease, or condition and then uses quality improvement methods to test and implement changes that might make things better. Projects, as the atomic units of organizational improvement, are very important. However, for all too many projects, the
Sidebar 1. Sample “Handholds” for Use When Starting to Improve Quality Performance

- Adopt a specific, “how good, by when, as measured by” aim for improvement at the whole organization level, and monitor it at the highest level of governance.
- Develop a plan (including scale, pace, resources, key drivers, measures) for achieving the aim in the time allotted, and steer the execution of that plan at the corporate-suite, not the quality department, level.
- Channel leadership attention to the aim.
- Engage patients and families in achievement of the aim.
- Connect the aim to the organizational business model (engage the chief financial officer).
- Connect the aim to the hearts and minds of the medical staff.
- Develop the technical capability needed to achieve the aim.

improvements seldom spread to other relevant areas, are rarely sustained for more than a few months, and are almost never knit together with other related projects to achieve significant improvement in an organizationwide ("system-level") measure of something important, such as overall mortality rate. In other words, “everybody do some projects” is not a plan for organizationwide improvement.

We wrestled with this problem 10 years ago or so in the IHI/Robert Wood Johnson Pursuing Perfection initiative® and developed a theory of what leaders might need to do in order to achieve measurable improvement at the level of whole systems. The theory—the Seven Leverage Points framework—has proved to be remarkably useful, in terms of both building training programs for executive leaders and supporting those executives’ ability to create concrete, specific plans for getting organizationwide, not just project-level, results in clinical quality and safety.

Why have these Leverage Points been useful? I think it’s because busy executives and board members are faced with an enormously complex challenge in guiding health care organizations and need some good “initial handholds”—places to get a grip and begin—if they are to start improving their quality performance. The seven individual “handholds” are not rocket science. Executives have done something similar for years for strategic business aims. The Leverage Points merely make quality and safety strategic business aims, like financial performance and growth, in handholds such as those shown in Sidebar 1 (above).

I should point out that the Leverage Points framework is hardly a “normative management theory,” in that I cannot tell a CEO, “If you do these seven things you will achieve system-level results.” It is rather closer to a “descriptive management theory,” that is, “these seven things are associated with achievement of system-level results.” I’m quite sure that we have a lot more to learn about this and that the framework will be revised, expanded, or even discarded as we learn more.

That said, I am quite proud that hundreds of executive teams in the United States, Canada, and Europe, led in each instance by the CEO—a requirement on which I have insisted for the “executive quality academies”—have learned and attempted to apply the Seven Leadership Leverage Points to their quality and safety challenges. Many of those organizations, using the Leverage Points as a guiding framework, have shown us that safety can be improved and sustained, not just in one unit or disease, but for the entire organization.

Marcia Delk: At the start of this interview, you cited boards’ increased awareness of clinical safety and quality issues as a key development. Can you expand on why it is so important for the board, along with the organization’s senior leaders, to become a driver of quality and safety, given that the majority of board members are usually not even health care professionals?

The board is the highest authority within any organization and therefore is the primary source of what I’ve referred to as the will or “backbone” to make the changes necessary to improve safety. Such changes, especially deep cultural changes, are very difficult indeed. For example, the Seton Health (Austin, Texas) system leadership adopted a firm rule—no elective inductions prior to 39 weeks—as part of its strategy to eliminate preventable harm to newborns.8 Staff faced inevitable pressure from doctors and families to bend this rule but stood firm, knowing that the board had their back. This is a massive cultural change—from putting physician autonomy and patient convenience first to putting patient safety first. Seton hasn’t had a pre–39-week elective induction in years, and its birth trauma rate is approaching zero. Many other boards have taken similar stances on mandatory use of time-outs and checklists, handwashing and infection control practices, and abusive behavior.

Everyone in the organization watches the signals sent by the...
board. Is it really serious about safety? Will it provide the necessary resources? If an important doctor, for example, a surgeon who is a major source of revenue to the hospital, fights the board on an issue such as infection control policies, will the board back down? Once we start measuring things, if we don't look good, will the board bury the data? If management and medical staff spend most of their time giving excuses to the board about why results aren't happening, does the board ask any hard questions? Making the organization safer, and changing its culture, starts at the top, and the board is the very top.

The board is also one of the primary organizational reservoirs of what Deming called "constancy of purpose." The quality transformation of any organization takes 10 to 20 years. Given the turnover rate of CEOs, that means that transformation is a “2- to 4-CEO project” in the United States, for example, and a “5- to 10-CEO project” in the English NHS. If transformation is really to take place, it cannot be the pet project of one of these CEOs. It must be a long-term commitment of the board.

**Penny Carver:** You have developed some very successful approaches to engaging physicians in safety and quality work. Can you tell us what you feel has been most successful?

There is a complicated answer to this question, but let me make it very simple. In any sort of health care organization, whether it’s a group practice, a hospital with an independent medical staff, or a major academic medical center, there are three absolute requirements for physicians’ engagement in quality and safety:

1. **Ask doctors to engage and to lead the improvement of clinical care.** I find that far too many organizations have given up before they even start, and don’t really ask, in a respectful way, “What do the doctors want to improve? How would they measure it?” Ask them, and listen to the answer.

2. **Expect doctors to be responsible leaders and to deliver results.** I find this to be a particular challenge in hospitals with independent medical staffs. One excellent way to deal with it is for the board to ask the medical staff leaders to outline their plan for results and to report to the board on a regular basis on whether the medical staff is on track to achieving the results. In other words, treat the medical staff leaders like responsible adults.

3. **Make it easy for doctors to do this work.** Most doctors are very busy with clinical care. Make it easy to try out improvements, to lead improvement teams, to get data, and to communicate results. If it costs doctors enormous amounts of time and effort to do improvement work, it won’t happen.

**Marcia Delk:** Health care reform, as represented in the Affordable Care Act, is presenting a very large “to do” list to hospitals, physician practices, and care systems. What are the greatest safety and quality challenges facing health care senior leaders for the next decade?

Let’s talk about safety first. I think that the U.S. Congress, government regulators, accreditation agencies, and the public are growing impatient with our lack of overall progress on safety. I fully expect that leaders are going to face a powerful surge in expectations—and incentives and regulations—to reduce preventable infections, injuries, complications, and deaths. It’s an urgent problem. We haven’t done enough, fast enough, in our industry, and we can expect that the payers and regulators are going to turn up the heat.

The second challenge is to deal with a fundamental change in how health care works as a business—as it moves from a volume-driven to a value-driven model. Or, as I often phrase it, from “relative value units” to “potentially avoidable complications.” In the current business model, hospital chief financial officers (CFOs) are happy when the hospital has lots of admissions, the operating rooms are busy, and imaging centers stay open late to accommodate demand. In the new business model, the CFO will be unhappy about that portion of the admissions that are readmissions, as well as the surgical procedures that are not clinically indicated; overuse in computerized tomography and magnetic resonance imaging; and complications, such as pressure ulcers, that lead to increased lengths of stay without increased reimbursement. During the transition from the old to the new business model, there is going to be an enormous amount of organizational schizophrenia about what is good for business and what is bad for business. My suggestion is to commit to the new model—and once you’ve decided to go there, to move as quickly as possible.

And the third challenge, the deepest one of all, is a cultural challenge—to make value a value. For too long, doctors and other health care professionals have regarded the need to reduce the cost of health care while maintaining or improving quality as someone else’s problem at best and a professionally illegitimate notion at worst. They’re fine with improving quality, mind, just as long as you don’t talk about reducing costs.

The problem with that view is that the fundamental driver of health reform in the United States was not political, it was economic. Even the insured can no longer afford our product. Even if legislated health reform is repealed in its entirety, health care leaders in this country, as throughout the world, will still have to address this problem. And one root of the problem is that “delivering value” is not a traditional professional value.
Despite these three very serious challenges in front of us, I would note at least one ray of hope. I have had the enormous pleasure of helping to develop the leadership curriculum for the IHI Open School. The experience of dealing with these young leaders-in-training in nursing, medicine, health care administration, pharmacy, and other health professions from all over the world has convinced me that our health systems are about to change—to become safer, more reliable, more patient centered, and more efficient. If the current leaders don’t get the job done, there’s an extraordinarily capable set of leaders waiting to take their place.

References
An Interview with John H. Eichhorn

What does receiving the Eisenberg Award mean to you?
Of course, I am greatly honored to receive the Eisenberg Award. But, more importantly, the award increases the recognition that anesthesiology originated specific patient safety efforts and ignited the entire movement. I have been exceptionally privileged during my career to lead or facilitate truly outstanding teams—at Harvard Medical School; the American Society of Anesthesiologists (ASA); the Anesthesia Patient Safety Foundation (APSF); my international task force; the World Federated Societies of Anesthesiologists (WFSA); and the World Health Organization (WHO)—and I humbly accept this award also for all my colleagues throughout the years. Anesthesia care is dramatically safer today because of all this work during the last quarter century, something of which everyone involved should be extremely proud.

Why has anesthesiology been underappreciated as the origin of the patient safety movement?
One reason is that what we were attempting in the mid-1980s was brand new. The issue of medical errors hurting patients was discussed very rarely in health care. The term patient safety had not yet been heard; it was created with the APSF’s creation in 1985. Even when we had dramatic success, it was little noticed outside anesthesiology, and as anesthesia professionals, I guess we were used to working in the relative background, “saving lives” without much attention or fanfare. Later, when the concept of patient safety gained attention, it’s possible that some of those who became very well known as patient safety leaders did not even know that it had all started with anesthesiology. We did not speak up to claim credit, even though we were thrilled that the movement spread so widely and quickly.

How did you get stimulated and interested in patient safety?
Through a sequence of serendipitous coincidences. When I was a first-year anesthesia resident, I was working in an operating room (OR) one morning, and a fatal anesthesia accident occurred in an adjacent OR, when an endotracheal tube was mistakenly placed in the esophagus of an otherwise healthy, middle-aged patient receiving elective surgery. That was enormously sobering and made a huge impression on me. Also during my residency, my hospital opened a new building. During construction, the main oxygen line into the building was breached; there was a big scramble, but no patient was harmed. I wrote a subsequent paper about contamination found in the gas lines during testing by a sharp-eyed respiratory therapist.1 Then, in an oxygen pipeline accident in 1983 at a military hospital in Alabama, a tank of argon was mistakenly connected to the oxygen system, leading to the death of three patients. The U.S. Department of Defense had noted that the only relevant references were from my department, and the same respiratory therapist and I investigated the accident and presented a report that was well received. In 1984, the following year, Harvard’s liability insurance company convened a meeting of the chiefs of anesthesia from all nine different hospitals to urge action about the disproportionate cost of anesthesia accidents in the previous eight years—anesthesiologists constituted 3% of the faculty but cost 13% of the liability payouts. At the suggestion of my chairman, John Hedley-Whyte, I organized and chaired what we called the Harvard Risk Management Committee. Analysis of the accidents revealed recurrent problems, which, we realized, could have been prevented through more intense and vigilant monitoring during anesthesia. Our solution was the “Harvard monitoring standards,” as described in 1986.2
What was the most difficult aspect of this work?

Well, getting the committee of six extremely bright, opinionated, and strong-willed Harvard faculty members to agree on a controversial and confrontational strategy was quite a challenge. Then, the real issue was overcoming the barriers and “silo mentality” among the nine disparate anesthesia departments at Harvard. As chair of the committee, it took me quite a while and much cajoling during the spring of 1985 to win the chairs’ endorsement—I enlisted the "early adopters" to help overrule the holdouts.

Were you concerned that creating and publishing the original "standards" would promote malpractice lawsuits against you and your colleagues?

Yes, in a way that was an issue. My committee realized that the only way to guarantee that the monitoring strategies and protocol would be rigorously followed throughout all the departments for every case would be to get them adopted as “official standards of practice,” meaning that any adverse event occurring while the standards were ignored was an automatic loser in a malpractice suit. This had never been done anywhere before. Fortunately, the large majority of faculty was well on the way to adopting the protocol and did not see the standards as a threat, while those who were vehemently opposed needed a push. Also, from 1985 to 1991—when I left Harvard, there was never a malpractice suit based on a violation of these standards.

Beyond medico-legal fears, was there resistance by anesthesiologists to having formal practice standards?

Sure, the vast majority of physicians simply do not like being told what to do, however logical it may be. That's still true today and is one of the key barriers to genuine reform of the health care system in the United States. There will always be initial objections that “best practice” protocols prevent creativity and "individual expression" while stifling innovation. Fortunately, all these types of resistance essentially melted away when benefits of the “safety monitoring” strategy of the standards became obvious. The behaviors and equipment associated with safety monitoring became automatic and completely ingrained in American anesthesia practice to the point where anesthesia professionals since the early 1990s could not imagine starting an anesthetic without basic monitoring in place and would refuse to proceed in an elective situation without it.

How did the safety standards effort move to the national scene from its start at Harvard?

So many things were happening, all at the same time. In 1984, the inaugural president of the APSE, Dr. Ellison C. “Jeep” Pierce Jr., from Harvard, as President of the ASA, had helped put in place a committee structure including the newly created Committee on Standards of Care, of which, on the strength of the anesthesia standards work at Harvard, I became the de facto secretary. The original ASA Standards for Basic Intra-Operative Monitoring, adopted in October 1986, were an expanded and carefully qualified version of the Harvard standards. No American medical professional society had ever published “official” national standards. However, the model made so much sense and was well supported by the leadership. Recalling that only 10 years previously, the ASA had firmly rejected the idea of standards for obstetric (OB) anesthesia as essentially heretical, in retrospect it is remarkable that the ASA House of Delegates passed it, but everything came together perfectly. In the subsequent few years, standards for pre- and postoperative care were passed, and safety guidelines for several other practice areas (including OB anesthesia) were promulgated—firmly establishing anesthesiology as the trailblazer in patient safety.

How did the concept of anesthesia practice standards go global?

After the original Harvard and ASA standards were adopted and published and proved successful, the anesthesia professional societies in the United Kingdom, several European countries, Australia, and Hong Kong followed suit by developing and adopting their own standards. I was inspired by this and started to think bigger. In 1989, through another coincidence, I heard from staff at a communications company who were working with a manufacturer of monitoring equipment, which was dealing with the sudden huge demand for pulse oximeters for the OR. It occurred to those staff and myself that it might be possible to obtain grants from industry to fund an international effort to promote anesthesia monitoring standards. That was successful beyond anything I could have imagined, and the International Task Force on Anesthesia Safety was formed by inviting the anesthesia safety leaders from the countries with established standards to come together to attempt a global effort. No governments or professional societies were involved. With nearly two years' intense activity—and before word processing and the Internet—and many meetings, the International Standards for a Safe Practice of Anaesthesia were created. This comprehensive document went far beyond intra-operative anesthesia monitoring because so many parts of the world had much more fundamental issues and needs before getting to that topic. The protocol laid out a blueprint for the entirety of anesthesia practice, from professional standing/
What about your recent involvement with the World Health Organization (WHO)?

In 2007, buoyed by the success of its first Global Patient Safety Challenge focused on clean water and handwashing, WHO’s patient safety arm embarked on the second major program, Safe Surgery Saves Lives, because studies revealed that for a significant majority of the world’s population, having surgery was more of a risk than a benefit. The Safe Surgery campaign is headed by Harvard surgeon and best-selling author Dr. Atul Gawande, whom we credit with recognizing that the original surgeons who conceived the WHO effort had overlooked the critical role that anesthesia care has in improving surgical safety. I was invited to help on the project because of my 1992 role in the WFSA standards. Eventually, as part of Safe Surgery, the WHO Safe Anaesthesia Working Group was commissioned to update the 1992 standards. We also contributed key components to the 19-point Safe Surgery Checklist—which, I might add, is available in five languages other than English. For this updated version of the WFSA standards, the multiple detailed supporting documents (included by the WHO with the checklist) provide an even richer resource of background guidance for anesthesia practice, including the rationale for use of pulse-oximeter monitoring during every anesthetic everywhere. By the way, I am also involved in the Global Oximetry project, which has been charged by WHO to help develop robust technology, distribution and support systems, and education that will enable eventual placement of a pulse oximeter in every anesthetizing location in the world. It is extremely gratifying for me to be able to contribute to the WHO Surgical Safety Checklist and the WFSA International Standards, whose reach is to extend to every OR/anesthetizing location in the world. These achievements represent a rewarding culmination of my 28 years of efforts for patient safety.

What is it about anesthesia practice that led it to be first into patient safety and to lead the movement?

Thirty years ago the disproportionate number and severity of injuries from anesthesia mishaps were impossible to ignore. However, features of anesthesia practice were particularly amenable to the remedies that evolved. Anesthesia is more contained and controlled than other medical specialties, yielding a framework that could be studied. The Harvard Risk Management Committee identified failure of ventilation—the patient’s breathing—one way or another, as the cause of the large majority of catastrophic accidents. This enabled us to strategize on how to prevent that. Also, there is a clearly demarcated final common injury pathway of adverse incidents in anesthesia, which invites specifically targeted behaviors to disrupt that pattern, specifically through enhanced monitoring. Furthermore, anesthesia care requires a mind set of intense vigilance and multitasking—which I like to call “anesthesia sense”—and this made the protocols of safety monitoring logical to anesthesia professionals. Because anesthesia for surgery is facilitative rather than therapeutic, there is essentially zero tolerance for error, which promotes self-analysis and criticism. Also, there is a strong analogy between the thinking patterns involved in conducting an anesthetic and in piloting a commercial jetliner. Back in 1978, Jeffrey Cooper, Ph.D. at Harvard, a 2003 Eisenberg Award recipient for introducing human factors research into patient safety, had applied the concept of critical incident analysis, adapted from the aviation industry’s analysis of airliner crashes, to the study of anesthesia mishaps. That set the stage for anesthesiologists to understand our initial efforts and thus become the early adopters and ignite the patient safety movement.

At the very same time we realized the need for changes in behavior, electronic monitors—particularly the capnograph and the pulse oximeter—were just becoming widely available. These devices had the truly remarkable capacity to extend the human senses with much greater sensitivity—detecting the first hint of decreased breathing and the first subtle fall in oxygen, long before the patient started to turn blue—and to provide much earlier warning of untoward developments and much more time to diagnose and treat the problem, thus preventing catastrophic accidents. Using the new technology to implement the new continuous behaviors resulted in professionwide improvement in quality greater than could ever have been imagined.

What has given you the most satisfaction in your career?

Having the great good fortune to be in the right place at the
right time with an open mind allowed me to facilitate the development and adoption, with my colleagues, of the protocol-driven strategy of intraoperative safety monitoring—the continuo\_ presence of an anesthesia professional continuously monitoring the delivery system and the patient’s oxygenation, ventilation, and circulation.\textsuperscript{4} The ultimate universal application of this concept in anesthesia practice was a dramatic culture change that had much greater impact than I could have ever hoped. In his gracious letter of support for my nomination for this award, Dr. Gawande stated that 30,000 persons would have died from operations performed every year in the United States if deaths from unsafe anesthesia were to persist at the rates of the late 1970s. Helping in that regard gives me enormous satisfaction.

I am also extraordinarily proud of the quarterly Anesthesia Patient Safety Foundation Newsletter,\textsuperscript{6} which I created in 1985 and then edited until 2002. I’m still involved with it, and it continues today to be by far the largest-circulation anesthesia publication in the world, always spreading the word of anesthesia patient safety. Finally, after the adoption of the WFSA International Standards for a Safe Practice of Anaesthesia in 1992, I was told by the chief of anesthesia at the one remaining functioning hospital in then war-torn Sarajevo, Bosnia, that she had used the document to convince her ministry of health finally to give her the resources she needed to provide essential anesthesia care to their patients, mostly battle casualties. That brief moment, which meant so much to me, helped to further justify in my mind all the time and energy I had spent away from my family, while also stimulating me to keep on going.

**How should health care professionals balance the potential benefits of best practice protocols with an individual’s personal beliefs and habits?**

This is a huge issue right now in this country, and it will get even bigger as the squeeze on costs and resources increases. As I noted earlier, physicians in general don’t like being told what to do and traditionally have decried “cookie cutter medicine” as undermining the “art” of medical practice. Science, technology, and general progress are constantly bringing more and more options and information into the health care arena, tending to overwhelm some of the traditional approach to the art of practice. Accordingly, newer generations of practitioners who have grown up in the information age are much more accepting of the underlying concept of evidence-based best practices. These younger practitioners need to speak up to accelerate the acceptance of the protocols lest the health care system suffer its own catastrophic accident as it collapses from an inability to meet the burgeoning demand with shrinking resources.

*Do best practice protocols have to be “evidence based” with p < .05 in multiple studies?*

No, not always. While there are aspects of medical care where that should be possible, there are others, particularly involving extremely rare events such as anesthesia catastrophes, for which traditional statistical analysis is impossible. Then, there is also the philosophical question about “proving” something was prevented. Thus, there is a role for what I call “an alternate definition of truth beyond p < .05” based on rigorous analysis of experience, especially involving very rare events, such as when I reported on the anesthetics of 1,001,000 healthy patients anesthetized at Harvard.\textsuperscript{6} We knew early on that we were on the right track with the Harvard monitoring standards from the positive feedback by the Harvard medical liability insurer. The decreases in the number and severity of accidents led it to reduce the liability insurance premiums for anesthesiologists—by 66% for the 1986–1990 period. No offense to anyone, but insurance actuaries are not charitable people, and the only possible way that my insurance bill was cut 2/3 at the exact time the cost to surgeons and obstetricians was soaring was that we had functionally eliminated catastrophic anesthesia accidents in healthy patients—thus “proving,” without necessarily the p < .05 level, that safety monitoring in anesthesia works as intended.\textsuperscript{10}

*What should patients facing surgery ask and know about risks of anesthesia?*

It was an old truism, decades ago, in the OR environment, that it was hard for the surgeon to hurt the patient badly but very easy for the anesthesia provider to do so. The latter is no longer true. Because, occasionally, my work has been cited incorrectly as representing an “anesthesia mortality rate” for all patients in all surgeries, I need to point out that my frequently quoted statistics apply specifically to healthy people getting elective surgery—people who should expect no problems. In a given year, the risk of a healthy person experiencing an anesthesia catastrophe during elective surgery in the United States is vanishingly small: almost 100 times less than the risk of being killed in a vehicle wreck or about the same as the risk of being struck by lightning. That’s really, really safe on a population basis. However, statistics don’t apply to individuals and it is entirely reasonable for patients and/or their families to ask about the experience of the involved anesthesia professional, particularly with their specific procedure and surgeon, and to
also ask if the ASA monitoring standards are always observed and if the WHO Surgical Safety Checklist is employed for every case in that OR. No reputable professional should ever take offense at such questions because they show that the patient is a knowledgeable, thoughtful consumer of health care, exactly what we should want.

You have said often that the remarkable success in making anesthesia care incredibly safe is, in and of itself, a danger—how can that be?

Yes, that could sound counterintuitive. Yet, there is danger from complacency. The residents I train daily in the OR have never been without safety monitoring and, thankfully, have never seen or even heard of an actual intraoperative anesthesia catastrophe. While that’s great, it removes some of the intense awareness and, yes, fear that I still have after 36 years in anesthesia, provoked in part by what I saw and learned very early in my career. Thus, I worry sometimes that we—or our patients—could become “victims” of our success because some of the “edge” or motivation of zero tolerance for error is gone. Actually, I am more concerned about backsliding in safety behaviors caused by financially driven “production pressure” in the clinical arena, particularly in the OR. “Go fast . . . do more with fewer resources . . . you don’t really need to delay, do you?” This leads to what I call the “get away with it phenomenon”—repeated corner-cutting that is inherently unsafe but with no resulting problem or bad outcome. The questionable behavior is reinforced because it appears to work, and it becomes “normal.” The huge problem is that it will eventually lead to an accident, possibly a catastrophe. It is essentially not a question of “if” but, rather, “when.” This is a very good application of James Reason’s “Swiss cheese model.”11 Sooner or later, in an unpredictable manner, the holes will all line up—coincidence again—and the damaging event will slip through the compromised safeguards. I am encouraged, however, that the WHO Surgical Safety Checklist, if rigorously applied, will help reverse some of this trend in the OR and could inspire many more checklists relevant to a host of other health care situations.

In closing, what do you see in the future for patient safety—for anesthesia and in general?

Overall, I believe there will be much more high-fidelity simulation training, especially in crisis management, which should significantly improve quality and safety.

Also, with the advent of true confidential adverse event reporting to certified Patient Safety Organizations, which would then provide incisive experiential analysis—as we used with the original set of anesthesia accidents years ago—and rapid feedback, large components of the health care system can be alerted to evolving trends and dangers, allowing immediate prevention strategies. This is less likely to work with extremely rare events such as anesthesia catastrophes, but our understanding of those occurrences would benefit greatly from the implementation of a mobile event investigation team, funded by private and/or public sources, which would be ready on a moment’s notice to descend onto the scene of a catastrophe and assume control of the incident and the investigation, just like what happens with an airliner crash. This likely would require tort reform and a complete removal of all medico-legal implications and constraints, but it would generate a huge amount of material for patient safety science to work on, ultimately resulting in far fewer accidents to investigate or litigate.

I am worried, as noted, in general, about complacency and production pressure. But the culture of safety has become so strong now in OR anesthesia that I believe that our patients will continue to be extremely safe and that anesthesiology can continue to be the role model and to lead the way in patient safety for all of health care.

References

The Safe Tables Collaborative: A Statewide Experience

2010 John M. Eisenberg Award Recipient for Innovation in Patient Safety and Quality at the National Level

Carol A. Wagner, R.N., M.B.A.; Diane Cecchettini, R.N., M.S.; John Fletcher, M.B.A.

In 2000, the Institute of Medicine reported that 98,000 lives are lost each year in the United States due to errors in hospitals, stunning the health care field with the significant toll in lives, the increased cost to society, and the dissatisfaction for care providers. In 2004, the Washington State Hospital Association (WSHA) board, composed of about 30 CEOs from around the state, decided to focus on the safety of Washington hospitals. To create the infrastructure needed, in 2005 the state's hospitals greatly increased their commitment to patient safety and ensuring the right care is delivered, at the right time, to every patient, every time by creating and funding the association’s Patient Safety Program.

In March 2005, as the Institute for Healthcare Improvement (IHI) began its 5 Million Lives Campaign, the WSHA board issued its own challenge, in which it asked all Washington state hospitals to enroll in this potentially life saving campaign and to implement the recommended safety interventions. The WSHA leadership wanted to see if Washington could make significant and sustainable statewide improvements in the safety of health care. Could the "power of the collective" make a difference? All 97 community hospitals in Washington joined the campaign.

Statewide collaboration in patient safety was new. Hospitals are often competitors—for patients, physicians, nurses, and financing. Washington hospitals recognized the need to set competition aside and help one another achieve high-quality, safe care. By developing a program of Safe Table Collaboratives, large and small hospitals alike created a forum to improve care and make Washington nationally known for its patient safety achievements. In the Safe Table Collaboratives, hospitals set ambitious goals, implement the latest medical evidence to improve care, and measure progress. Hospitals share best practices and address issues of safety and quality, ranging from the prevention of health care–associated infections (HAIs) to advancing board leadership in patient safety.

The Safe Table Collaboratives have resulted in solid, measurable improvements in the quality and safety of patient care in Washington State’s hospitals. It is a program that could be replicated in other states with similar outstanding results.


Methods

PARTICIPATION

Staff from all Washington hospitals have participated in one or more of the collaboratives. Hospital leaders wanted their staff to come together with other staff, regardless of hospital size or type, to learn from one another. The collaboratives meet in person and via conference calls or Web conferences on a monthly basis. In total, there have been approximately 45 in-person meetings, with more than 4,000 total attendees.
GUIDING PRINCIPLES

Groups established under the collaborative structure use the following principles:
1. The focus is on improving processes to advance patient safety and outcomes.
2. The practices promoted by the group are implemented in a nonpunitive manner.
3. The group’s work is based on the latest medical evidence, professional society guidelines, regulatory requirements, and accreditation agency standards.
4. The group measures its progress and reports periodically to hospital leaders.
5. The group works with patients and families to improve care.
6. The group’s conversations are confidential and enjoy legal protection through Washington State law, allowing for frank and open conversation.

ADVISORY PANEL

The collaborative program is informed by an advisory panel composed of state agencies and other organizations working to improve health care quality. The group meets three times a year. Members include the state’s medical association, nursing unions, health department, the regional office of the Centers for Medicare & Medicaid Services (CMS), the state’s Quality Improvement Organization, and hospital representatives, among others. This group reviews the Safe Tables goals, provides feedback, and collaborates in the implementation of strategies. The group also works to eliminate barriers standing in the way of safety improvements. For example, hospitals were prohibited by local fire marshals from having hand sanitizers outside patient rooms; the health department used its leverage to hospital leaders.

MEASUREMENT

Using data for improvement is the underpinning of the Safe Table Collaboratives. To facilitate data sharing, WSHA developed a system to track and rapidly assess the impact of improvement initiatives. The Quality Benchmarking System is a secure, Web-based application that enables hospitals to input data, compare their data with top performers, and analyze data in real time. Information is entered using the definitions endorsed by the National Quality Forum (http://www.qualityforum.org/home.aspx), Centers for Disease Control and Prevention (http://www.cdc.gov), and other national entities. Data are directly entered and integrated, with additional data obtained from external sources such as Hospital Compare (http://www.hospitalcompare.hhs.gov) and the CDC into one comprehensive report. Data are immediately available to guide process changes and drive improvement in annotated control charts, which drill down to the unit level. In addition, hospitals can obtain high-level, board-ready reports.

ACCOUNTABILITY

The Safe Table Collaborative work is overseen by WSHA’s Patient Safety Committee as well as its board. The committee is chaired by a prominent hospital CEO in Washington. The committee was first chaired by the CEO of MultiCare Health System [D.C.] and is now chaired by the Senior Vice President and Chief Executive of Washington/ Montana Region, Providence Health & Services [J.F.]. Partner organizations help implement improvements through coordinated education and communications. The collaborative also fosters patient involvement through brochures, signage, and transparency on key measures.

STAFFING

The Safe Table Collaboratives are staffed half time by a director, who determines the agenda, recruits speakers, and creates information packets consisting of implementation tools and summaries of the latest medical evidence. A director of analytics works half time measuring and creating reports related to Safe Tables. An executive assistant helps with communications in addition to other duties. A conference coordinator plans the logistics for the event, which takes a total of 2.5 days, including a day at the event.

ENGAGING PATIENTS AND THEIR FAMILIES TO HELP PROVIDE SAFE CARE

In recognition of the fact that patients and families are integral parts of the care team, the Safe Table Collaboratives provide information and tools to patients and families for all projects, as seen in the following examples:

■ Posting extensive information on infections. Infections are one of the areas where the public worries the most. Through WSHA’s Web site, hospitals share their results on both process and outcome measures.

■ Providing educational materials with proactive steps patients can take to stay safe. WSHA has distributed about 1.7 million copies of the patient safety materials in multiple languages.

■ Giving patients, families, and visitors information on how they can stop the spread of infection by adhering to proper isolation precautions. WSHA has created color-coded patient, family, and visitor isolation-precaution education materials in five languages.
Encouraging patients to ask their caregivers and visitors to wash their hands
- Modeling inclusion of patient and families by sharing patient stories at each Patient Safety Committee meeting

Program Success
The five projects implemented through the Safe Table Collaborative model are now described. After a major initiative is completed through the Safe Table Collaborative, measurement and follow-up on implementation help ensure sustained success. The initiatives and related data are discussed on an ongoing basis at WSHA board meetings and at the annual CEO and Trustee Summits, and, when possible, the initiative is integrated into basic operations. For example, rapid response teams are now part of the statewide standard emergency code calls. A transparency Web site and comparative reports are also used to sustain results. Sometimes, after initial goals are accomplished, Safe Table Collaboratives (for example, the Preventing Infections Safe Table Collaborative) continue on an ongoing basis to address newly set goals.

PREVENTING INFECTIONS
Washington was among the first states in the United States to engage in a statewide initiative to reduce HAIs and continues to be a national leader in this effort. The infection prevention collaborative consistently has had participation from more than 100 hospital staff (physicians, nurses, infection preventionists, and patient safety leaders), representing 94 (97%) of the 97 community hospitals. The collaborative began with the basics of increasing hand hygiene and has achieved success in multiple areas, including reducing central line and ventilator infections, putting processes in place to reduce multidrug-resistant organism (MDRO) infections, and increasing staff influenza immunizations. The results of the preventing infections collaborative include the following:
- A steady decline in infection rates, with some hospitals reporting zero infections in areas of focus
- A reduction of central line and ventilator infections by more than 50%
- An increase in influenza immunization to 70% of all health care workers (across settings) in 2010, with a projected 80% of staff immunization in 2011—compared with an average for the United States of 37% for 2009 and 62% during the 2009–2010 H1N1 pandemic period.
- A more-than doubling of hospital hand hygiene rates among caregivers, including physicians, nurses, and other staff. For example, in July 2006, baseline data indicated that hand hygiene (washes/patient day) for ICUs averaged 31.7 and increased to 137.1 by December 2010; the comparable figures for non–ICUs were 29.3 and 68.6.

CREATING RAPID RESPONSE TEAMS
Rapid response teams are called by staff, and sometimes patient families, at the first sign of a patient’s deterioration, before the patient’s heart or breathing stops. Through a Safe Table Collaborative, participants were given hands-on tools, education, and policies to implement rapid response teams. Some 72 (74%) of the 97 community hospitals now have rapid response teams. In a survey of 1,500 registered nurses (RNs) in Washington, a large majority of nurses reported that rapid response teams enhance their skills, are beneficial to their patients’ quality of care, and are very supportive of nursing.

INCREASING BOARD LEADERSHIP
Washington hospitals recognized the need for corporate-suite and board-level leadership to actively lead that organization’s patient safety and quality efforts. In 2007, WSHA initiated a Safe Table Collaborative, Increasing Board Leadership, with the launch of a “CEO and Trustee Patient Safety Summit,” which is held annually during the second quarter. This focus on high-level leadership in patient safety efforts is reflected, for example, in IHI’s 5 Million Lives Campaign intervention, Get Boards on Board. During the annual summit, boards have the opportunity to learn from national experts on board leadership in patient safety. They learn how to interpret sometimes complicated clinical reports and discover what questions to ask to advance quality in their hospitals.

Engaging hospital leaders has resulted in a significant shift in the way hospital boards operate. Across the state, Washington hospital boards report a broadening of their focus to include oversight of patient safety as well as fiscal and legal issues.

CHIEF MEDICAL OFFICERS’ LEADERSHIP IN STRENGTHENING HOSPITAL AND PHYSICIAN RELATIONSHIPS
Sound relationships between hospitals and physicians are essential to coordinating care, which is often fragmented, and hospital and clinic chief medical officers play a key role—as a combination of change leaders and peace keepers—in this work. In 2009 WSHA, with the Washington State Medical Association as a co-sponsor, created the Chief Medical Officer Safe Table Collaborative to support chief medical officers’ efforts to strengthen relationships and build effective systems to deliver safe and reliable care.
SAFE PRACTICES TO PREVENT HARM

Nurses and physicians often make split-second decisions to save a patient’s life. Something as simple and preventable as using the wrong emergency code call could lead to patient harm. With a large number of physicians and staff working in multiple hospitals, differences in basic practices among hospitals create harm and add complexity, making it very difficult for health care workers to provide safe care. Participants in a Safe Table Collaborative developed statewide standards in four areas: surgical checklist (World Health Organization), isolation precaution signage, emergency code calls, and color-coded wristbands. The WSHA board set the goal of implementing these standards throughout the state in one year.

As a result of this work, the standardized practices are now used in hospitals statewide. For example, Washington is the first state to achieve use of a surgical checklist. Washington hospital patients and staff encounter these same four standards, no matter where they work or are hospitalized.

Washington is one of three states selected by the Commonwealth Fund to participate in the State Action to Avoid Rehospitalizations (STAAR) initiative. In its reducing rehospitalizations initiative, the Safe Table Collaborative is working to improve transitions of care after patients leave the hospital and to develop strategies to address systemic barriers to reducing avoidable rehospitalizations. Some 57 (59%) of the 97 community hospitals in Washington are engaged in implementing major process improvements to reduce rehospitalizations through the Safe Table process.

Discussion
LESSONS LEARNED

Collaboration has resulted in measurable statewide improvements in the safety of health care in Washington State. These improvements are being sustained and built upon as new medical evidence emerges. The experience of the collaborative yields three lessons:

1. Progress is easier to achieve using the power of the collective when hospitals voluntarily set targets and all are asked to participate. Including all hospitals creates a positive environment for innovations in safer care. Setting a target creates the vision and dialogue about where our communities want health care to be. The development of specific safety issues of focus, common definitions, and statewide expectations has been one of the pieces most actively pushed by hospital CEOs through WSHA’s board. This process is a powerful tool that fosters discussions at hospital governing boards, as well as among hospital CEOs and clinicians in the state. Leadership can emerge from surprising places, especially smaller hospitals, which often provide particular expertise in implementation.

2. Although transparency of data has been painful at times for some organizations, the end result is an improvement of care for all patients. Transparency provides a structure for accountability and focus within hospitals. The media, community, and state governmental leaders value access to hospital-specific data, displayed in a format geared with patients and families in mind. Although helpful for improvement, it is still unclear how patients are applying the information in their health care decision making and choices.

3. Partnerships are invaluable. The Safe Tables Collaboratives would not be nearly as effective without partnership in this work from government agencies, the state medical association, professional societies, nursing leadership, nursing unions, the state’s Quality Improvement Organization, and other statewide groups that focus on quality.

NEXT STEPS

The Safe Table Collaboratives program has expanded its work to focus on reducing costs in addition to improving patient safety. Even though Washington health care costs on a per capita basis are relatively low, these costs are not sustainable. Through the collaborative, WSHA has launched a series of initiatives designed to reduce costs while improving safety. Through the reducing rehospitalizations initiative, WSHA is currently working to reduce rehospitalizations through smooth transitions. Unlike previous Safe Tables Collaboratives, this initiative includes the entire health care continuum, from primary care providers to nursing homes and home health providers. Another initiative will soon begin with a focus on reducing preventable emergency department visits. In both these initiatives, the redesign of the care delivery system is being built from the perspective of the patient. Part of the conversation will focus on the nonsustainability of the current fee-for-service payment system, in which hospital revenues increase with rehospitalizations and emergency department visits. As hospitals begin their work on improving care and getting patients to the most appropriate setting, they have also begun exploring opportunities to pilot changes in payment methodology.
The experience of the Safe Tables Collaborative has confirmed the message from the Institute of Medicine that hospitals do need to be made safer, which has been reinforced by more recent findings. Robust quality improvement efforts, along with strong engagement from hospital leaders, can make a significant difference in improving the safety and quality of care in hospitals. WSHA and its members are committed to continued use of the Safe Tables Collaborative model to push patient safety and quality forward.

In 2007, the Washington State Hospital Association’s Patient Safety Program was able to expand with a significant contribution from Premera Blue Cross.

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Toward the Elimination of Catheter-Related Bloodstream Infections in a Newborn Intensive Care Unit (NICU)

Nosocomial sepsis is a common occurrence in the newborn intensive care unit (NICU) setting. A recent article from the National Institute of Child Health and Human Development (NICHD) Neonatal Network reported an incidence of late-onset sepsis of 36% in very-low-birth-weight (VLBW) infants. The most common contributor to nosocomial sepsis is catheter-related bloodstream infections (CR BSIs). The "mental model" frequently ascribed to sick and premature neonates is that they are biologically vulnerable to sepsis because of their immature immune systems and invasive procedures needed for their survival. There have been many publications on successful quality improvement (QI) efforts to decrease CR BSIs in the NICU. Yet, we do not know of a publication describing progress toward the goal of eliminating CR BSIs in the NICU setting.

In 2002 and 2003 the NICU at The Children’s Hospital at Providence Alaska Medical Center (Anchorage, Alaska) had an overall nosocomial sepsis rate for VLBW infants, which was within the 25th to 75th quartiles for the Vermont Oxford Network (VON), but we were encountering deaths and significant morbidity associated with nosocomial sepsis, including larger infants. Accordingly, in 2003, using principles learned from participation in several VON QI collaboratives, the first of which began in 1998, we undertook a comprehensive QI initiative spanning several years—initially to decrease, and subsequently to eliminate, CR BSIs. The primary question that guided our improvement effort was whether it was possible to eliminate CR BSIs in a NICU that cared for VLBW and surgical infants and infants who required central catheters for their care. This effort depended heavily on implementing principles that define high-performing clinical microsystems, which we learned in the “Your Ideal NICU” VON collaborative (2005–2007).

Methods
SETTING
The Children's Hospital at Providence Alaska Medical Center, which serves Anchorage and the surrounding communities within 50 miles, has approximately 2,600–2,700 of the 11,000–12,000 births that occur annually in Alaska. Its 47-bed tertiary NICU receives more than 500 admissions per year, both inborn and outborn, including 90–110 VLBW infants and infants needing surgery.

INITIATING THE QI PROJECT
We used historical control data from our NICU spanning the years 2002–2003. In initiating our QI interventions in the last quarter of 2003, we reviewed the literature, with an emphasis on best practices. Our NICU has a multidisciplinary professional practice committee that meets twice a month, and this team provided the foundation of the QI work. Our clinical staff has an established culture of evidence-based collaborative decision making.

We relied heavily on the model of the Plan-Do-Study-Act (PDSA) method of rapid-cycle change and used random audits for problem solving and improving performance, as practiced...
in the VON QI collaboratives.\textsuperscript{21-28} We also used the VON concept of “potentially better practices” (PBPs), as developed through analysis of the processes of care and literature review.\textsuperscript{21}

According to the VON, given that change depends on local context, it is better to test PBPs for effectiveness “rather than to assert that a given practice is a universally applicable ‘best practice.’”\textsuperscript{21}\textsuperscript{21p. 537}

Initially, the aim of this project was to reduce CR BSI. In 2005, after reducing CR BSIs with the implementation of best practices, we undertook an effort to eliminate all CR BSIs. We actively searched for contributors to each case of CR BSI in the NICU using the “web of causation” as a foundation in order to better understand why we were unable to eliminate all CR BSIs.\textsuperscript{29} The web of causation encourages the identification and investigation of all potential sources that result in an outcome. Starting in 2005, we kept a prospective database with details about each case of sepsis, conducted frequent reflective informal conversations with nursing staff about preventive strategies, and deconstructed events leading to each sepsis event. Using this knowledge, we undertook a learn-as-you-go approach and used hypothesis testing to test the effects of planned changes on preventing CR BSIs.

**STUDY DESIGN, SAMPLE, AND MEASURES**

We used a time-series design. The study population included all admissions to the NICU from January 2002 to December 2010 who had a central catheter placed for their care. Our primary outcome was the rate of CR BSI per 1,000 line days. Sepsis cases were identified from the medical record and the hospital’s vendor-provided computer-based infection-tracking system. Data on catheter days were collected daily by trained personnel. Each case of sepsis was independently reviewed by the hospital’s infection control department and classified according to Centers for Disease Control and Prevention criteria by etiology.\textsuperscript{30} Our infection control department independently classified a positive blood culture as a true sepsis versus a contaminant. The definition of a contaminated blood culture was one of two blood cultures growing a skin organism (coagulase-negative \textit{Staphylococcus}) or blood cultures growing different species of a skin organism, and antibiotic treatment stopped by the clinical team within 72 hours of initiating treatment with a clinical assessment indicating a contaminant.

**ETHICAL ISSUES**

Improvements included implementation of best practices (or PBPs) already proven effective in other environments and practices, which made for improved adherence to protocols, thereby meeting ethical standards for QI efforts. Therefore, we did not seek Institutional Review Board approval for the project.

Our database does not include patient-identifying data, and access is restricted. Case reviews were conducted with staff under quality review confidentially at the time of the occurrence; identifying information was not retained after the review was completed. We used statistical process control analysis to demonstrate changes after interventions. Control charts and statistical analysis of significance were conducted using Minitab Statistical Program version 14 (State College, Pennsylvania).

**Interventions and Results**

The “web of causation” and implemented PBPs are shown in Table 1 (page 213). The PBPs were introduced with random audits to ensure adherence.

**INITIAL INTERVENTIONS**

In the fourth quarter of 2003, we worked on practices related to hand hygiene, maximum sterile barrier precautions for central line placement, certainty of diagnosis—and changing our mental model on the preventability of CR BSI. The CR BSI rates for 2002 through 2010 are shown in Figure 1 (page 214). We decreased our CR BSIs starting in 2004, and the improvement was statistically significant. Although there was considerable variation in rates from quarter to quarter, CR BSI rates for 2004 and 2005 showed an annualized decrease of about 60%. However, we were unable to make additional gains.

**SUBSEQUENT INTERVENTIONS**

Analysis of our database showed that more than 50% of CR BSIs were occurring between days 5 and 15 of life, when most infants had an umbilical artery (UA) and/or an umbilical venous (UV) catheter in place. On the basis of this finding, we undertook several additional interventions. In 2006 we limited the time an umbilical catheter stayed in place to 7 to 8 days. After a trial period, in 2007 we adopted a “closed” UA system to prevent repeated open access to the UA line and initiated skin preparation for line placement with 2% chlorhexidine for all infants, except those at less than 25 weeks gestation. Results are shown in Table 2 (page 215).

In 2006 we experienced a greater number of consecutive sepsis-free days but noted clustering of CR BSI cases. We conducted “reflective” bedside conversations with staff. A reflective process, initiated by leaders, provides for a safe place to think, learn, collaborate, and promote understanding.\textsuperscript{46} On the basis of staff input, we became concerned about the difficulty nurses were having in keeping strict adherence to sterility, reflecting interrup-
tions during the procedure, when priming total parenteral nutrition (TPN) intravenous tubing at the bedside. We then tested the hypothesis that taking this task away from bedside nursing staff, limiting the number of people doing the task, and improving the process would further decrease our CR BSI rate. This process was fully implemented in the first quarter of 2008. In the subsequent four quarters, we experienced one CR BSI and were free of any CR BSI in our NICU for 248 days, with more than 1,700 line days. We experienced only one percutaneous indwelling central catheter (PICC) line–related sepsis since July 2008 (Table 2). More importantly, we obtained valuable information based on hypothesis testing that the preparation of TPN for the bedside, once it was received from pharmacy, was a critical step toward the goal of eliminating CR BSI.

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**Table 1. The “Web of Causation” and Implementation of Potentially Better Practices**

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* CR BSI, catheter-related bloodstream infection; NICU, neonatal intensive care unit; GA, gestational age; PICC, percutaneous indwelling central catheter; UA, umbilical artery; TPN, total parenteral nutrition; IV, intravenous; VLW, very-low-birth weight.
The reconfirmation of this hypothesis came in the second quarter of 2009, when we experienced a cluster of sepsis in one infant with a surgically placed catheter. We discovered that this case was related to a breakdown of our established process for TPN preparation for bedside use—namely, the cycling of TPN fluid. After we understood the reason for this intervention, which was only rarely used in our unit, we definitively stopped its use.

Our deconstruction of events leading to the PICC line CR BSI in April 2010 (Table 2) revealed that the infection occurred two days after a surgical procedure on the infant. Our hub scrub protocol (alcohol scrub for 5 seconds/12 strokes) was not being followed in the operating room by anesthesiology staff for medications given during surgery, as we learned from our nursing staff. Our investigation of the surgically placed line sepsis that occurred in May 2010 (Table 2) revealed that protocols for surgically placed central lines were generally driven by the surgical team and were different than our NICU’s central line-placement procedure. The practice for surgically placed lines allowed for a break in the line, frequently near an ostomy site for infants who had surgical intervention. This led to a change in practice, allowing an extension set to be placed at the time of surgical line placement in the operating room. The advantages are twofold, in that the break in the line for tubing change is no longer near a potentially contaminated area and the NICU thereby has consistency of care in all types of central lines. This infection also led to a staff nurse’s recognition that our surgically placed line protocol needed updating to meet current infusion standards.

**Discussion**

As many as 42% of VLBW infants develop nosocomial sepsis, and there is significant inter-institutional variation in the incidence of this serious morbidity. Decreasing the incidence of nosocomial sepsis in NICUs is therefore a priority focus of many QI efforts. We used evidence-based best practices at the onset of our QI project and reduced our CR BSI rates by about 60%. At that point we suspected that using best practices was an incomplete strategy for eliminating all CR BSIs. On the basis of this realization, we undertook a journey to determine what factors were contributing to our CR BSIs despite our adherence to best practices. The cultural aspects of this journey, as we learned from the VON “Your Ideal NICU” collaborative, included, as stated, the implementation of principles that define high-performing clinical microsystems—with an emphasis on process and systems improvement, creating ideal processes for work, developing a learning culture in the context of clinical work, involving people who do the work, adding standardization to PDSA cycles after a goal is achieved, using information to support clinical work, working across hospital boundaries, using the concept of the “web of causation” to understand contributors to sepsis, and employing the concept of “stopping the line” if something is not right. Applying these principles was critical in achieving a level of performance that many might consider impossible in the NICU setting—the ability to potentially eliminate CR BSIs. The reasons for modest gains in published studies on improvement efforts to decrease CR BSIs in the NICU setting are unclear but may reflect the fact that best practices have not been clearly defined in the NICU setting.

The practices that had the greatest impact in helping us approach our goal of eliminating CR BSIs were (1) obtaining two peripheral blood cultures from different sites when undertaking a sepsis evaluation, (2) changing our process for how intravenous (IV) fluids and TPN were primed for bedside use, (3) determining the role that different types of central lines

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**Figure 1.** CR BSIs began to decrease in 2004, and the improvement was statistically significant. Although there was considerable variation in rates from quarter (Q) to quarter, CR BSI rates for 2004 and 2005 showed an annualized decrease of about 60%—without subsequent additional gains. IV, intravenous; UCL, upper control limit; X, mean.
were playing in contributing to CR BSIs in our NICU setting, and (4) deconstructing the events leading to each case of sepsis. The investigation of our two cases of CR BSI that occurred since the first quarter of 2008 indicate that in the process of attempting to eliminate all CR BSI new potentially best practices may be uncovered. It is important to recognize that there may be additional or other practices that might prevent another unit from achieving similar results. This is especially true given that bedside nursing practices may vary widely between units. Therefore, we believe that a key element for success is the development of a culture in which each case of CR BSI provides an opportunity for learning in the context of the unit’s practices. Supporting clinical practice with a rich information environment, a key concept in clinical Microsystems work, provides the foundation of this learning culture. The fact that we were able to deconstruct the two post-2008 CR BSI cases to determine a potential reason for the associated bloodstream infections leads us to believe that CR BSI can be eliminated in the NICU setting. The fact that those cases originated outside the NICU emphasizes the importance of looking at practices beyond the boundaries of a clinical microsystem—in this case, the NICU—and even the hospital itself for possible causes of CR BSI and for subsequent solutions.

Our approach of taking a critical nondirect patient-related task (preparation of TPN fluids for the bedside) away from bedside nurses offers an alternative approach to maintaining quality control in a busy unit. Such a model has the potential to disassociate the correlation between inadequate staffing and bloodstream infections. Our experience also suggests that such focused teams learn and improve their processes rapidly. This approach also has the advantage of decreasing variation in a critical process by limiting the number of staff involved and is consistent with the understanding that elimination of variation is a fundamental principle of industrial quality control.

Although widely used in business and industry, it is uncommonly practiced in the health care environment.

There are several shortcomings of this study. First, because it is not a randomized control trial, we cannot conclude that our interventions resulted in improvement. Nevertheless, the use of statistical process control methodology indicated two periods of special cause variation that imply that a systematic change occurred. Second, although we emphasized certain interventions that we felt were critical to achieving success, as indicated in Table 1, other interventions were also implemented. It is difficult to gauge the impact of all the PBPs listed because of uncontrolled elements inherent in clinical care.

Conclusions

Although the results do not guarantee that CR BSIs can be totally eliminated in the NICU setting, they do suggest that this goal is feasible. Our experience should provide momentum for an alternative mental model to the notion that infants in the NICU, especially those that are less than 1,500 grams birth-weight, are destined to develop CR BSI during their hospital stay. The authors thank Marjorie Godfrey, M.S., R.N., and Jeffrey Horbar, M.D., for their leadership and mentoring role in teaching the authors the concepts used in this study and for their guidance.

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References

Biol Neonate


Timeliness and Efficiency

Using Real-Time Demand Capacity Management to Improve Hospitalwide Patient Flow


In 2004, The Joint Commission issued its first accreditation standards—effective January 1, 2005—for managing patient flow.1

The current Leadership Standard, LD.04.03.11, states, “The hospital manages the flow of patients throughout the hospital.”2

When first issued, the standard served as a call to action for hospitals to focus more formally on patient flow issues. Yet, many hospitals still lack the processes and structures to admit or transfer patients to an inpatient bed on a timely basis. This often results in emergency department (ED) overcrowding,3–5 because the beds are being used by patients waiting to be admitted. Such overcrowding has been shown to have an adverse effect on patient outcomes and the well-being of health care workers.6–8

To address the Joint Commission standard, many hospitals established flow committees to identify the major barriers to patient flow and then embarked on improvement projects focused on these barriers. In our observations, three issues affecting the results from this approach have surfaced, as follows:

1. The improvement projects selected are often not connected to the true bottlenecks identified at the time that problems with patient flow occur.9

2. The changes that result from the projects may optimize only part of the system but may not optimize flow throughout the hospital.10

3. Few hospitals have the resources or the capability to work on the numerous proposed projects.11

Given those issues, in 2006 the Institute for Healthcare Improvement (IHI), in the context of its Improving Hospitalwide Patient Flow Community began developing a method to improve hospitalwide patient flow on the basis of a more...
focused approach to matching patient demand to hospital capacity. This community brought together multiple hospitals with the common aim to improve patient flow as called for in the Joint Commission standard. Matching capacity and demand is not a new idea. A structured approach to this concept had been applied extensively in industry.12,13 The key question was whether a more structured approach to matching capacity to demand could assist hospitals in improving patient flow. The structured approach described in this article is referred to as real-time demand capacity management (RTDC), as represented by the experience of the University of Pittsburgh Medical Center (UPMC) at Shadyside, which was a participant in IHI’s Patient Flow Community (which ended in 2009). UPMC Shadyside, as the first pilot site, began testing and implementing RTDC in early 2007.

**Initial Patient Flow Efforts at UPMC Shadyside**

UPMC consists of 18 hospitals, most of which are located in Western Pennsylvania. UPMC Shadyside is a 526-bed tertiary care hospital with 70 ICU beds and 20 separate units. Approximately 50% of admissions come through the ED. UPMC Shadyside is an academic teaching hospital with a case mix index (CMI) that approaches 2.0.

UPMC Shadyside identified improved patient flow as one of its strategic goals in 2002. A patient flow improvement team was formed to manage patient flow projects. From 2002 to 2006, the team developed a red-yellow-green system to identify units in trouble. The system called for patients to be held in the ED or the postanesthesia care unit (PACU) rather than being admitted to “red” units. Although the system benefitted the red units, it worsened problems elsewhere. Other projects focused on bed turnaround time, ED length of stay (LOS), and efficiencies in surgery. Work on ED LOS centered on the front-end processes of improving “door to doc” time. Although the efforts helped to improve that segment of the ED LOS, it did not improve overall ED LOS because there was no focus on creating the capacity in the hospital for the patients requiring admissions. In surgery, attempts were made to smooth admissions from elective surgery throughout the week. Despite convincing evidence that the elective surgical schedule created bottlenecks at various times, the team was unable to gain the support necessary to alter the surgeons’ schedules. Other surgical initiatives resulted in improvements in first-case start times but had a minimal effect on hospital flow. UPMC Shadyside was still overwhelmed from 3:00 P.M. to 8:00 P.M., and key hospital patient flow measures did not show any improvement.

In 2006 a strategic flow oversight committee, which is chaired by the chief operating officer and includes vice presidents and department heads, created the flow improvement team, which signaled a new beginning to improving hospital-wide patient flow. In a change from the makeup of past improvement teams, middle managers and frontline staff from the inpatient units formed the core of the team. The senior administrative director for ancillary services and capacity management [D.K.] has served as facilitator of the team, which has continued to report regularly to the strategic flow oversight committee on progress toward hospital flow goals.

**Implementing Real-Time Demand Capacity Management**

UPMC Shadyside joined the IHI Patient Flow Community in 2006 and became a pilot hospital for the development of RTDC. The four steps of RTDC are depicted in Figure 1 (above). Standard processes for these four steps and standard structures for unit bed huddles and the hospital bed meetings were needed.

Before making any changes, the UPMC Shadyside flow team observed the daily hospitalwide bed meeting to better understand the current way in which way patients were assigned to beds. The observations revealed several opportunities for improvement, including the following key ones:

1. The bed meeting usually ended without a specific plan to accommodate patient demand that day.
2. What one unit called a discharge or an available bed was not necessarily the same as that of another unit.

A foundational element of RTDC is the need for agreed-on definitions so that all units convey their bed needs in a standard
format. At UPMC Shadyside, the following definitions were established:

- **An available bed** was defined as one that was cleaned, staffed, and ready to accept a patient.
- **A discharge** was defined as a patient who had left a bed and would not return.
- **Capacity** was defined as discharges plus available beds.
- **An admission** was defined as a patient who had been physically placed in a bed.

Selecting pilot units to test RTDC is an important initial step. Because Shadyside’s neurosurgery (NS) service line had consistent problems with bed capacity, the flow team determined that the NS ICU and stepdown unit would be good places to begin testing RTDC. The flow team met with the leadership and frontline staff of these units. The units agreed that proactively planning for discharges would make a big difference in their evening work load, and they agreed to begin testing the four RTDC steps in January 2007.

**STEP 1. PREDICTING CAPACITY**

**NSU and Stepdown Unit.** The first tests of RTDC should be focused on developing a process to predict capacity. On the NS ICU and the stepdown unit at UPMC Shadyside, the process to be tested consisted of case management’s development of a list of patients who were potential discharges for the next day. Initially, the list was simply written on a piece of paper and posted at the nurses’ station. The evening and night-shift nurses updated it on the basis of new knowledge from late-rounding physicians or a patient’s changing medical condition. The goal was to have an accurate list of potential discharges by 7:00 A.M. This initial test presented a few challenges. Discharge lists already existed in some units. The existing lists took on a variety of forms that could be found in various places. Therefore, a standardized template for the discharge list was developed and agreement was reached on a standard location. A second challenge was to have the care managers predict discharges on the basis of their knowledge of what would happen versus what should happen. Feedback to the case managers on the accuracy of their predictions helped overcome this challenge.

To further develop the process of predicting discharges, the NS ICU and the stepdown unit each tested an early morning huddle (8:00 A.M.) to review the list of potential discharges. The objective of this unit huddle was to have the unit care team realistically decide how many of the patients could be discharged on that day—including how many by 2:00 P.M. The flow team hypothesized that if the capacity and demand could be better matched within the 8:00 A.M.-to-2:00 P.M. time frame, then the overcrowding typically seen in the late afternoon and evening would be eased.

The unit huddle was initially attended by the unit manager, care manager, unit secretary, and the staff nurses. Following some testing, it was decided that staff nurses would attend only when one of their patients was being discussed. Best practices for unit bed huddles were developed by observing key units. It was then required that all unit huddles be attended, at a minimum, by the charge registered nurse (RN), care manager, social worker, and staff RN. The huddles were to be held in a public area versus a conference room with participants standing, not sitting. Each potential discharge was to be discussed with an actionable item identified to complete the discharge. The huddle lasts approximately 10 minutes.

During the initial testing phase, the existing 8:30 A.M. hospital-wide bed meeting at UPMC Shadyside continued to occur each day. Immediately following this meeting, the unit managers from the NS ICU and the stepdown unit, the bed coordinator, and the flow team met to test a “new” version of the bed meeting. For this new version, the unit managers of the test units reported only their capacity (available beds and discharges). The results of the previous day’s predictions were also reviewed. The accuracy of predictions—calculated on the basis of whether specific patients predicted to be discharged were actually discharged by 2:00 P.M.—was a key measure in the early stages of testing the process of predicting discharges. The goal was to attain about 80% success. An important lesson learned from reviewing the results of the previous day’s predictions was that the units needed to identify the specific patients who were the potential discharges. Those patients could then be “connected” to the specific actions required to successfully achieve the discharge.

It was also important that someone be assigned the responsibility for those actions. Figure 2 (page 220) shows the discharge worksheet developed to document the actions needed to discharge each patient. A sample unit-level RTDC recording form is shown in Figure 3a (page 221).

**Spread to Other Units.** The process of predicting capacity was spread to other units at UPMC Shadyside in late January 2007. Groups of units were brought on in approximately one-week intervals—surgical/procedural units first and the medicine units in the last group. By late February 2007, all units were predicting their capacity daily. A process for predicting discharges was provided to the unit managers on the basis of the work achieved by the NS ICU and the stepdown unit. The process was as follows:
Case management develops a potential discharge list for the next day.

- Evening- and night-shift nurses update the potential list on the basis of new knowledge.
- Units hold daily unit-based huddles.

Most of the units rapidly reached 80% accuracy in their discharge predictions. For those units that did not, the flow team heightened the focus on implementing the standard process and on learning from predictions. Tips for predicting discharges are shown in Sidebar 1 (right).

**STEP 2. PREDICTING DEMAND**

The objective of Step 2 is to reach 80% accuracy in predicting admissions by unit. To accomplish this, all sources of potential demand (admissions) need to be reviewed. At UPMC Shadyside, unit managers of the NS ICU and the step-down unit made calls to the ED and to the admissions department to determine if there were any current patients awaiting admission to their units. The operating room (OR) schedule was reviewed, as were potential transfers. A prediction was then made regarding the number of admissions to their units before 2:00 P.M. The admission information was entered on the unit-level RTDC recording form. As shown in Figure 3b (page 221), the sample unit predicted seven admissions before 2:00 P.M.

The NS ICU and the stepdown unit gathered the information they needed for the hospitalwide bed meeting. During testing, however, these units reviewed the information together in the “new” bed meeting that took place after the existing meeting. As with predicted capacity, once the flow team, the NS ICU, and the stepdown unit were satisfied with the process for predicting demand, the flow team started spreading Step 2 to other units in late February 2007, with a date for conversion to the “new” hospitalwide bed meeting using RTDC set for mid-March 2007.

Tips for predicting demand are shown in Sidebar 2 (right).

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**Sidebar 1. Tips for Step 1: Predicting Capacity**

1. From experience, the best units to select for initial testing in order of preference are (i) connected units (for example, ICU and step-down or PACU and a surgical floor), (ii) service lines (all the medical units, for example), or (iii) a willing unit. The goal should be for all units in the hospital to be predicting discharges within four weeks.
2. The prediction should be a single number, rather than a range, of how many patients will be discharged each day by 2:00 P.M.
3. Each predicted discharge should be connected to any action needed to accomplish the discharge within the time frame.

* PACU, postanesthesia care unit.

**Sidebar 2. Tips for Step 2: Predicting Demand**

1. Consider known admissions first, such as patients already in the ED or PACU, patients on the surgery schedule, or patients scheduled for a direct admit or an internal transfer. Historical data on admissions can be used to refine the prediction.
2. The ED is a primary source of admissions for all other units. This requires the ED to be involved with the predictions.
3. Multiple like units, such as medical units, will need to accommodate patient admissions in an equitable and clearly defined way.

* ED, emergency department; PACU, postanesthesia care unit.

**STEP 3. DEVELOPING A PLAN**

After processes are established to predict both capacity and demand, units can assess their status. If predicted demand in the 8:00 A.M.-to-2:00 P.M. time frame is greater than predicted capacity, a plan to achieve a match is needed. During testing at UPMC Shadyside, it was determined that ownership by the units was stronger when a detailed plan was written down. For example, the statement “The case manager will try to get one more discharge” did not constitute an acceptable plan. The
“who,” “what,” “where,” and “by when” needed to be included. It also became apparent that two sources for plans—at the unit and system levels—needed to be considered. Any resource shared (for example, laboratory and x-ray) by units in the hospital was considered to be a system-level resource. If a unit manager was unable to develop a plan to match capacity and demand using the unit’s own resources, the nursing supervisor was to decide which system-level resources to deploy. Examples of unit- and system-level plans are shown in Table 1 (page 222).

In the sample RTDC recording form shown in Figure 3c (above), demand was predicted to exceed capacity on the unit. Because the unit was not able to devise a plan, a system-level plan was needed: The plan was to transfer one off-service patient to another unit by 10:00 A.M. The units involved then needed to develop the details for executing this plan—who will do what, by when, for which patient to accomplish the transfer. During testing, it was learned that for plans to be successful, specific time needed to be set aside after the bed meeting for staff on the units to discuss the details. Tips for developing a plan are shown in Sidebar 3 (right).

From the initial selection of test units in early January 2007, Steps 1 to 3 of RTDC were spread throughout the hospital in approximately 10 weeks. At this point, the “traditional” hospitalwide bed meeting was replaced with the “new” bed meeting.

**Sidebar 3. Tips for Step 3: Developing a Plan**

1. The predictions of demand and capacity by unit and the plan, if needed, should be displayed at the hospitalwide bed meeting for all to see.
2. If a plan is needed, a unit should consider first what actions (plan) it can take at the unit level. Actions will be specific to a given patient (e.g., patient needs a ride or a prescription written) and will take personal involvement from frontline staff to execute.
3. If a unit is unable to develop a plan, system-level actions (e.g., hospitalists to expedite the discharge of patients from certain units) need to be considered. Deployment of shared resources can be decided at the hospital bed meeting.
4. The objective of a hospital bed meeting should be to identify the units that need plans, discuss those plans, and decide whether system-level actions are necessary.
5. Focus initially on developing a plan for a specific time period (e.g., 8:00 A.M. to 2:00 P.M.). Finer synchronization of capacity to demand can then be considered (e.g., a bed is needed at 10:30 A.M. for an early surgical patient). RTDC Steps 1, 2, and 3 can be tested simultaneously without a need to achieve a defined level of accuracy in one step before moving to the next.

**STEP 4. EVALUATING THE PLAN**

A key component of RTDC is the evaluation of and feedback on the actions taken. At UPMC Shadyside, after RTDC
Steps 1 to 3 were spread housewide by late March 2007, the flow team turned its focus to testing and standardizing the process for Step 4. Although feedback on the success of predictions and plans was given to units during testing, formalization of this process was needed across all units. To start, units were requested to review any plan they developed the previous day. Each unit was to ask the same question, “Did what we plan to happen really happen?” The success or failure of the plan was to be documented in the final column of the unit-level RTDC recording form. The number of units consistently reviewing their plans and documenting whether they were successful increased rapidly. This increase was fueled by a test to review the success or failure of plans from the previous day at the beginning of the hospital bed meeting. This review became part of the process for evaluating plans.

After most of the units were consistently evaluating their plans, the flow team focused on having the units determine why a plan failed. Tests were run to incorporate a more detailed discussion on the plan from the previous day into the unit bed huddle. Unit staff quickly realized that making the actions in the plans more specific made it easier to determine why the plan failed—as seen, for example, in changing “Arrange for a physical therapy session for patient X” to “John will call physical therapy by 9:00 a.m. to arrange for a physical therapy session by noon for patient X.”

Besides using the information from evaluations to improve predictions and plans, the UPMC Shadyside flow team also used the evaluations of plans and predictions to identify barriers to patient flow. These barriers then became the focus of improvement projects. Sample barriers and the subsequent process changes are shown in Table 2 (page 223). Once the barriers surfaced, the changes needed could often be implemented quickly.

Tips for evaluating the plan are shown in Sidebar 4 (above).

**Sidebar 4. Tips for Step 4: Evaluating the Plan**

1. Evaluate the plan on the basis of the actions documented at the hospital bed meeting. Do not evaluate the plan based on the success of matching demand and capacity throughout the time interval, which might also be affected by poor predictions.
2. Focus improvement efforts only on barriers found to be common occurrences. Working on a barrier that is seldom observed would be a waste of resources and would not substantially contribute to improving patient flow.

**Evaluating Real-Time Demand Capacity Management**

**OUTCOME MEASURES**

To determine the impact of RTDC on patient flow at UPMC Shadyside, the flow team gathered data on the measures shown in Table 3 (page 224). At the unit level, data on the reliability of predictions and on measures of flow between units (that is, number of patients held overnight in the PACU, cardiothoracic [CT] ICU to 3 Main transfer time) were collected and shared on a daily, weekly, and monthly basis. Hospitalwide measures (for example, percentage of patients leaving [ED] without being seen, ED median LOS for admitted patients, and aggregate length of stay [ALOS]) were reported monthly and reviewed by the strategic flow oversight committee and the flow team to evaluate overall progress.

---

<table>
<thead>
<tr>
<th>Table 1. Examples of Unit- and System-Level Issues and Action Plans*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit Level</strong></td>
</tr>
<tr>
<td>Issue Needing Resolution</td>
</tr>
<tr>
<td>Unwritten discharge on a surgical unit</td>
</tr>
<tr>
<td>Have bed, but no telemetry monitor</td>
</tr>
<tr>
<td>Discharge completed, need ambulance transportation earlier than scheduled</td>
</tr>
</tbody>
</table>

| System Level | **Action** |
|---------------------------------------------------------------|
| Issue Needing Resolution | Action |
| Unit will not fit their specialty | Nursing supervisor identifies a unit where the needed number of off-service patients can be moved. |
| Need two additional discharges early | Nursing supervisor contacts hospitalist to round on that unit first. |
| Unit in need of additional resources to complete multiple early discharges needed | Nursing supervisor allocates SWAT RN to that unit for a specific time period. |

* RN, registered nurse.
ANALYTIC METHODS

The flow team used time-series designs to analyze the data for the outcome measures. Data were plotted over time on run charts. Patterns in the data were observed to determine the impact of interventions on the outcome measures. Observing the data over time also allowed the team to monitor whether improvement in the outcome measures was sustained.

RESULTS

Improvements were achieved and have been sustained through early 2011 for all measures.

Unit-Based Reliability of Discharge Predictions. As stated, the process of predicting discharges was introduced in the NS ICU and its stepdown unit at UPMC Shadyside in January 2007. As shown in Figure 4 (page 225), the reliability of the predictions started at approximately 50% in these units and increased quickly. The prediction of discharges was spread to other units in late January 2007. Starting in March 2007, the data in Figure 4 represented the accuracy of predictions for all units. By July 2007, the reliability of predicting discharges reached 80% throughout the hospital. In January 2009, the goal was increased to 85%, a level at which performance was maintained through 2009, which led to the decision to discontinue formal aggregation and reporting of data on the measure. Missed predictions, however, were still reviewed for learned opportunities.

Holds in the PACU and the Transfer Time from the CT ICU to 3 Main. Indicators of delays in flow between units were monitored. Data for two such measures are shown in Figure 5 (page 225) and Figure 6 (page 225). Overnight holds in the PACU were occurring on the average of once a week through March 2007. Two months after RTDC work started, this problem was eliminated. Because of the success of the NS ICU and its stepdown unit, the CT ICU and 3 Main became early adopters of RTDC. The transfer time between these units was > 100 minutes before March 2007 (Figure 6), which was reduced to < 80 minutes by April 2007 and to < 70 minutes by January 2009.

Percentage of Patients Who Left Without Being Seen in the ED. Because overcrowding in the ED was a priority for UPMC Shadyside, the percentage of patients who left without being seen (LWBS) was monitored. A goal of < 1% for LWBS was established in 2007. As shown in Figure 7 (page 226), LWBS was routinely < 0.5% by May 2008.

ED Median LOS for Admitted Patients. A goal of four hours was established for the median LOS in the ED for admitted patients. After improvement work was undertaken in the ED before the implementation of RTDC, the median LOS decreased to approximately 4.5 hours at the end of 2006, as shown in Figure 8 (page 226). With the implementation of RTDC, the median LOS was routinely < 4 hours after March 2008.

ALOS. As shown in Figure 9 (page 227), the upward trend in ALOS began to reverse, starting in 2007. Since then, the ALOS has generally been maintained at < 5.75 days. There is a need, though, to continue to focus on times of high census and higher than normal CMI to maintain the budgeted ALOS, which was reduced to 5.75 in July 2008.

Discussion

Reports of the design of systems to better match capacity to demand in health care settings are emerging. Some hospitals have focused on reducing the variation in patient demand by making the status of the hospital visible to admitting physicians or by thoughtful scheduling of elective surgeries. These load-leveling techniques are useful but not sufficient because they do not include the actions needed to efficiently manage the transition of patients each day. Nor are these tech-

Table 2. Sample Barriers and Process Changes

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Process Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dialysis patients who were potential discharges often had afternoon treatment times scheduled and could not be included in the before-2:00 P.M. discharge predictions.</td>
<td>The dialysis unit created treatment slots in the morning to be used for patients requiring treatment on their day of discharge.</td>
</tr>
<tr>
<td>Discharges were routinely delayed because of the need for magnetic resonance imaging that could be done on an outpatient basis.</td>
<td>Outpatient scheduling was adjusted to ensure one add-on per day, thus ensuring that a patient could receive an appointment within four days of discharge.</td>
</tr>
<tr>
<td>Delays in getting postoperative craniotomies delayed patients being discharged from the neurosurgery ICU.</td>
<td>All postoperative computed tomography scans for craniotomies were scheduled for 5:00 A.M. on postoperative day 1.</td>
</tr>
</tbody>
</table>

* Figures 4–9 are also available in online article.
techniques designed to identify the key barriers to patient flow. Other approaches to match capacity to demand have included development of color-coded indicators (usually from green to red) that signal the ability of each unit in the hospital to accept additional patients.19 The status of each unit is then linked to actions to correct any mismatches in capacity and demand. Nor do green-yellow-red systems routinely include an evaluation of whether the actions occurred, so that the effect on patient flow usually remains unknown. As described earlier, UPMC Shadyside tried a similar intervention with a lack of success.

Overall, the various redesign systems that depend on making unit status visible are often reactive, in which actions are signaled only after patient flow in the hospital is severely stressed. They also usually contain a generic list of actions focused on all areas of the hospital. In contrast, RTDC calls for development of a proactive plan focused on the specific actions needed to create sufficient capacity that day. Lessons from traffic flow indicate that improving the matching of capacity and demand for a few patients earlier in the day will relieve congestion later.20

One of the authors [R.R.] had earlier attempted to improve patient flow with the prediction of demand and capacity for individual inpatient care units31—an approach that acknowledged the importance of involving frontline staff. If the staff of a unit predicted that their demand would be greater than their capacity, the unit was able to limit new admissions. RTDC builds on this work by including formal steps at the unit level, and, when needed, the system level, to develop a specific plan to match demand rather than limit admissions. RTDC also adds an evaluation step so that the prediction and planning process can be improved and barriers to patient flow identified.

Implementation of RTDC has also been described by Northwest Community Hospital (NCH; Arlington Heights, Illinois).19 NCH, which joined the IHI Patient Flow Community in 2008, reported three other elements that are also useful for optimizing patient flow: a bed management process, long-range forecasting and planning, and an early warning and response system (termed its peak census policy). To optimize patient flow, an effective bed management process is needed so that the patients can be efficiently transferred within the hospital when available beds are identified. Long-range forecasting and planning can inform the establishment of staffing levels on the basis of predicted demand. Predictions of demand would take into account previous day-to-day, month-

Table 3. Measures of Hospital Patient Flow*  

<table>
<thead>
<tr>
<th>Measure</th>
<th>Definition</th>
<th>Source</th>
<th>Pre–RTDC Performance Level</th>
<th>Post–RTDC Performance Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Overall Monthly Unit-Based Reliability of Discharge Predictions</td>
<td>(Total number of discharges predicted at the hospital bed meeting / total actual discharges for the day) X 100</td>
<td>Unit-Level RTDC Recording Form and the electronic bed tracking system</td>
<td>&lt; 60%</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>2. Monthly Number of Patients Held Overnight in the PACU</td>
<td>Number of NS ICU patients remaining in the PACU at 6:00 A.M. who met criteria for discharge before 2:00 A.M.</td>
<td>PACU Daily Report</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>3. Cardiothoracic ICU to 3 Main Transfer Time</td>
<td>Average time from bed assigned to bed occupied for patients transferring from CT ICU to 3 Main</td>
<td>Electronic bed tracking system</td>
<td>110 minutes</td>
<td>&lt; 70 minutes</td>
</tr>
<tr>
<td>4. Percent of Patients Who Left Without Being Seen (LWBS) in the ED</td>
<td>(Number of patients who left the ED without treatment after registration / total ED visits for the time period) X 100</td>
<td>ED Tracking System</td>
<td>1.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td>5. ED Median LOS for Admitted Patients</td>
<td>Median time for all admitted ED patients from arrival (registration) to departure (leave ED for inpatient bed)</td>
<td>ED Tracking System</td>
<td>&gt; 5 hours</td>
<td>&lt; 4 hours</td>
</tr>
<tr>
<td>6. Aggregate Hospital LOS</td>
<td>Total inpatient days / monthly total admissions</td>
<td>Admission Discharge Transfer (ADT) System</td>
<td>Approaching 6 days</td>
<td>&lt; 5.75 days</td>
</tr>
</tbody>
</table>

* RTDC, real-time demand capacity management; PACU, postanesthesia care unit; NS, neurosurgery; CT, cardiothoracic; ED, emergency department; LOS, length of stay.
to-month, and seasonal variation. RTDC can then assist in making the adjustments needed on a daily basis as actual demand varies from historical trends.

With regard to NCH’s peak census policy, many other hospitals have similar high-census alerts, known by such terms as \textit{code red} or \textit{code purple}. At UPMC Shadyside, large fluctuations in demand (Step 1) or capacity (Step 2) are predicted and planned for (Step 3), and actions are evaluated (Step 4) as part of RTDC, but UPMC Shadyside does not use separate processes for times of high census. Two other issues distinguish RTDC as practiced at NCH and UPMC Shadyside. First, NCH uses a formula for predicting discharges (for example, predicted discharges = 80% of confirmed discharges [that is, orders written] plus 50% of potential discharges). However, we believe that after gaining some experience in implementing RTDC, hospitals should move to the method used at UPMC Shadyside, where, as stated, predicting the number of discharges is based on what needs to be accomplished to discharge a specific patient on that day and whether that can be accomplished by 2:00 P.M. Second, at UPMC Shadyside, as described earlier, but not at NCH, evaluation of plans (Step 4) is performed separately from the evaluation of predictions (Steps 1 and 2). That is, plans to match capacity to demand are evaluated on the basis of whether the actions to discharge specific patients by 2:00 P.M. on that day actually occurred. If the plan was accomplished but capacity did not match demand by then, then a prediction problem exists that can be studied.

RTDC improves on other approaches for patient flow because it assists in creating \textit{resilience} in a hospital. (Resilience represents the ability to anticipate system breakdown and deal with it proactively rather than reactively.) RTDC promotes the improvement in the ability to anticipate capacity and demand for a fairly short time horizon, which is accomplished by systematically having people make predictions and plans and by then giving feedback. Predictions are based on what is likely to happen

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure4.png}
\caption{Monthly Accuracy of Discharge Predictions, January 2007–November 2009}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure5.png}
\caption{Number of Patients Overnight in the Postanesthesia Care Unit (PACU), January 2006–March 2010}
\end{figure}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure6.png}
\caption{Cardiothoracic (CT) ICU to 3 Main Transfer Time, January 2006–September 2010}
\end{figure}
rather than what should happen. The near-real-time observability for many players as to these predictions is also centrally important. RTDC also assists in creating resilience by allowing hospitals to decide when to relax production pressure to reduce risk. In contrast, the commonly used “out by 10” (A.M.) strategy, for example, maximizes production pressure whether the beds are needed or not on a given unit. The operating rule and the essence of RTDC is the “right number of patients transitioned at the right time.”

As stated, RTDC is based on creating standard processes and structures, and organizations will most likely see gains weaken over time if they do not adhere to them. It is also important that someone be designated to lead and organize the work day to day. At UPMC Shadyside, this person [D.K.] has helped to implement RTDC in other hospitals in the UPMC system.

Conclusions
On the basis of the results shown at UPMC Shadyside, RTDC represents a promising approach to improving hospitalwide patient flow. Hospitals will find in implementing and sustaining RTDC that the four steps are integrated into current bed management processes and are not an add-on to the work needing to be accomplished everyday.

The authors acknowledge the conceptual contributions of their colleagues Diane Jacobsen and Marilyn Rudolph to this work. They also acknowledge the numerous organizations in the Institute for Healthcare Improvement (IHI) Community on Improving Flow through Acute Care Settings for their willingness to test and contribute to the development of the approach described in this article.

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Online-Only Content
See the online version of this article for color versions of the following:
Figure 4. Monthly Accuracy of Discharge Predictions, January 2007–November 2009
Figure 5. Number of Patients Overnight in the Postanesthesia Care Unit (PACU), January 2006–March 2010
Figure 6. Cardiothoracic (CT) ICU to 3 Main Transfer Time, January 2006–September 2010
Figure 7. Percentage of Patients Who Left Without Being Seen (LWBS), January 2006–September 2010
Figure 8. Emergency Department (ED) Median Length of Stay (LOS) for Admitted Patients, July 2005–July 2010
Figure 9. Aggregate Length of Stay (ALOS), July 2004–August 2010
Aggregate Length of Stay (ALOS), July 2004–August 2010

Figure 9. The upward trend in ALOS began to reverse, starting in 2007, and has generally been maintained at < 5.75 days.

References

Monthly Accuracy of Discharge Predictions, January 2007–November 2009

Figure 4. Data shown represent all units, except for January 2007, for which the data represent only the neurosurgery intensive care and step-down units. In January 2009, the goal was increased to 85%, a level at which performance was maintained throughout 2009.

Number of Patients Overnight in the Postanesthesia Care Unit (PACU), January 2006–March 2010

Figure 5. Overnight holds in the PACU were occurring at an average of once per week through March 2007, but this problem was eliminated two months after work on real-time demand capacity management began.
Cardiothoracic (CT) ICU to 3 Main Transfer Time, January 2006–September 2010

Figure 6. The transfer time between the CT ICU and 3 Main of > 100 minutes before March 2007 which was reduced to < 80 minutes by April 2007 and to < 70 minutes by January 2009.

Percentage of Patients Who Left Without Being Seen (LWBS), January 2006–September 2010

Figure 7. A goal of < 1% for LWBS was established in 2007, and by May 2008, LWBS was routinely < 0.5%.
Figure 8. With the implementation of real-time demand capacity management, the median LOS was approximately 4.5 hours at the end of 2006 and was routinely < 4 hours after March 2008.

Figure 9. The upward trend in ALOS began to reverse, starting in 2007, and has generally been maintained at < 5.75 days.
Innovation

ProvenCare Perinatal: A Model for Delivering Evidence/Guideline-Based Care for Perinatal Populations


News stories and articles in peer-reviewed journals which highlight the shortcomings of the United States health care system are common. For example, studies have shown that patients receive half of the evidence-based care that they should.1 For children the deficit is even worse.2 Furthermore, evidence of unwarranted variation in care delivery in different communities, states, and regions is well documented,3–5 and the care provided results in adverse outcomes at alarming rates.6 So the question arises: How do health care professionals effectively change this paradigm? Nolan has argued that achieving change requires intention—in the form of organizational will—to provide safer and more reliable care, new ideas about how this work gets done, and programs that are designed to ensure patients participate in their care.7 In addition, Batalden and Davidoff have proposed that purposeful integration of generalizable scientific evidence into the particular context, informed by “enquiry into the identity of local care settings— their processes, habits and traditions,”8(p. 2) with a focus on measurable outcomes, can lead to an improved change in daily patient care.

In 2005, the executive leadership of Geisinger Health System (GHS) accepted the challenge to demonstrate that a large integrated health care delivery system, enabled by an electronic health record (EHR), could successfully reengineer a complicated clinical process, reduce unwarranted variation, and reliably deliver evidence-based care for patients with a specified clinical condition. Starting with elective coronary artery bypass graft (CABG), we demonstrated that an improvement model that embeds evidence-based medicine into the work flow, applies the principles of reliability science (standardization, error proofing, and failure mode redesign)9,10 to the care redesign process, and engages patients in their care could result in the right care delivered 100% of the time and improve patient outcomes.11,12 The model—ProvenCare®—was next applied to elective total hip replacement and cataract surgery.13 In early 2007 GHS applied the model to the percutaneous

Article-at-a-Glance

Background: Geisinger Health System (GHS) has applied its ProvenCare model to demonstrate that a large integrated health care delivery system, enabled by an electronic health record (EHR), could reengineer a complicated clinical process, reduce unwarranted variation, and provide evidence-based care for patients with a specified clinical condition. In 2007 GHS began to apply the model to a more complicated, longer-term condition of “wellness”—perinatal care.

Adapting ProvenCare to Perinatal Care: The ProvenCare Perinatal initiative was more complex than the five previous ProvenCare endeavors in terms of breadth, scope, and duration. Each of the 22 sites created a process flow map to depict the current, real-time process at each location. The local practice site providers—physicians and mid-level practitioners—reached consensus on 103 unique best practice measures (BPMs), which would be tracked for every patient. These maps were then used to create a single standardized pathway that included the BPMs but also preserved some unique care offerings that reflected the needs of the local context.

Results: A nine-phase methodology, expanded from the previous six-phase model, was implemented on schedule. Pre- to postimplementation improvement occurred for all seven BPMs or BPM bundles that were considered the most clinically relevant, with five statistically significant. In addition, the rate of primary cesarean sections decreased by 32%, and birth trauma remained unchanged as the number of vaginal births increased.

Conclusions: Preliminary experience suggests that integrating evidence/guideline-based best practices into work flows in inpatient and outpatient settings can achieve improvements in daily patient care processes and outcomes.
coronary intervention (PCI), in which multiple microsystems, with different leadership, would need to work together to achieve ProvenCare PCI. We recognized this as a new mesosystem—that is, “an interrelated set of peer microsystems that provide care to certain patient populations or support the care provided to these populations” formed to support the work of several microsystems providing care to a patient population. For each ProvenCare model, a new mesosystem is organized to integrate the care delivery process between contributing microsystems, and a new mesosystem leadership is defined.

In 2007 GHS’s Women’s Health Service Line (WHSL) leadership wondered if the ProvenCare model would be adaptable to more-complicated, longer-term conditions of “wellness,” such as perinatal care? For a pregnancy, when there is an unwarranted variation in care, and the right care is not delivered, the outcome can be devastating for the mother and child. In 2005 the Institute of Healthcare Improvement (IHI), in recognition of the impact of unwarranted variation in care of pregnant women, launched the Idealized Design of Perinatal Care Collaborative to improve care through process redesign and implementation of induction and augmentation bundles of care. The WHSL decided to initiate a ProvenCare Perinatal pathway to provide evidence-based care for the entire gestational and postpartum period, which incorporated the IHI induction and augmentation bundles of care. Unlike the previous ProvenCare programs—known as ProvenCare Acute, with acute and episodic conditions as targets—the perinatal initiative encompassed both inpatient and outpatient care and involved a significantly larger number of practice sites and clinicians. Understanding the local context (Figure 1, right) in a large perinatal care system catalyzed an evolution of the established ProvenCare improvement model. This article describes the development and implementation of an enhanced nine-step ProvenCare methodology for a multisite improvement.

### Changing Daily Patient Care Using the Best Evidence and Science

**Figure 1.** The formula proposed by Batalden and Davidoff (adapted from Batalden PB, Davidoff F: What is “quality improvement” and how can it transform healthcare? Qual Saf Health Care 16:2–3, Feb. 2007), which illustrates the important linked relationship between scientific evidence and the particular (local) context to produce measured performance improvement, depicts the basis for change in the ProvenCare model. The balloons specify issues to be considered in applying the formula to ProvenCare Perinatal.

### Adapting ProvenCare to Perinatal Care

**Setting and Scope**

ProvenCare Perinatal differed from previous GHS initiatives in terms of not only fundamental definition and local context but geography and scope. Unlike acute problems such as hip degeneration (which requires hip replacement) or blocked arteries (which may require CABG surgery), pregnancy is a state of wellness and is typically an exciting time for the woman and her family. Patients are followed in 22 Geisinger obstetrics practice sites—as opposed to 1 or 2 hospital-based clinics for ProvenCare Acute. Some of these sites are high-volume clinics dedicated solely to women’s health, whereas others are low-volume primary care sites with visiting obstetricians. These 22 practice sites span 31 counties, some 200 miles apart east to west. Infants are delivered at two GHS tertiary care centers and two non-GHS community hospitals.

ProvenCare Perinatal incorporates antepartum, intrapartum, and postpartum care; patients have an average of 13 clinic visits during the pregnancy plus an inpatient stay. The breadth and depth of applicable evidence-based medicine and consensus-driven guidelines far exceeded the five previous ProvenCare initiatives. The ProvenCare Perinatal pathway drove changes in our process for establishing staff engagement across the system and in how we used the EHR to support the work.

**Evidence/Guideline-based Medicine**

ProvenCare initiatives rely primarily on evidence-based medicine. However, one of the challenges of this initiative was the scarcity of randomized controlled trial evidence for this patient population. We therefore used a combination of evidence-based medicine promoted through Institute for Clinical Systems Improvement (ICSI) health care guidelines and consensus-driven guidelines promoted through the
American College of Obstetricians and Gynecology (ACOG)\textsuperscript{17} (Appendix 1, available in online article). The local practice-site (microsystem) providers—physicians and mid-level practitioners—used this literature to reach consensus on 103 unique best practice measures (BPMs) generalizable across all 22 sites, with an understanding that these would be tracked for every patient. As many as 300 opportunities to deliver these BPMs exist per patient—if the mother begins her care within the first trimester and continues throughout the postpartum visit. This number of BPMs was significantly greater than that of the CABG initiative (19 BPMs; 40 opportunities).\textsuperscript{9,10} The large number of pregnant patients who come through our system (approximately 4,400 each year), combined with the sheer number of BPMs and multiple visits, drove a change in how we incorporated data fields into the EHR to track performance outcomes. Every BPM had to be built into a structured data field (a discrete field versus free text [such as in a written note]) to enable automated reporting.

**DEVELOPING THE NINE-PHASE MODEL**

The unique context of each site within our perinatal care system, the large number of BPMs, and the willingness to reexamine every aspect of operations to achieve safe and reliable care required an expansion of our ProvenCare Acute model and our project management and communication structure. A side-by-side comparison of the original model and the expanded model is provided in Table 1 (above). Table 2 (page 232) provides a general time line for each of the phases. The nine-phase methodology was implemented on schedule, with the identification of standardized work flows that were instituted across all phases.
Table 2. Implementation Plan for ProvenCare Perinatal*

- Engage champions: Week 0 (October 2007)
- Understand context: Weeks 1–10 (October 2007)
- Compile evidence: Weeks 2–10 (October 2007)
- Establish BPMs: Weeks 11–17 (December 2007)
- Identify barriers to compliance with BPMs: Weeks 18–27 (February 2008)
- Go live beta: Weeks 49–64 (September 2008)

* Starting dates are shown in parentheses. BPM, best practice measure
† Completed March 2009.

the 22 sites.

Phase 1. Engage Champions. The quality improvement (QI) specialists from the GHS division of quality and safety met with the WHSL administrative and executive leaders [including L.A.L., A.A.W., R.A.N.] to discuss roles and expectations of ProvenCare. In addition, a series of administrative meetings was organized to address challenges associated with the larger scope of the project. It became clear that a new management and communication structure needed to be designed (Figure 2, page 233)—which entailed the development of the WHSL microsystem, the ProvenCare meso-team, and the ProvenCare steering team—and that in-depth knowledge of the local context at each practice site was essential.

Phase 2. Understand Context. To understand the context of each practice site, the improvement specialist was sent to map out the process flow (as the visual representation of the work flow) and determine the unique aspects at each clinic—and “put a human face” to the initiative. This phase constituted the first addition to the original ProvenCare Acute phases.

Creating process-flow maps is usually completed in Phase 3 of ProvenCare Acute, but because it was critical to understand the current state of the clinical practice pattern in every setting it was important to get this work started early. The process-flow maps are not a description of the processes as they should happen or how the policy states they will happen but rather what processes actually happen.

Each of the 22 sites created a process-flow map to depict the current, real-time process at each location. At each site, a meeting was held with the frontline staff members who execute the processes daily; only they possess the information needed to develop accurate maps. We then used these process-flow maps to create a single standardized pathway that included the BPMs but also preserved some of the unique care offerings that reflected the needs of the local context. This new standardized pathway would then guide the nurse/provider in completing the BPMs as part of his or her normal work flow, while also allowing providers to offer care specific to their local context.

Addition of specific tests was driven by the patient demographics and provider preference at the unique clinic site.

For example, the flow map for one of the clinics indicated that hepatitis C screening was ordered for every patient. The current guidelines do not recommend that all patients receive hepatitis C screening during pregnancy, so it was not included as a BPM. However, this particular clinic is located in a county where illegal drug use is prevalent and there is a high incidence of hepatitis C. It was important that the order for this test be located within the provider’s work flow for ease of use but not located in the group of tests that are included in the BPMs. As a solution, the GHS information technology (IT) team developed a section of the provider’s navigator that held frequently ordered tests.

Through our understanding of the context of each practice site, we (1) chose one provider to represent clinics in each region (northeast, central, west) as members of the Perinatal ProvenCare steering team and (2) put into place a communication network to help us execute all subsequent phases of the ProvenCare model. An example of how the network deliberated on issues is provided in Sidebar 1 (page 234). All critical decisions were made in this manner, which help ensure high levels of staff engagement, optimize team participation, and create an avenue for consensus.

Phase 3. Compile Evidence. Similar to what was done in the ProvenCare Acute model, the providers in ProvenCare Perinatal were tasked with compiling evidence from various sources (including governing body guidelines, Quality Improvement Organizations, and peer-reviewed articles). Yet unlike the ProvenCare Acute model, in which all physicians participated, only seven perinatal representatives met each week to bring forth evidence for discussion. As part of their role, the seven providers were responsible for requesting, sharing, and discussing literature with their colleagues at each clinic. Regular communication from administrative leadership to all clinics ensured that each representative performed as expected and encouraged every microsystem provider to lend his or her input.

Phase 4. Establish BPMs. A list of BPMs was compiled from the evidence reviewed by the meso-team providers. A draft list for each trimester was disseminated back to the local microsystems for feedback and discussion. Mandatory service-line meetings, led by executive leadership, were held to discuss and reach consensus on the BPMs grouped within each trimester. Approximately three and a half months were required to estab-
Phase 5. Identify Barriers to Compliance with BPMs. Each microsystem team was presented with the standardized process-flow map for its clinic and the list of BPMs. The QI improvement specialist facilitated dialogue to illuminate barriers within the current process to reliably incorporate BPMs. For example, barriers to provide Rh-immune globulin (RhoGAM) to patients with Rh-negative blood existed across all 22 practice sites. The need for RhoGAM occurs within the minority of patients; if missed, the consequences could be dire. This is particularly concerning, given the fact that patients do not always receive appropriate medications—only 62.6% of patients do, according to one study. Although it is a human plasma-derived product, RhoGAM is delivered to the patient through the established medication administration pathway in most health care institutions.

The key barrier to timely administration of RhoGAM was the lack of an accurate tracking mechanism. RhoGAM should be administered at 28 weeks gestation or as close to 28 weeks as possible. We found that patients who attended their 28-week visit received the medication; however, patients who missed this visit and came in at 32 or 34 weeks were at risk because it was not routine for the providers to review RhoGAM status after 28 weeks. As a solution, an electronic mechanism for updating and displaying gestational age in the header bar of the patient record was developed. This functionality and a feed-forward pathway of the patient's blood type enabled an alert to fire at 28 weeks to notify the provider that RhoGAM should be administered. The alert would continue to fire at every visit, from 28 weeks on, until documentation that RhoGAM had been ordered and administered was complete.

This phase constituted the second addition to the original ProvenCare Acute phases. Typically, the identification of barriers to compliance with BPMs is completed as part of the process redesign phase. However, because of the large number of different clinic processes involved in ProvenCare Perinatal, this step needed to be completed before process redesign—and was of sufficient enough magnitude to warrant its own phase. This new phase, then, clarified our pathway for the process redesign.

Phase 6. Process Redesign. The meso-team met weekly to develop work flows that addressed identified barriers. Members of the steering team were always available to address IT questions needing immediate responses in order to create a more robust work-flow proposal for the meso-team's next meeting. This was an iterative process with constant communication within and between the teams.

Every two to four weeks, a draft work flow was offered to all microsystem teams for discussion. These meetings took place through conference calls and real-time interactive Web conferencing technology, in which staff called in from their offices and could view the proposed work flow on their computers. Feedback was brought to the meso-team, which sent the next iterations with the incorporated changes to the microsystem teams for approval. The steering team facilitated rapid feedback and ease of convening while still empowering members of the mesosystem with decision making. The iterative process with dynamic communication between all members of the larger perinatal mesosystem was important to initiative momentum.

For example, for the work flow for gestational age and dating criteria for the initial patient assessment, the literature provided the operational definition of gestational age, and the steering and meso-teams worked with IT to outline the work flow that most efficiently captured this in the EHR. The proposed work flow went to the microsystem teams for vetting.
Phase 7. Develop a Phased Implementation and a Just-in-Time Education Plan. In this phase—the third addition to the original ProvenCare Acute phases—the implementation plan was thoroughly discussed in advance and the order in which sites “went live” with the new work flow was determined, as follows:

- The first pilot site was a small clinic with flexible, engaged staff whose patients delivered at a GHS hospital.
- The second pilot site was one of the largest clinics where patients delivered at a non-GHS community hospital.
- The third pilot was its associated outreach clinic, where obstetricians held clinic once a week.

These 3 sites provided a wide array of situations for the IT team to test the work flows and identify and address as many glitches as possible before we rolled out the work flows to the other 19 sites.

The clinical operations leader [A.A.W] was available for every site during training and implementation. Her role was to partner with on-site IT experts to work through glitches in real time and provide support to the clinical teams. Experts remained on site until implementation issues were resolved. For example, the gestational-age field did not populate in the EHR correctly. This posed a major problem for the new work flow because many of its components (for example, timing of tests, alerts) were driven by gestational age. This issue was communicated from an expert on site to the IT expert at the command post, who resolved it in real time.

After the pilot sites were able to function on their own, implementation to the rest of the clinics occurred at a more rapid pace because a high percentage of the process issues was already resolved. This multiphase, multisite initiative required continued presence of work-flow experts to resolve larger issues early, respond to local nuances as the initiative rolled out across multiple microsystems, and maintain the desired level of standardization across all sites.

Immediately before implementation, the work-flow development experts—that is, the IT experts who constructed the work flow—provided education to staff. Just-in-time training (one to two days before implementation and same-day training) helped keep the lessons fresh in the minds of staff.

Phase 8. Go-Live Beta. After the new work flow was implemented, measurement and quick-time data feedback to the meso-team was important. Providing feedback (at the aggregate, clinic site, and provider levels) demonstrating the impact of the changes helped to maintain engagement. During this phase the team continued to address process breakdowns (for example, in some of the clinics, nutrition counseling alerts were not “firing” appropriately and taking corrective action in real time).

Phase 9. Go-Live Production. In this phase, which is found in all ProvenCare initiatives, Go-Live Production is entered with successful deployment and a completed financial model.

Evaluation

MEASURES

As with all ProvenCare initiatives, all-or-none measurement is both the goal and the expectation. With up to 300 opportunities to provide best practice for each patient, evaluation is a challenging yet highly critical task. Guided by the need for measurable outcomes for “measured performance improvement” (Figure 1), the clinicians on the steering team grouped the 103 BPMs into five clinically relevant bundles. Sample BPMs for the bundles are shown in Table 3 (page 236). The bundles provide a quick reference for process reliability and for evaluating specific clinical outcomes associated with the BPMs. In addition, metrics were developed to do the following:

- Capture the appropriate number of applicable BPMs for each patient on the basis of when she enters or exits the system.
and her clinical condition

- Monitor the compliance in executing the BPMs (and/or process steps) and reporting at the aggregate, clinic, and individual provider levels

**SAMPLING**

To provide compliance data, sample populations for pre- and postimplementation of ProvenCare were used. Patients who received prenatal care across all 22 clinics and gave birth in a GHS facility were identified through an electronic billing database.

The pre-ProvenCare sample was randomly obtained for women who delivered from January 2008 through October 2008. Manual chart review was required for the entire pre-ProvenCare sample. The manual abstraction process was overseen by a QI specialist and carried out by three frontline nurses. The post-ProvenCare sample was randomly obtained for women who delivered from April 2009 through June 2010. If a patient received care at any point during this period we captured the reliability of the care they received from the point at which they entered the ProvenCare pathway. Electronic abstraction followed by manual validation was used. When it was determined that the electronic methods for pulling the data yielded several false negatives, a manual review to validate any noncompliance with BPMs was conducted by the same team of nurses who reviewed the pre-ProvenCare patient charts.

Data for the neonatal intensive care unit (NICU) admissions came from the GHS NICU database. GHS patients were defined as mothers of infants who were seen by a GHS provider for at least 13 weeks (one trimester) before delivery and who gave birth within a GHS hospital. All infants were admitted to the NICU within 24 hours of birth. The pre-ProvenCare population represents patients from January 2007 through March 2009. The post-ProvenCare population represents patients from April 2009 through September 2010.

**STATISTICAL ANALYSES**

Pearson chi-square tests (STATA version 8.2; StataCorp; College Station, Texas) were used to analyze compliance of measures and NICU admissions data pre- and post-ProvenCare implementation. Statistical control charts (SPC for Excel Software; BPI Consulting, LLC; Cypress, Texas) were used to track changes in cesarean-section (C-section) rates.

**RESULTS**

**Compliance with BPMs.** An electronic dashboard, recently completed, that tracks compliance with the BPMs for each patient and provides real-time feedback to each clinic, is undergoing validation.* “Opportunity reports,” currently in limited use pending validation, would indicate which specific BPMs that have not been executed are generated for each patient and are available at the time of her visit. For example, opportunity reports might indicate that a patient nearing her 28th week has not had her glucola test or that a patient who has delivered does not have a postpartum visit scheduled.

Data are shown in Table 4 (page 237) on compliance with the BPMs or BPM bundles that the meso-team physicians considered the most clinically relevant to the patient population. As can be seen, statistically significant improvements occurred for every BPM or BPM bundle, with the exception of initial Rh screen and RhoGAM administration and initial Rubella screen and measles, mumps, rubella (MMR) administration.

Evidence suggests that postpartum depression (PPD) is identified in fewer than 50% of cases.³ PPD screening, which is the first step to accurate diagnosis, has been provided to 100% of our patients since November 2009.

**Patient Outcomes.** The meso-team identified a number of patient outcomes that they expected the IHI elective induction and augmentation bundles to influence. For example, at Geisinger Medical Center (GMC), one of the two GHS medical centers, there has been no change in the primary C-section rates since the implementation of ProvenCare Perinatal (Figure 3, page 237). At Geisinger Wyoming Valley (GWV), the other GHS medical center, the rate of primary C-sections decreased by 32% from 30.3% to 23.8% (Figure 4, page 237); both GMC and GWV rates are less than the current average of 32.9% for the United States.² As part of the process redesign (Phase 6), an elective C-section cannot be scheduled unless it meets the specific criteria outlined in the IHI induction and augmentation bundles. Furthermore, if the gestational age is less than 39 weeks, a forcing function was built into the process whereby a second physician must sign off on the procedure before it is scheduled. As more data become available, we will continue to investigate the relationship among maternal wellness, reduction of C-sections, and birth trauma rates.

As shown in Table 5 (page 238), women who received at least 13 weeks of prenatal care and delivered within a GHS hospital have been less likely to have had their infants admitted to the NICU since the implementation of ProvenCare (p value < .01). The number of diagnoses of insulin-dependent gestational diabetes associated with NICU admission has also decreased significantly (p = .04).

* Aggregated data from the dashboard database were not available in time for this article.
Table 3. ProvenCare Perinatal Bundles with Examples of Associated Best Practice Measures (BPMs)*

<table>
<thead>
<tr>
<th>Bundles</th>
<th>BPMs (examples)</th>
<th>No of Opportunities†</th>
<th>Possible Impacted Outcomes</th>
</tr>
</thead>
</table>
| Diabetes                     | 28-week glucola                                      | 1                    | ■ Decreased maternal/fetal complications related to uncontrolled and late-diagnosed gestational diabetes  
|                              | Urine dip—glucose each visit                         | 13                   | ■ Decreased incidence of LGA babies                                                       |
|                              | Weight gain                                          | 13                   | ■ Decreased incidence of insulin-dependent gestational diabetes                           |
|                              | Fundal height 20 week and each visit after           | 10                   | ■ Decreased NICU admission rate                                                           |
|                              |                                                      |                      | ■ Decreased NICU LOS                                                                      |
|                              |                                                      |                      |                                                                                           |
| Preeclampsia/                | Urine dip—protein each visit                         | 13                   | ■ Delayed onset or prevention of Eclampsia/HELLP syndrome                                 |
| Eclampsia/HELLP              | Edema each visit                                     | 13                   | ■ Decreased number of newborns born with complications associated with late diagnosis of preeclampsia/eclampsia/HELLP |
|                              | Smoking cessation screening and intervention         | 13                   | ■ Decreased NICU admission rate                                                           |
|                              | Weight gain                                          | 13                   | ■ Decreased NICU LOS                                                                      |
|                              | BP each visit                                        | 13                   |                                                                                           |
|                              |                                                      |                      |                                                                                           |
| Preterm Labor                | Fundal height each visit post 20 weeks               | 10                   | ■ Decreased incidence of early delivery                                                   |
|                              | Smoking cessation screening and intervention         | 13                   | ■ Decreased NICU admission rate                                                           |
|                              | Establish EDD                                        | 1                    | ■ Decreased NICU LOS                                                                      |
|                              | Fetal movement assessment                            | 12                   |                                                                                           |
| Induction/Augmentation       | Assessment of gestational age and dating criteria    | 1                    | ■ Decreased rate of primary cesarean section                                             |
| Bundle (IHI)                 | Monitoring fetal heart rate for reassurance          | 1                    | ■ Increased rate of successful pharmaceutical inductions                                  |
|                              | Pelvic assessment                                    | 1                    | ■ Decreased cost of care (LOS)                                                            |
|                              | Monitoring and management of hyperstimulation        | 1                    | ■ Decreased time laboring                                                                 |
|                              | Bishops score                                        | 1                    |                                                                                           |
| Maternal and Fetal Wellness  | RhoGAM administered prior to discharge to nonsensitized Rh− patients with Rh+ babies | 1                    | ■ Overall maternal and fetal wellness                                                     |
|                              | Rubella sensitization screening and intervention      | 1                    | ■ Decreased NICU admission rate                                                           |
|                              | Obesity intervention                                 | 1                    |                                                                                           |
|                              | Smoking cessation screening and intervention         | 13                   |                                                                                           |
|                              | Postpartum visit bundle (episiotomy evaluation, uterine involution assessment, contraception discussion) | 1                    |                                                                                           |
|                              | Influenza vaccination for mom                         | 1                    | ■ Decreased incidence of newborn admissions related to influenza, birth–3 months            |
|                              | Postpartum Depression Tool                           | 1                    | ■ Decreased severity of postpartum depression by appropriate identification and action      |
|                              | Edinburgh Scale                                      |                      | ■ Increased appropriate referrals to psychiatry                                            |

* The number of times that each BPM must be satisfied in the care pathway and potential outcomes that may be affected by execution of all BPMs within the bundle are indicated. LGA, large for gestational age; NICU, neonatal intensive care unit; LOS, length of stay; HELLP, hemolysis, elevated liver enzymes, and low platelet count; BP, blood pressure; EDD, estimated due date; IHI, Institute for Healthcare Improvement; RhoGAM, Ph-immune globulin; Rh, rhesus.

† The number of opportunities for a patient who has one clinic visit in the first trimester, delivers at 40 weeks gestation, and attends all scheduled appointments.
Table 4. Compliance in Providing Best Practice Measures*

<table>
<thead>
<tr>
<th>Best Practice Measures and/or Process Steps</th>
<th>Pre-ProvenCare (N = 101)</th>
<th>Post-Implementation (N = 1,010)</th>
<th>Pearson’s Chi-square p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes bundle (all-or-none)</td>
<td>30.89%</td>
<td>79.02%</td>
<td>.00</td>
</tr>
<tr>
<td>Preeclampsia bundle (all-or-none)</td>
<td>42.63%</td>
<td>67.83%</td>
<td>.00</td>
</tr>
<tr>
<td>Postpartum visit bundle (all-or-none)</td>
<td>61.63%</td>
<td>97.62%</td>
<td>.01</td>
</tr>
<tr>
<td>Smoking cessation intervention</td>
<td>45.27%</td>
<td>88.50%</td>
<td>.00</td>
</tr>
<tr>
<td>Intervention for obesity offered</td>
<td>3.51%</td>
<td>77.47%</td>
<td>.00</td>
</tr>
<tr>
<td>Rh blood factor initial screen and RhoGAM administration</td>
<td>91.53%</td>
<td>100.00%</td>
<td>.53</td>
</tr>
<tr>
<td>Rubella sensitization initial screen and MMR administration</td>
<td>88.07%</td>
<td>98.88%</td>
<td>.43</td>
</tr>
<tr>
<td>Postpartum depression screening</td>
<td>n/a</td>
<td>100.0%</td>
<td>n/a</td>
</tr>
</tbody>
</table>

* Rh, rhesus; MMR, measles, mumps, rubella.

Geisinger Medical Center (GMC): Control Chart for Monthly Cesarean-Section Rates (p-Chart) Before and After the Implementation of ProvenCare Perinatal, January 2008–September 2010

Figure 3. There has been no change in the C-section rates at GMC since the implementation of ProvenCare Perinatal, although the average rate remains below the national average. GMC has a NICU and serves as the tertiary/quaternary hospital for Central and Northeast Pennsylvania. UCL, upper control limit; LCL, lower control limit.

Geisinger Wyoming Valley (GWW): Interrupted Control Chart for Monthly Cesarean-Section Rates (p-Chart) Before and After the Implementation of ProvenCare Perinatal, January 2008–September 2010

Figure 4. The average cesarean-section (C-section) rate at GWW decreased from 30.3% before implementation to 20.7% after implementation of ProvenCare Perinatal. Any point within the control limits—upper control limit (UCL) and lower control limit (LCL)—indicates normal variation in the month-to-month rates.
Discussion

The Perinatal ProvenCare initiative was significantly more complex than the five previous ProvenCare endeavors in terms of breadth, scope, and duration. Because the initial ProvenCare framework was not compatible with the needs of the perinatal context, we developed a nine-phase model for process redesign and a new framework for communication and management. The decision-making framework effectively aligned a diverse group of providers with a common purpose—to effect a redesign that achieved a standardized pathway for delivery of evidence-/guide-based care to pregnant women across multiple sites. Although the results are preliminary, they suggest improvement in clinical processes and outcomes, which we believe are attributable to the redesign of work-flow processes.

We managed the complexity of ProvenCare Perinatal by using a combination of fundamental QI tools and concepts, such as process-flow maps and clinical microsystem thinking, and innovative ideas, as represented, for example, in our communication and management model. The entire initiative was driven by a thorough understanding of each site's local context, which began with the creation of a detailed process-flow map at each of the 22 care sites. The process of developing the process flow maps has confirmed our belief that a single practice's unique aspects—reflecting provider/nurse education and practice, patient demographics, and geographical location—must be reflected in evidence-based pathways if they are to prove reliable and sustainable.

In enabling communication with all providers and nurses and ensuring that every person was on the same page as this initiative took form, our communication and management model that was relevant and effective called for administrative leadership to engage regularly with all of the clinics and their providers. Early on in the initiative, communication between each clinic and administrative leadership was conducted at least weekly. By the completion of Phase 3, with such communication established, administrative leadership's follow-up with each clinic became less frequent—that is, every two to four weeks.

Most of the barriers that we encountered in developing and implementing the initiative related to the functionality of current technology, as represented, for example, in the lack of an accurate tracking mechanism as a barrier to timely administration of RhoGAM, as discussed earlier (Phase 5, page 233). Typically, the practice site's providers/nurses would identify a process that IT would then attempt to build into the EHR. If the technology could not support the specific work flow, IT would come back to the providers/nurses and develop an alternative option.

During implementation, we found that the practice site staff quickly became involved in creating the process flow maps to depict the current processes at their location and in later providing feedback on the draft work flow maps being considered for the standardized pathways.

The rollout of the standardized pathways was facilitated by Phase 7 of the new ProvenCare model: Develop a phased implementation and just-in-time education plan. The guiding force of this phase was a thorough knowledge of the context (Phase 2) within each site. Having conducted pilots at three sites to identifying and address potential IT issues, we were able to staff each site with adequate IT resources and were subsequently able to reallocate resources to the sites needing additional assistance.

There were some limitations in the design and evaluation of the Perinatal ProvenCare initiative. First, we encountered significant challenges in abstracting baseline data. Manual abstraction of a single patient medical record that spanned 10 months across multiple providers and clinics required significant resources, thereby limiting the number of cases in the pre-ProvenCare cohort. Second, we relied on the judgment of the seven providers on the meso-team to identify a large number of BPMs and attribute to each of them specific outcomes. However, it is difficult at this stage to determine if the groupings of BPMs and outcomes are correct. In addition, questions remain as to the weighted effectiveness of any one BPM within a bundle. For example, did the observed decrease in the diagnosis of insulin-dependent gestational diabetes associated with

Table 5. Neonatal Intensive Care Unit (NICU) Admission Rates and Insulin-Dependent Diabetes*

<table>
<thead>
<tr>
<th>GHS Patients</th>
<th>Total GHS Babies</th>
<th>GHS NICU Admissions</th>
<th>Percent NICU Admissions</th>
<th>NICU Babies Born to Mothers with Insulin-Dependent Gestational Diabetes</th>
<th>Percent Insulin-Dependent Gestational Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-ProvenCare</td>
<td>4526</td>
<td>427</td>
<td>9.43</td>
<td>18</td>
<td>4.2</td>
</tr>
<tr>
<td>Post-ProvenCare</td>
<td>3738</td>
<td>271</td>
<td>7.25 (p &lt; .01)</td>
<td>4</td>
<td>1.5 (p = .04)</td>
</tr>
</tbody>
</table>

* GHS, Geisinger Health System.
NICU admissions result from an increase in compliance in the delivery of all four BPMs or did a single BPM within this bundle largely drive the outcome? Continued data collection over time will help us to better determine the relative effectiveness of the individual BPMs.

Finally, this revised ProvenCare model has been applied on only one condition of wellness, and its applicability may be limited. Furthermore, characteristics of the GHS macrosystem that may not be present in other health systems may limit the model’s generalizability. For example, institutions that do not have leadership’s commitment to the model and employed physician base may find this model difficult to successfully or effectively execute. In addition, the presence of an integrated EHR and dedicated IT resources engaged in process redesign, as well as the ability to provide dedicated QI specialists to guide and oversee initiatives of this size, may also play a significant part in successful implementation.

Conclusion

Preliminary experience with the ProvenCare Perinatal initiative suggests that integrating evidence-guideline-based best practices into work flows in inpatient and outpatient settings can achieve improvements in daily patient care processes and outcomes. Application of this model across health systems in a collaborative format may prove its generalizability.

References


Online-Only Content

See the online version of this article for Appendix 1. Best Practice Measures

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## Appendix 1. Best Practice Measures*

<table>
<thead>
<tr>
<th>Components of Care</th>
<th>Guideline/ Evidence-Based</th>
<th>Consensus-Based</th>
<th>Evidence/Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Pregnancy confirmation</td>
<td></td>
<td>X</td>
<td>ACOG</td>
</tr>
<tr>
<td>2 Menstrual history</td>
<td></td>
<td>X</td>
<td>ACOG, ICSI 13</td>
</tr>
<tr>
<td>3 Pregnancy history</td>
<td></td>
<td>X</td>
<td>ACOG</td>
</tr>
<tr>
<td>4 Chronic disease</td>
<td></td>
<td>X</td>
<td>ACOG</td>
</tr>
<tr>
<td>5 Thyroid dysfunction</td>
<td></td>
<td>X</td>
<td>ACOG</td>
</tr>
<tr>
<td>6 Tobacco/drug/alcohol use</td>
<td></td>
<td>X</td>
<td>ACOG</td>
</tr>
<tr>
<td>7 Hepatitis</td>
<td></td>
<td>X</td>
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</tr>
<tr>
<td>8 Depression</td>
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<td>9 Postpartum depression</td>
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<td>10 Allergies</td>
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<td>12 Breast</td>
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<td>13 Gyn surgeries</td>
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<td>14 Complications from anesthesia</td>
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<tr>
<td>15 Abnormal pap</td>
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<tr>
<td>16 Infertility</td>
<td></td>
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<tr>
<td>17 Trauma or violence</td>
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<td>X</td>
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<td>18 Thalassemia, history</td>
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<td>24 Familial dysautonomia, history</td>
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<td>25 Sickle cell disease or trait, history</td>
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<td>30 Mental retardation, history</td>
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<td>31 Maternal metabolic disorders (PKU)</td>
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<td>33 Other fetal anomalies</td>
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<td>X</td>
<td>ACOG</td>
</tr>
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<td>34 Medication History</td>
<td></td>
<td>X</td>
<td>ACOG, ICSI 12</td>
</tr>
<tr>
<td>35 TB exposure</td>
<td></td>
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<tr>
<td>36 Patient/partner with genital herpes</td>
<td></td>
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<tr>
<td>37 Rash or viral illness since last menses</td>
<td></td>
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<tr>
<td>38 Hepatitis B</td>
<td></td>
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<tr>
<td>39 History of STD</td>
<td></td>
<td>X</td>
<td>ACOG</td>
</tr>
<tr>
<td>40 HIV (including partner hx)</td>
<td></td>
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</tr>
<tr>
<td>41 BP</td>
<td></td>
<td>X</td>
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<tr>
<td>42 Calculate body mass index</td>
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<td>Fetal Heart Tones, 10 weeks+</td>
<td>X</td>
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<td>ICSI 27-@10-12 weeks and every visit after, ACOG</td>
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<td>Physical exam: HEENT</td>
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<td>Physical exam: Teeth</td>
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<td>Physical exam: Breasts</td>
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<td>Physical exam: Lungs</td>
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<tr>
<td>Physical exam: Heart</td>
<td></td>
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<tr>
<td>Physical exam: Abdomen</td>
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<tr>
<td>Physical exam: Extremities</td>
<td></td>
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<tr>
<td>Physical exam: Skin</td>
<td></td>
<td>X</td>
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<tr>
<td>Physical exam: Lymph nodes</td>
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<td>Physical exam: Vulva</td>
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<tr>
<td>Physical exam: Vagina</td>
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<tr>
<td>Physical exam: Cervix</td>
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<tr>
<td>Physical exam: Uterus size</td>
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<tr>
<td>Physical exam: Adnexa</td>
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<td>Physical exam: Assessment of boney pelvis</td>
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<td>1st trimester screening</td>
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<td>CBC</td>
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<td>Physician consensus, ACOG, ICSI 15</td>
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<td>Urine culture</td>
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<tr>
<td>Type/Rh</td>
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<td>Chlamydia</td>
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<td>Pap</td>
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<td>Syphilis (RPR)</td>
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<td>Cystic Fibrosis screening offered</td>
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<td>Thalassemia (if history warrants)</td>
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<tr>
<td>Tay-Sachs (if history warrants)</td>
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<tr>
<td>Canavan (if history warrants)</td>
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<td>Smoking cessation</td>
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<td>X</td>
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<tr>
<td>Nutrition counseling for obesity</td>
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<td>Antenatal education</td>
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<td>Influenza</td>
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<td>Domestic abuse questioning</td>
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<tr>
<td>Establish EDD</td>
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<tr>
<td>Birthing class offered</td>
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<td>Fetal aneuploidy Screening</td>
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<td>ICSI 23</td>
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(continued on page AP3)
### Appendix 1. Best Practice Measures* (continued)

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<th>Components of Care</th>
<th>Guideline/Evidence-Based</th>
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<tbody>
<tr>
<td>84 Urine 2-dip</td>
<td>X</td>
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<tr>
<td>85 Quad screening offered (15–20wks)</td>
<td>X</td>
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<tr>
<td>86 Glucola (26–28 wks)</td>
<td>X</td>
<td>ACOG</td>
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<tr>
<td>87 Rh– mothers, repeat Type and screen &amp; administer RhoGAM (28 wks)</td>
<td>X</td>
<td>ACOG, ICSI</td>
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<tr>
<td>88 Ultrasound offered (18–22 wks)</td>
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<td>89 Fundal height (after 20 wks)</td>
<td>X</td>
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<tr>
<td>90 Fetal movement</td>
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<td>91 Bleeding assessment</td>
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<td>92 Presentation</td>
<td>X</td>
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<td>93 Preterm labor signs/symptoms</td>
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<td>94 Labor education</td>
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<td>95 Edema</td>
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<tr>
<td>96 Pain scale</td>
<td>X</td>
<td>ACOG</td>
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<tr>
<td>97 Elective induction bundle</td>
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<td>IHI</td>
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<td>98 MMR administration for rubella negative patients (as determined by the 1st prenatal labs)</td>
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<td>ACOG, consensus</td>
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<tr>
<td>99 RhoGAM administered prior to discharge to nonsensitized Rh– pts with Rh+ babies</td>
<td>X</td>
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<td></td>
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<tr>
<td>100 Episiotomy repair</td>
<td>X</td>
<td>ACOG</td>
<td></td>
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<tr>
<td>101 Review birth control</td>
<td>X</td>
<td>ACOG</td>
<td></td>
</tr>
<tr>
<td>102 Uterine involution</td>
<td>X</td>
<td>ACOG</td>
<td></td>
</tr>
<tr>
<td>103 Postpartum depression assessment</td>
<td>X</td>
<td>ACOG, ICSI, literature</td>
<td></td>
</tr>
</tbody>
</table>

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