For better or worse, Healthcare Information Technology (HIT) has received unprecedented levels of investment in the last five years and is cemented as one of the key strategic areas of focus for all health systems. For some time, broad system-wide HIT initiatives such as adoption of Electronic Medical Records (EMRs) and Meaningful Use monopolized the dialogue and investment. With those initiatives largely digested by healthcare systems, attention is quickly being drawn to analytic systems that can directly impact outcomes.

Forward-thinking clinicians are hungry for solutions to long-standing challenges within their specific service lines. At home and in business, they have seen technology streamline and often improve their experience and they are looking for the same in their clinical practice.

Obstetrics is particularly well positioned to benefit from advanced systems. Suffering from high malpractice exposure, a shrinking population of hands-on clinicians and patient profiles with increasing complexity, many of the country’s leading obstetricians are looking to augment traditional training and education.
with tools designed to address specific weak links in the care process.

Specifically, the goal is to make clinical practice more precise, consistent and efficient – in short, safer for mothers and babies.

To this end, PeriGen, the leader in Clinical Decision Support (CDS) systems for obstetrics, assembled an advisory group tasked with:

- Describing current patient care challenges
- Prioritizing where in OB that technology can have the most positive impact
- Defining the scope of research projects to demonstrate the impact

This multidisciplinary group, comprised of obstetric chairs of top health systems, experienced labor & delivery clinicians, a leading malpractice attorney and perinatal software creators, came together to create OB 3.0, a roadmap for a new era of HIT and clinical synergy in obstetrics.

**Underlying Assumptions**

OB 3.0 started with the following premises:
(A) Basic EMR adoption and utilization is high
(B) EMRs alone rarely address specific service line issues and so, with an EMR foundation in place, health systems can and must now focus on systems designed to help solve specific clinical problems; (C) Widespread adoption by clinicians of IT innovation requires ample supporting research.

The group noted that obstetrics in general has been slow to adopt technology. Little has changed in labor and delivery units compared to the rest of the hospital. By necessity, and the nature of its vulnerable patients, obstetric care is defined by a conservative approach. However, it is sobering to consider that the rate of medical error in births with severely adverse outcomes has been reported to reach 50% or more.1-6

Large studies, with results replicated in different sites, are needed for clinicians to have confidence in the conclusions, especially when adverse outcomes are infrequent. Comparisons of outcomes in the periods “before” and “after” introduction of the intervention are the most common study design in health care quality programs; they are the ONLY kind in aviation, where remarkable achievements in safety have occurred.7-12
An important caveat in any “before” and “after” study is related to the attribution of what caused, or failed to cause, the desired effect. Health care is a complex and dynamic process and ultimately all the moving parts must work well together for optimal outcomes. The most basic elements of the process are timely recognition and effective action or in classical clinical terms diagnosis and therapeutics. Measurements of the impact of an HIT implementation on clinical outcome reflect the cumulative effect of all components of the care process, namely the impact of technology as well as clinical behaviors on outcomes. Where possible, it can be useful to assess each step in the process to determine where failures or bottlenecks occur. This kind of analysis often leads to the next generation of HIT improvements or highlights where clinical behaviors need modification.

Proceeding from these premises, the environment and spirit of the meeting was positive, lively, uninhibited and clearly driven by the vast and practical experience of those present, all of whom contributed. As discussions progressed conclusions emerged in 4 key areas:

1. Identifying standardization of care as the top opportunity for positive impact

2. Determining barriers to standardization

3. Describing practical and desirable IT solutions to promote and sustain standardized care

4. Clarifying key clinical/administrative behaviors that support standardization of care
The quest for exciting and game changing approaches to solve today’s medical problems is appealing. However, not only are such miracles seldom found, but experience shows that much improvement can be gained by applying existing best practices uniformly.7-9 Across all large endeavors, such uniform processes have been shown to improve outcomes. The lessons learned from recent and dramatic stories of implementation of various aspects of a comprehensive safety program on the obstetrical unit demonstrate that such uniform processes have, like in other complex organizations, led to widespread improvement in such outcomes as lowering cesarean section rates and decreasing malpractice claims and costs.10-15 In healthcare standardization generally reduces health care costs.16
Barriers to Standardized Health Care

When considering impediments to the delivery of standardized health care, two issues quickly took the lead outranking other issues by far: miscommunication and normalization of deviance.

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Miscommunication

In obstetric care, particularly labor and delivery, critical decisions such as when to admit a patient or how to manage a labor and other complications are often made remotely. Physicians working in busy offices or at home make judgements from a brief conversation or message. In this environment, clarity and timely communication between nurse and doctor is paramount.

Reviews of malpractice cases, especially those involving babies with neurologic injuries either caused or alleged to have been caused by the labor and delivery process, have shown that miscommunication and/or disagreement among caregivers is a common source of substandard care.\(^1\)\(^,\)\(^17\)\(^,\)\(^18\) Either one of these issues, miscommunication or disagreement, has the potential to result in catastrophic outcomes.

Since gathering, assimilating and sharing information is the foundation upon which clinical decisions are made, it is not surprising that miscommunication is one of the most common issues contributing to medical error.

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Normalization of Deviance

(The gradual process through which unacceptable practices or standards become the accepted norm.)

Normalization of deviance is an ingrained trait of humans. We naturally seek efficiency and expediency, especially when faced with multiple issues competing for our time and focus. The natural tendency is to revert to the easiest path rather than the optimal, but potentially more demanding option. This choice is most often followed by a good
outcome and reinforces the “easy” behavior. “I did this, it worked. It was easy. I did the right thing.” Consequently, minor deviations from expected standards become perceived as normal and harmless. Deviations creep from borderline situations to more egregious ones. Rationalization reinforces this tendency. Humans are masters of rationalization. Rationalization of suboptimal behavior is easy when it is based on outdated, incomplete or biased information. Thus information, communication and behavior are closely linked.

This triad is especially important in obstetrics where clinicians must assess their patient’s current state and also project what is likely to happen in the near future. Many obstetrical interventions are intended to prevent the development of complications because it is often impossible to recover unscathed when the complication actually occurs. Examples of such proactive interventions are cesarean delivery to avoid hypoxic brain injury or antibiotics administration to avoid intrauterine sepsis. The importance of recognition and its cousin projection was underscored by stories recounted at the meeting. A common theme expressed by clinicians reviewing their own adverse outcome: “I just didn’t see it coming”.

Causes of Miscommunication

Communication errors can originate at a variety of levels in obstetrics and many are interrelated. Identifying the many sources of miscommunication helps to clarify mitigation strategies.

It goes without saying that missing or incorrect information seriously compromises decision-making. However, information overload can be a problem as well, resulting in failure to perceive critical items in a timely fashion. Disorganized workspaces, voluminous records or
cluttered computer screens can make information essentially inaccessible.

Inconsistent or subjective assessments can perpetuate and compound miscommunication. Numerous environmental factors known to impair judgment and clinical assessments are present during labor and delivery. Fatigue, distraction, bias, inexperience, an accusatory hierarchal culture are some of the more deleterious factors. EFM tracing interpretation is well known to be inconsistent under the best of conditions, such as a controlled research project, let alone in real life conditions. Tracing abnormalities that are “minimized” by an inexperienced or exhausted nurse and communicated as such to an off-site doctor can lead to a harmful delay in correct intervention.

Good communication begins with a clear exchange of relevant information and ends with a clear understanding of a mutually agreeable action plan. Unresolved disagreement on the basic assessment, or on its clinical relevance or on the final action plan produces a problem.

While most labor & delivery units will have a defined process for resolving differences of opinions, the fact remains that it’s not always followed. The human tendency to defer to an authority figure is a recognized psychological phenomenon. Unlike modern business that use “a more flattened”, or matrix organizational structures, healthcare is based on a steeper hierarchal model which promotes greater deference to authority. A hierarchal structure helps a system to operate in the presence of multiple players with different skills and to enable quick decision-making in critical situations or even to choose a reasonable clinical management plan in situations when there is no obvious right or wrong. However, authorities can make erroneous decisions especially when they do not have all the relevant information, or are temporally affected by human factors like denial, bias or wishful thinking and fatigue. A strict hierarchy makes questioning authority difficult, no matter how potentially harmful the consequences of error may be.\textsuperscript{19}

Clinical guidelines are often designed intentionally to be simple and therefore easy to apply and communicate consistently. This goal has merit. However, their simplicity can lead to problems. Complex medical problems, where there is evolution over time with multiple determinants in constant flux are not easily reduced to a few scenarios defined by simple rules. Inadequate or overly simplistic guidelines can promote miscommunication and inconsistent clinical action because so much is left to interpretation when the simple rule is not exactly relevant.
For example: The EFM categorization rules produce a simple, easy to apply, three-level classification of EFM tracings. The method results in the large majority of tracings falling in the middle category (Category II). This is equally true for tracings where the outcome is normal and for those where the outcome is highly abnormal. Correct intervention with a Category II can range from continued observation to urgent delivery. Thus communicating that the tracing is in Category II does little to impart the degree of tracing abnormality or necessary actions.\textsuperscript{20,21}

Likewise current clinical guidelines that define the labor disorders are problematic for clinicians. Arrest of dilation is defined with clearly “pass/fail” rules that are applicable only in late labor (after dilation has reached 6 cm). What is the clinician to do when arrest of dilation labor arises before dilation of 6 cm?\textsuperscript{22,23}

Fortunately all of the impediments listed in this section can be mitigated to a large degree by specific IT techniques. In some situations the most logical point of the IT application is in real time at the bedside. In other situations a longer term historical trend analysis is necessary to identify where corrective actions should occur. In the next section several mitigation strategies are discussed and it will become evident that the distinction between actual presence at the bedside and virtual presence at the bedside is becoming blurred.
In general, desirable IT applications should deliver pertinent information in a timely fashion, promote standardization and improve efficiency. During OB 3.0, it became apparent that healthcare information technologies must play a role in three areas.

1. Providing assistance at the beside
2. Helping leaders and managers to shape organizational behavior
3. Bringing highly qualified personnel to the bedside in a virtual fashion
To counter this problem, HIT solutions should be able to consolidate and display essential clinical information efficiently and intelligently. Different data sets are required for different clinical conditions. For example, when assessing labor progress, all of the essential information needed should be on one screen making it easier for the clinician to make an informed opinion with confidence. Moreover, different displays are needed for different problems such as management of oxytocin versus care of a hypertensive patient. In general, interactive graphical timeline displays are an efficient way of consolidating information especially when multiple factors are tracked over many hours.

**Quantitative methods** can reduce assessment inconsistency by providing actual numerical measurements. Quantitative measures are less likely to be misunderstood than qualitative terms like “small” or “terrible” especially when these adjectives are chosen subjectively. Quantitative methods also naturally lead to graphical displays so that, at a glance, clinicians can see increasing deviations from safe zones.

As discussed earlier, simple rule-based definitions of complex clinical abnormalities are often problematic. Clinical challenges like these are prime targets for new mathematical approaches. There are only so many rules that a human mind can process, especially when considering multiple factors that change over time. However, with the computational capacity of everyday computers, it is possible to apply a number of well-established statistical or machine learning techniques to these complex problems. For the clinician this can mean new evaluation methods that are applicable more widely (unlike current labor disorder definitions that are confined to late labor only). Such methods can also provide finer resolution of the abnormality spectrum, so that a specific clinical management is more directly linked to the evaluation (unlike current nonspecific management recommendations ranging from no intervention to urgent intervention for a Category II tracing).
Mitigation for Unresolved Differences of Opinion

Quantitative methods can also help to reduce differences of opinion by contributing an unbiased and consistent reading.

The following text describes some specific HIT techniques well-suited to help solve particular obstetrical problems. Some are available today; others are in active research programs.

Automated pattern recognition can help to reduce inconsistency in EFM tracing interpretation. For example, heart rate variability is a pivotal parameter in the assessment of the EFM tracing. Usually it is estimated by visual inspection using gridlines on a paper. Using digital signal processing techniques we can now detect and measure heart rate parameters directly from the electronic signal, lessening the potential for human error and interpretation variation. Automated calculations can reduce time spent by nurses to manually calculate and transcribe fetal heart rate and contraction parameters and support more consistent and standardized communication with physicians.

Data visualization techniques can produce efficient and consolidated displays that highlight the presence of specific concerning combinations warranting clinical review.

Trend displays with visible safety limits are another efficient way of highlighting a trajectory headed for problems.

Multifactorial modeling techniques can be used to produce more finely graded assessments of complex processes such as dilatation and descent in labor.\cite{24,26}

Probabilistic models could be developed for several conditions to indicate the evolving likelihood of adverse outcome as the patient’s variables change. Examples include the likelihood of successful vaginal delivery given the course of the second stage, advice about when to induce labor given maternal and fetal characteristics, and the likelihood of either sustaining complications or the developing hypoxic injury given fetal heart rate patterns and projected length of labor.

Classification and regression trees (CART) are a type of probabilistic model that is well suited for finding high-risk clusters. Clinicians often make clinical decisions based on clusters of certain signs and symptoms. CART is a method to find clusters of factors that are most likely to result in an outcome with the complication in question and
gives the risks in each cluster. CART could even be applied to clinical problems, where the determinants of outcome may include system factors such as levels of staffing as well as standard health parameters. One challenge for medical informatics is to distill the mass of detailed information to identify these “toxic” combinations. In turn, modern intelligent electronic medical records are well positioned to continuously search for these toxic combinations and warn clinicians in time so they can change management and minimize untoward consequences.

**EFM analysis moving beyond classical NICHD-defined features**

Several research groups are developing new signal-processing techniques to extract information that is invisible to the human eye, as well as the standard patterns that are visible but inconsistently labeled by clinicians today. Should these techniques provide significantly better sensitivity, specificity and timeliness than visual inspection, computerized assistance will be necessary to make this information available at the bedside.27-31

Mindful of the need to balance clinical effort with the resulting benefit for women in labor, Table 1 shows the clinical issues that ranked highest among the OB 3.0 participants as the most desirable HIT solutions at the bedside.

<table>
<thead>
<tr>
<th><strong>Table 1: High Priority Clinical Areas to Benefit from a Bedside HIT Application</strong></th>
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<tbody>
<tr>
<td>1. Better assessment of electronic fetal monitoring</td>
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<tr>
<td>2. Better assessment of electronic fetal monitoring in the antepartum period</td>
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<tr>
<td>3. Better assessment of labor progression in both first and second stages</td>
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<tr>
<td>4. A noninvasive EFM assessment method for detecting intrapartum chorioamnionitis</td>
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<tr>
<td>5. Proactive alerts regarding significant deviation of expected healthcare practices</td>
</tr>
<tr>
<td>6. Personalized probabilistic models to estimate the likelihood of adverse outcome</td>
</tr>
</tbody>
</table>
For Leaders who Shape Organizational Behavior

Just as information, communication and behavior are closely linked in clinical care, they are vital for obstetric managers. Statistical reports with information on patients, outcomes and processes helps define, prioritize, and monitor quality-of-care benchmark initiatives. Measurements show where progress has occurred or where it is needed. They motivate clinical teams (or individuals) with evidence of their own success or need for improvement.

Table 2 shows the following general categories of topics considered the most important for tracking with statistical reports.

<table>
<thead>
<tr>
<th>Table 2: Priority Topics for Statistical Reporting</th>
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<tbody>
<tr>
<td>1. Measures of core obstetrical activities</td>
</tr>
<tr>
<td>2. Near-miss reporting</td>
</tr>
<tr>
<td>3. Critical non-compliance behaviors</td>
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</tbody>
</table>
Remote Care with Virtual Centers of Expertise

There is little doubt that geography is one of the most important determinants of access to health care. 39% of deliveries occur in hospitals that deliver less than 500 babies per year and an additional 20% in hospitals delivering 500-1000 babies. Remote regions have smaller ratios of physicians to patients and almost always lack some types of subspecialty physicians. On occasion, these centers will have to manage complicated problems and assistance from a specialist is highly desirable. Although the adoption of Obstetric Hospitalists has been a great boon to avoiding the pitfalls of remote care and improving the problems of poor communication, it is impractical to implement hospitalist programs in smaller and more remote hospitals which comprise the majority of obstetric care facilities in this country. Their delivery volumes are too small to occupy a full time laborist.

When the physical presence of specialized medical skill is not feasible, technology can assist by providing virtual centers of expertise. Virtual ICUs are increasingly common in the US. A virtual command center staffed with nurses and doctors using high-resolution video conferencing and transmission of monitoring data can be hundreds of miles away and serve multiple remote sites simultaneously. In some places the center acts as a second set of eyes, in others it is a source of consultative expertise. Collaboration is inherent and educational. Virtual centers of expertise are feasible only with reliable infrastructure to host the rapid data exchange.

If gathering, assimilating and sharing information is the foundation upon which decisions are made
at the bedside, in virtual centers its importance is multiplied many fold. Although standardization may be easier to achieve given the relatively small group of experts who staff such a virtual center, they will face other pressures such as the clinical responsibility for potentially hundreds of virtual patients under surveillance at any one time.

Automated intelligent methods to prioritize the true level of abnormality and direct the expert’s attention to the most urgent issue is imperative. Good prioritization is particularly important in obstetrical situations where false alarms are common and adverse events are rare but can evolve rapidly with dire consequences.
What did the OB 3.0 group advise about the best way to implement new processes to streamline and improve care? Many individuals in this group have extensive experience studying, teaching, and most importantly implementing approaches to promote efficiency and high reliability in health care. These colleagues have learned a number of lessons. Five key principles of designing a standardized system were distilled and described in Table 3.

**Table 3: Key Principles of Designing a Standardized System**

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>Select a Reasonable Process</strong></td>
<td>The chosen uniform process may not be the optimal one. Ideally it is evidence-based, but not necessarily entirely based on established fact. Developing the process is itself iterative. Thoughtful, reasonable choices are essential in designing a uniform process. There is often insufficient evidence available to support every component however a “lack of evidence” is not “evidence of a lack of effect”.</td>
</tr>
<tr>
<td><strong>Analyze and Modify</strong></td>
<td>The chosen process should be subjected to automatic, uncompromising peer review and modified as necessary.</td>
</tr>
<tr>
<td><strong>Target Critical Behaviors</strong></td>
<td>Identifying and targeting the most critical behaviors or precursor situations leading to adverse events help achieve effectiveness of the process.</td>
</tr>
<tr>
<td><strong>Clarify and Define</strong></td>
<td>Develop standardized approaches with wide involvement and consensus. However, in many situations, especially where behavior is both ingrained and often driven by convenience and or profit, hard stops are more effective than total flexibility and whole-group agreement.</td>
</tr>
<tr>
<td><strong>Choose Wisely</strong></td>
<td>Have an efficient balance between effort required and effect achieved—i.e. how much safety can be achieved by how much effort.</td>
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</table>
A comprehensive approach to changing the culture of labor and delivery uses established mechanisms to create a “Learning Organization” focused on highly reliable patient care improvement. Many of these specific approaches, listed in Table 4, require the efficient support that can be provided only by technology. Examples include immediate availability of check lists, mechanisms for anonymous event reporting, easy access to defined protocols, identification of near misses for reviews by the safety team as well as comprehensive statistics on healthcare operations so that problems can be identified and improvements made and progress tracked.

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<tr>
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<th>Table 4: Specific Approaches for Changing the Culture of Labor &amp; Delivery</th>
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<tbody>
<tr>
<td>1</td>
<td>Minimize hierarchy / create collegial interactive teams</td>
</tr>
<tr>
<td>2</td>
<td>Seminars describing crew resource management - teamwork training &amp; crisis response methods used in aviation</td>
</tr>
<tr>
<td>3</td>
<td>Allow anonymous adverse event reporting</td>
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<tr>
<td>4</td>
<td>Team rounds and/or sign-out goals</td>
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<tr>
<td>5</td>
<td>Drills</td>
</tr>
<tr>
<td>6</td>
<td>Simulation</td>
</tr>
<tr>
<td>7</td>
<td>Checklists</td>
</tr>
<tr>
<td>8</td>
<td>Standardized protocols for well-established &amp; high-risk clinical situations</td>
</tr>
<tr>
<td>9</td>
<td>Recertification</td>
</tr>
<tr>
<td>10</td>
<td>Safety teams that work on the fly to recognize defects, brainstorm &amp; implement solutions</td>
</tr>
<tr>
<td>11</td>
<td>Utilize an EMR with built-in decision-support</td>
</tr>
<tr>
<td>12</td>
<td>Learn from near-misses, near-miss teams or conferences</td>
</tr>
<tr>
<td>13</td>
<td>Avoid sleep deprivation</td>
</tr>
<tr>
<td>14</td>
<td>Debriefing</td>
</tr>
</tbody>
</table>
The core challenges of obstetrical care - miscommunication and normalization of deviance combined with adversity to innovation can be countered with conversion to cultures of safety and with technological tools that truly mitigate the underlying causes of medical error and improve clinician efficiency.

The OB 3.0 participants uniformly recognized that while education, experience and critical thinking
are paramount and irreplaceable they will always introduce some level of variability, that at times can become egregious and harmful. Curtailing undesirable variability through IT systems that provide standardized “guardrails” intelligently tailored for patient-specific scenarios can have a positive impact.

Participants also agreed that many communication challenges inherent to obstetrics are addressable. Solids strengths of computers lie in their capacity to retain, organize and display data. Information technology plays an important role by increasing the level of objective data available for consideration, facilitating escalation and documentation. These information technology features are likely to improve the clarity, speed and efficacy of clinical conversations.

Participants noted that complementarity is imperative. Computers are more adept for certain kinds of tasks like continuous monitoring or repetitive calculations than humans. Vigilance fatigue is inevitable and a common culprit in human error. Computers are tireless, consistent and immune to normalization of deviance. They are well suited to tracking multiple factors over long periods such as course of labor, and to consistently identify deviation from expected or safe patterns. Humans, on the other hand, are far more adept at higher level reasoning, empathy and intuition. Let the computers apply their capacity for billions of calculations per second to analyze, organize, and display critical information and give reminders without bias so that clinicians focus their time and energy on what they do best, applying sound clinical judgment and compassion to take care of their patients.

Considering the greatest unmet clinical needs in obstetrics and the particular strengths of computerization the group converged on a few key challenges. They sought better methods to; manage labor (first and second stage), interpret electronic fetal monitoring and report summary statistics on clinical outcomes and clinician practices.

It was also very evident that obstetrics will increasingly need technology to extend precious clinical resources across a health system, from the hub to its spokes.

Virtualization of health care is no longer a theoretical conversation. Participants saw technology as the only scalable means to achieve substantial improvements in accessibility to highly qualified personnel.

The enthusiasm and energy to move down the paths discussed above has generated the hope that we can accelerate real progress. Humans have a long history of inventing tools to achieve their goals more efficiently. IT applications in healthcare are no exception. Multidisciplinary meetings such as this help define the top priorities in IT tools for clinicians at the bedside and for leaders who are responsible for the quality and efficiency of care as well as supplying services to remote sites.

The challenges are clear. Our path forward calls for development of the resources and technology that will help hospitals and health systems become “Highly Reliable Organizations” that continuously build upon evidence-based medicine leavened with well-researched innovations.
ABOUT THE AUTHORS

This paper is the result of the many minds -- leading obstetricians, clinical researchers, technology thought leaders, and risk management professionals -- that were brought together by PeriGen, a perinatal software company, to review the state of obstetrics, examine the professional and healthcare challenges being faced, and share best practices and ideas about how to meet them head-on.
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Matt Sappern joined PeriGen from his position as Senior Vice President, Client Sales at Allscripts, a $1.3 billion global leader in the electronic medical records industry. At Allscripts, Matt’s Client Sales team achieved record bookings in 2011. Matt joined Allscripts in 2010 following its merger with Eclipsys, where he served as a corporate officer and Senior Vice President of Professional Services responsible for directing the Services division, encompassing the company’s consulting, implementation, and education and training services. Before that, he served as Senior Vice President of Technology Solution Services at Eclipsys, which he joined in 2003, after serving in leadership roles at WebMD, Time Warner, Primedia and Young & Rubicam. Matt holds a Bachelor of Arts in Political Science from Emory University in Atlanta, GA.

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A specialist in Obstetrics and Gynecology and Maternal-Fetal Medicine, in addition to his work with PeriGen and its clients, Thomas J. Garite, MD, holds two positions which include: Chairman, Society for Maternal-Fetal Medicine Foundation and Director of Research and Education for Obstetrix/Pediatrix Medical Group. He is also the former Editor-In-Chief of the American Journal of Obstetrics and Gynecology. Dr. Garite is the author or co-author of five textbooks and has published over 100 original journal articles and a similar number of abstracts, chapters and invited articles. He is a past president of the Society for Maternal-Fetal Medicine, as well as a twelve-year member of its Board of Directors. He has also served as a Member of the Board of Directors of the Division of Maternal Fetal Medicine of the American Board of Obstetrics and Gynecology, and Director of the Oral Examinations for this Board, as well as a Member of the Technical Bulletin and Course Coordination Committee of the American College of Obstetricians and Gynecologists. A recipient of the Career Achievement Award from the Society for Maternal-Fetal Medicine and the National Teaching Award from the Association of Professors of Obstetrics and Gynecology, Dr. Garite remains active in clinical research.
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Specializing in Obstetrics and Gynecology and Maternal-Fetal Medicine, Dr. Barnhard has published over 25 peer-reviewed articles on Maternal-Fetal Medicine, and is a member of numerous maternal fetal medicine societies. Dr. Barnhard is the former Vice-Chairman of the Department of Obstetrics & Gynecology, the Director of Obstetrics, and the Director of Quality Improvement & Patient Safety at Lenox Hill Hospital.

He has held academic appointments at Mount Sinai Medical Center and the State University of New York, and is currently on the faculty of the Department of Obstetrics and Gynecology and Women’s Health at the Albert Einstein College of Medicine at Yeshiva University. Dr. Barnhard's specific areas of interest include family umbilical cord banking, prenatal molecular diagnostic testing, and fetal ultrasound. A graduate of Columbia University, Dr. Barnhard attended the Stackler School of Medicine in Tel Aviv, Israel, and completed his residency at the Albert Einstein College of Medicine in New York.

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In addition to his distinguished legal practice, Mr. Brzezinski regularly makes presentations across the country on a variety of legal issues facing physicians and nurses in the fields of obstetrics and gynecology. These include presentations at national and regional meetings of attorneys, physicians and risk management experts.

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He is a Past President of the Society of Maternal-Fetal Medicine and a Past Chair of the American College of Obstetricians and Gynecologists Technical Bulletin Committee. In addition he is active in The Joint Commission of Perinatal Care Technical Advisory Board.

Dr. Clark is well-known perinatal presenter and author of a wide selection of journal and book selections.

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A perinatal nurse practitioner specializing in high risk obstetrics, Becky Cypher brings to PeriGen a wealth of military and civilian experience that includes clinical and leadership roles spanning more than 25 years of experience. Becky retired from the U.S. Air Force in 2008 after serving two decades of active duty service. She has held numerous leadership positions in the Association of Women’s Health, Obstetric and Neonatal Nurses including section chair and secretary treasurer, two terms on the national board of directors; and a member of numerous committees, most notably the revision committees for the fetal monitoring programs.

Becky is the author or co-author of several peer reviewed journal articles and textbook chapters. She is the co-editor on the fetal monitoring textbook: “Pocket Guide to Fetal Monitoring: A Multidisciplinary Approach”. Becky continues to consult and lecture nationally on a variety of OB topics and currently serves on the editorial board for the Journal of Perinatal and Neonatal Nursing.
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An experienced obstetrician, [Emily Hamilton](mailto:EmilyHamilton@PeriGen.com) has held various academic appointments at McGill University, including Director of the Residency Education Program in Obstetrics and Gynecology, and Director of Perinatology. Currently, she is an Adjunct Professor of Obstetrics and Gynecology at McGill, as well as leading PeriGen’s clinical research team.

With over 20 years of experience as a practicing obstetrician, Emily has served on various Canadian National Task Forces defining Clinical Practice Guidelines for fetal surveillance. Her research team has included members with diverse backgrounds such as mathematics, computer science and engineering along with experienced nursing and medical clinicians. They were successful in creating mathematical models to be used at the bedside to help the clinicians assess fetal heart rate patterns, labor progress, and the risk of shoulder dystocia. This research was applied to the development of the [PeriCALM®](http://www.PeriCALM.com) suite of fetal monitoring technologies. Emily presents regularly at academic conferences focusing on patient safety and risk management for obstetrical services, and holds 31 US and international patents related to obstetrics.

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[Chip Long](mailto:ChipLong@PeriGen.com) is an executive healthcare IT and military veteran bringing nearly 30 years of provider and vendor experience to PeriGen. In his role as Senior Vice President of Growth and Development, Chip is responsible for directing all efforts concerning marketing, lead generation, field sales, account management, and business development. Chip joined PeriGen from Merge Healthcare, where he served as vice president of sales for the eastern region of the United States. Previously, he was a senior member of the team that led Extended Care Information Network (ECIN) to a successful acquisition by Allscripts and served in various leadership roles at Enterprise Systems, Inc. (ESI) through its IPO and subsequent acquisitions first by HBOC and ultimately by McKesson in 1998. Chip began his health care career as a nursing information systems specialist at the University of South Alabama Medical Center. He also served as a telecommunications specialist with the U.S. Army, first on active duty from 1982 to 1984, and an active reservist through 1989. Chip holds a BA from the University of West Florida and MBA from Loyola University.
Dr. Stephanie Martin is board-certified in Ob/Gyn and Maternal Fetal Medicine. She currently serves on the board of the Society of Maternal-Fetal Medicine. After college at the University of Dallas, she graduated from medical school at Texas College of Osteopathic Medicine in Fort Worth. From there she moved to California and completed her OB/Gyn residency and MFM fellowship at the University of California Irvine Medicine Center in 2000.

Her particular expertise is in obstetric critical care and complex maternal medical conditions, particularly cardiac disease. Dr. Martin has authored multiple book chapters and articles on the topics of critical care obstetrics, maternal cardiac disease, maternal pulmonary disease and cardiac arrest, among other topics. She is a sought after speaker and has travelled internationally to give talks on these and other obstetrical issues.

Duncan Neilson, MD
Clinical Vice President
Legacy Medical Group
Portland, OR

Duncan Neilson, MD is Clinical Vice President of Legacy Health’s Surgical Specialties Division. Legacy is a five-hospital health system serving Oregon and Southwest Washington state that delivers approximately 7,140 babies a year.

His initial assignment at Legacy was as an OB/GYN staff physician. He has served as Chief of Women's Services and on the Board of Legacy Health System. He is actively involved in the American College of OB/GYN, the American College of Surgeons, the Pacific Coast OB/GYN Society, and the Society for Humanism in Medicine.

Dr. Neilson earned his medical degree from Johns Hopkins University where he was Alpha Omega Alpha. He did his internship and residency at John Hopkins Hospital.
Alfred G. Robichaux, III, MD
Chairman
Department of Obstetrics & Gynecology
Ochsner Health System
Jefferson, LA

Alfred G. Robichaux, III, MD leads the Department of Obstetrics & Gynecology for Ochsner Health System, an 11-hospital system delivering an estimated 7,200 babies a year and serving southeast Louisiana. Dr. Robichaux earned his medical degree from the Louisiana State University Health Sciences Center. Following graduation, he completed his internship and residency at Ochsner Clinic Foundation. In 1984, Dr. Robichaux completed a Maternal Fetal Medicine Fellowship at the George Washington School of Medicine. He serves on the ACOG Committee on Patient Education and the Committee on Obstetric Practice.

In a survey of doctor’s attitudes about their peers, Dr. Robichaux was named the Top Obstetrician in the New Orleans Metropolitan Area, according to New Orleans Magazine. He consistently ranks as one of the Best Doctors in America in several national publications and was named to the prestigious Who’s Who in the South and the Southwest. Dr. Robichaux was also appointed by the governor to serve on the Louisiana Perinatal Commission. He has been on staff at Ochsner since 2005 and practices at the Ochsner Baptist Medical Center in New Orleans.

Dr. Robichaux is board-certified in obstetrics and gynecology and maternal fetal medicine. His areas of special interest include fetal surgery, fetal malformations, and pregnancy problems.

Sam Smith, MD
Chairman & Medical Director
Obstetrics & Gynecology
MedStar Franklin Square
Baltimore, MD

Samuel Smith, MD, is chairman of the Department of Obstetrics & Gynecology and medical director of the Women’s and Children’s Service Line at MedStar Franklin Square Medical Center, a hospital serving Baltimore, MD that delivers approximately 2,351 babies a year. He is also chairman of the Department of OB-GYN at MedStar Harbor Hospital which also serves Baltimore. This location delivers an estimated 1,484 babies a year. He is an associate professor in the Department of Gynecology and Obstetrics at the Johns Hopkins University School of Medicine.

Dr. Smith received his medical degree in 1981 from the University of Maryland School of Medicine, completed his residency in Obstetrics and Gynecology at Georgetown University Medical Center in 1985, and completed his fellowship in Reproductive Endocrinology-Infertility at Harvard University’s
Brigham and Women’s Hospital in 1987. Dr. Smith is board certified in Obstetrics and Gynecology and in Reproductive Endocrinology-Infertility. He served on the ASRM Practice Committee for six years and was chair of the ASRM Patient Education Committee for six years.

Dr. Smith has received numerous honors and recognitions including Phi Beta Kappa, Alpha Omega Alpha, and Baltimore’s Top Doctor Award in Reproductive Endocrinology-Infertility for six consecutive years. He has distinguished himself in the area of Patient Safety and Quality as the Chairman of MedStar Health’s Council for Ideal Obstetrical Care. Most recently, he is a founding member and on the Board of Directors of the ACOG Council on Patient Safety in Women’s Health Care.

John Yeast, MD, MSPH
Vice President of Research & Education
Saint Luke’s Hospital
Kansas City, MO

John Yeast, M.D., M.S.P.H., is the Vice President of Research & Education at Saint Luke’s Hospital of Kansas City, Missouri and CEO of Saint Luke’s Physician Specialists, LLC. The Saint Luke’s Health System is comprised of ten hospitals across the Kansas City region delivering over 6,000 babies a year. Dr. Yeast is also Professor and Vice-Chairman in the Department of Obstetrics and Gynecology, University of Missouri-Kansas City. He also serves as the Research Institutional Official for Saint Luke’s Hospital.

He earned his medical degree at the University of Missouri’s Columbia School of Medicine, did his residency at Naval Regional Medical Center in San Diego, CA and his fellowship in Maternal-Fetal Medicine at the University of California’s Irvine School of Medicine.

Dr. Yeast is board-certified in Obstetrics and Gynecology as well as Maternal-Fetal Medicine. From 1986 until 2001, he was director of Saint Luke’s Perinatal Center in Kansas City. He also serves as an examiner for the American Board of OBGYN, a reviewer for both the American Journal of Obstetrics and Gynecology (AJOG) and Obstetrics and Gynecology (OBG). He is a board member of Horizon Academy, and a former Trustee of the Saint Luke’s Hospital Foundation. He is a former board member and past president of The Center for Practical Bioethics.
### REFERENCES


