

The Hard Work of Improving Outcomes for Mothers and Babies

Obstetric and Perinatal Quality Improvement Initiatives Make a Difference at the Hospital, State, and National Levels

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KEY POINTS

- Quality improvement and patient safety efforts are a growing focus for perinatal care providers.
- The maternal-focused and perinatal-focused quality improvement initiative results offer strong examples of the impact that perinatal quality improvement and safety work have in improving the delivery of care.
- Expanded work at the hospital, state, and national levels is essential to drive sustainable quality improvement and patient safety efforts that will make every hospital a safer and better place to give birth and be born.

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INTRODUCTION

Quality improvement and patient safety efforts are a growing focus for perinatal care providers. This work has developed in response to major public health goals to reduce maternal and neonatal morbidity and mortality while balancing pressures from consumers and payers to ensure that care is safe, reliable, and effective.¹ Although quality improvement work has been present in medicine for more than 3 decades, it is only recently that a focus on quality improvement and patient safety has become an integral part of perinatal care.^{2–8}

In obstetrics, quality improvement efforts have gradually expanded from local initiatives at single institutions to statewide efforts through state-based perinatal quality collaboratives (PQCs), and recently to national initiatives incorporating multiple state PQCs. Hospital-level work continues to expand as hospitals and health care networks realize the benefits of standardized data measures, quality improvement science, and team-based training and communication strategies to drive improvements in outcomes for mothers and babies.^{9–13} At the state level, PQCs are networks of perinatal care providers and public health professionals working to improve pregnancy outcomes for women and newborns by advancing evidence-based clinical practices and processes through continuous quality improvement. At the national level, numerous initiatives now seek large-scale improvements in obstetric outcomes. The Centers for Disease Control and Prevention (CDC) have taken a leadership role in supporting state PQCs, recognizing PQCs in 39 of 50 states, and supporting 6 (California, New York, Ohio, Illinois, Massachusetts, North Carolina) with Division of Reproductive Health funding for further project development.¹⁴

In addition, the CDC has developed a guide, *Developing and Sustaining Perinatal Quality Collaboratives*, outlining how to initiate and support state-based perinatal quality improvement collaboratives with a goal of achieving a PQC in every state.¹ A launch meeting for the National Network of Perinatal Quality Collaboratives (NNPQC) in 2016, sponsored by the March of Dimes/CDC, was attended by teams representing PQCs in different stages of development from 49 of 50 states.¹⁵ Other national organizations designed to help state collaboratives and hospital perinatal quality improvement teams have also launched major initiatives. These groups include The Alliance for Innovation on Maternal Health (AIM) program with the American Congress of Obstetricians and Gynecologists (ACOG) and the Council for Patient Safety in Women's Health Care; the Collaborative Improvement and Innovation Network (COIN) to Reduce Infant Mortality; Hospital Engagement Networks; March of Dimes Big 5 State Prematurity Collaborative (including California, New York, Texas, Illinois, Florida); and National Institute for Children's Health Quality.^{16–19} Most of these national initiatives have developed since the mid-2000s and have progressed rapidly. At all of these levels, the need for better obstetric data and appropriate performance measures has been clear.

This article highlights key perinatal-focused and obstetric-focused quality improvement initiatives at the local, state, and national levels that have shown improved patient outcomes and clinical care. Quality improvement work with published data is divided into initiatives focused on birth and neonatal outcomes (perinatal quality improvement), reducing maternal morbidity and mortality (obstetric quality improvement), and team-based training. Birth and neonatal outcome-focused quality initiatives include reducing early elective delivery before 39 weeks' gestation, increasing antenatal corticosteroid administration for eligible women, increasing risk-appropriate perinatal care, optimizing prenatal care and access, and optimizing breastfeeding at discharge. Maternal-focused topics include cesarean section rates,

surgical site infection, and postpartum hemorrhage. Reports on team-based training initiatives that may include communication, simulation, or other skills used to help teams improve quality and safety outcomes are included. The article also reviews emerging topics in perinatal quality and safety that are the current work of state and national efforts.

Quality Improvement Terminology

Quality improvement efforts use a unique set of terms to describe quality improvement methodology. Although these terms share similarities with existing concepts and paradigms that physicians, nurses, public health professionals, and other researchers use in existing evidence-based research practices, it is important to understand their subtle differences. **Box 1** includes a selection of these terms for further reference.^{14,20–22}

Box 1

Definitions for perinatal quality improvement collaboratives

Outcome measures

- Evaluate the impact of system changes on maternal or infant health outcomes.
- Example: a project to reduce severe maternal morbidity associated with severe-range blood pressure would have an outcome measure of percentage of cases with new-onset severe hypertension with any adverse maternal outcomes.

Process measures

- Evaluate the impact of system change on steps or parts of the system that have been shown to lead to improved maternal or infant health outcomes.
- Example: a process measure for a perinatal quality improvement project to reduce severe maternal morbidity associated with severe-range blood pressure would be percentage of cases with new-onset severe hypertension treated within 60 minutes.

Balancing measures

- Evaluate the impact of system change in one part of the system on other parts of the system.
- Help hospital teams and perinatal quality monitor for unintended consequences of system change that are causing problems in other parts of the system.
- Example: a balancing measure for a perinatal quality improvement project to reduce severe maternal morbidity associated with severe-range blood pressure would be percentage of cases with new-onset severe hypertension with diastolic pressure decreasing to less than 80 mm Hg within 1 hour of medication administration.

Collaborative learning

- Core quality improvement tool used by perinatal quality collaboratives in which hospital quality improvement teams learn quality improvement strategies from each other through interaction on webinars, conference calls, LISTSERV discussions, Web-based discussion boards, hospital site visits, and exchange of quality improvement data reports.

Plan-Do-Study-Act cycles

- Method to test system changes by creating a plan to test a change (Plan), conducting the test of change (Do), learning from the change (Study), and modifying the test based on the results (Act).

Rapid-response data

- Core quality improvement tool used by perinatal quality collaboratives in which data are submitted by hospital quality improvement teams at least monthly and immediately returned in graphic report format for review of progress toward process and outcome measure goals over time and compared with other hospitals.

Perinatal Quality Improvement

Morbidity and mortality associated with preterm birth, maternal complications of pregnancy, fetal anomalies, and sudden infant death syndrome are the primary causes of infant deaths in the United States. The preterm birth rate in the United States is approximately 1 in 10 and African American women are twice as likely to deliver preterm compared with white women.²³ Local and state quality initiatives have focused on birth and neonatal outcomes work to affect morbidity and mortality across the country, some of which is highlighted later.

Reducing elective delivery before 39 weeks

Reduction of non-medically indicated deliveries before 39 weeks (early elective delivery [EED]) has been one of the most successful perinatal quality improvement initiatives. Recognition of adverse neonatal outcomes associated with early term delivery before 39 weeks, including neonatal intensive care unit (NICU) admission, respiratory distress syndrome, and long-term neonatal morbidity, prompted a nationwide reexamination of elective delivery policies.^{24–27} Initiatives to reduce the rate of EED have ranged from single-center to multistate collaborative efforts, with initial elective delivery rates ranging from 9.6% to 33.1% and postinitiative rates decreasing to as low as less than 2.5% to 16.2%.^{24–29} NICU admissions, which are another outcome measure, were either unchanged^{26,29} or significantly decreased.^{30,31} Stillbirth rates, which are a balancing measure, have overall not increased following initiative implementation.^{29–32}

Most of these efforts incorporated hospital policy changes and provider education, dissemination, and feedback.^{12,28–35} The Ohio Perinatal Quality Collaborative initiative worked with 20 Ohio hospitals to reduce the rate of EED. Hospital improvement teams implemented interventions and identified key drivers for success, such as optimal determination of gestational age with ultrasonography and implementation of hard-stop policies for scheduling delivery. These efforts reduced EED from 25% to less than 5% ($P < .05$).^{36,37}

The March of Dimes Big 5 State Prematurity Initiative was a multistate collaborative effort between California, Florida, Illinois, New York, and Texas to decrease EED. The collaborative selected 26 hospitals without previous EED initiatives to participate. Each hospital used the Elimination of Non-medically Indicated (Elective) Deliveries before 39 Weeks Gestational Age toolkit as an implementation guide along with associated training, policy development, and patient education. The initiative saw a decrease in scheduled EED from 2010 to 2011 by 83%, from 27.8% to 4.8% ($P < .001$).³⁸ This multistate quality improvement program was able to engage diverse national stakeholders and was effective across a diverse population of patients, hospitals, and health care systems, and provides an important example of what broader collaboration can achieve.^{31,33}

Increasing antenatal corticosteroid administration for eligible women

Antenatal corticosteroid (ACS) administration before preterm delivery results in decreased rates of respiratory distress syndrome, intraventricular hemorrhage, necrotizing enterocolitis, and other morbidities associated with prematurity.^{39,40} Current guidelines recommend that all preterm deliveries before 34 weeks and certain preterm deliveries before 36 (6/7) weeks receive ACS.⁴¹ However, baseline data from 1998 suggested that only 76% to 85% of eligible women receive ACS before a preterm delivery, and administration rates may be lower for fetuses of less than 28 weeks' gestation.^{42–45}

The California Perinatal Quality Care Collaborative (CPQCC) implemented a state-based quality improvement initiative to increase ACS rates in women at risk for

preterm delivery between 24 and 34 weeks' gestation. Maternal-fetal medicine specialists served as champions to support and facilitate local quality improvement work through an ACS quality improvement toolkit. The toolkit included quality improvement methodologies and sample documents for policies, procedures, staff education, and competency testing. Toolkit resources were also disseminated through workshops and presentations throughout the state. ACS rates increased for eligible infants from 76% in 1998 to 86% in 2001. Participating hospitals continued to have higher rates of administration approximately 5 years later (85% versus 69%; $P < .001$). However, there is still significant variation of reported rates of ACS administration across California, ranging from 68.4% to 92.9%, with hospitals with lower-level NICUs having lower rates.⁴³

Additional work in other states has suggested that a component of the variability in ACS rates may be related to poor documentation and under-reporting of ACS use. The Ohio Perinatal Quality Collaborative incorporated improved documentation and birth certificate reporting as a component of their ACS initiative.⁴⁶ In addition, they reported elements identified during the Ohio ACS initiative that were needed for high-reliability use of ACS.⁴⁷ The March of Dimes Big 5 State Collaborative launched its second multistate quality initiative in 2015 through 2017, to continue to support hospital work toward increased ACS administration among eligible women.

Increasing risk-appropriate perinatal care

The initial regionalization of perinatal health services in the 1970s was a collaborative effort that led to reduced perinatal mortality and improved outcomes for preterm infants.^{3,48–50} Current guidelines for regionalized perinatal care recommend that neonates less than 32 weeks and less than 1500 g (ie, those that represent the most critically ill neonates and account for significant neonatal morbidity and mortality) deliver at a hospital with a level III NICU because of the improved morbidity and survival rates seen at these centers.⁵⁰ With changing health care environments some areas have seen increased numbers of high-risk deliveries occurring outside level III centers.^{51,52}

Numerous organizations and states have undertaken initiatives to improve the regionalization of perinatal care, focusing primarily on risk-appropriate care for very low birth weight (VLBW) infants.⁵³ One example, the maternal-fetal medicine (MFM) division at the University of Arkansas with the support of the state's Medicaid agency, Department of Health, and medical society launched a statewide program, Antenatal & Neonatal Guidelines, Education, and Learning System (ANGELS) in 2003 to provide an enhanced level of care to the more rural parts of the state and increase referral to higher perinatal levels of care.^{13,54} Using telemedicine support for select high-volume birth centers without neonatal intensive care support services in Arkansas, maternal-fetal medicine specialists collaborated with local providers to develop and adopt best-practice guidelines. These telemedicine-supported hospitals without neonatal intensive care support services were able to decrease their deliveries of VLBW infants from 13.1% in 2009 to 7.0% in 2010 ($P = .01$). Similar hospitals without neonatal intensive care support services in Arkansas that did not receive telemedicine support saw no change in the percentage of deliveries of VLBW infants (23.5% in 2009 vs 23.7% in 2010). There was also a reduction in neonatal mortality for VLBW infants (12% to 6.7% before and after the program, respectively) at the targeted hospitals.⁵⁵

Risk-appropriate perinatal care is a Healthy People 2020 goal, a National Quality Forum process measure, and a major driver in the national Collaborative Improvement and Innovation Network to Reduce Infant Mortality (IM CoIN). To achieve these goals and increase the percentage of mothers and newborns delivered and cared for at

appropriate-level facilities, national standard hospital classifications and improved reliability of hospital discharge data for accurate data collection and interpretation are needed.⁵¹ In addition, although not all indicated transfers to level III hospitals occur before delivery, improving the neonatal transport process warrants further evaluation.^{49,51,56} Implementation and adoption of the CDC Levels of Care Assessment Tool (LOCATe), based on American Academy of Pediatrics, ACOG, and Society for Maternal-Fetal Medicine guidelines, should help states and hospitals assess levels of care in birthing hospitals, and is another important step in this process.⁵⁷ Achieving these improvements in risk-appropriate perinatal care at the hospital and state levels has become an important quality measure and goal given the potential for improved maternal and neonatal outcomes.

Prenatal care optimization and improved access

Access to care and preventive medicine is paramount to long-term improved health outcomes. In pregnancy, this includes early access to prenatal care and expanded coverage to include preconception, postpartum care, mental health, and ancillary social services. In 2010, the Centers for Medicare and Medicaid Services (CMS) implemented the Strong Start for Mothers and Newborns initiative involving selected hospitals and birth centers across the United States. Participating sites tested 3 models for enhanced prenatal care: (1) centering or group prenatal care to foster peer interaction and psychosocial support; (2) comprehensive prenatal care at birth centers with access to health professionals, social work, and case management; and (3) maternity care homes, combining traditional prenatal care with education, health promotion, and additional health services in a single care facility. The goals of the project include testing ways to encourage best practices for reducing the number of early elective deliveries that lack medical indication for all payer types and to reduce preterm birth and adverse outcomes among women enrolled in Medicaid and other public-payer services. Preliminary results have shown significant improvements in outcomes over the course of the project for participating hospitals, including a 64% reduction in early elective deliveries, 58% to 94% increases in breastfeeding rates, 23% reduction in cesarean delivery rates, and 12% reduction in preterm birth rates compared with national averages. In addition, participating hospitals enjoyed high patient satisfaction scores.^{58,59}

In 2014, the CMS Maternal and Infant Health initiative launched the Postpartum Care Action Learning Series in 11 states, designed to strengthen the postpartum visit through quality improvement strategies. One year after its launch, there were 18 active initiatives at hospital, local, and state collaborative levels, including home visits, texting programs, modifications to the electronic medical record for postpartum visit tracking and billing, and reducing language barriers to care.⁶⁰ One promising preliminary result is the effort of a single hospital to reduce its language barrier through bilingual, bicultural prenatal partners, resulting in an improvement in postpartum visits in the intervention group (73% vs 51%).⁶¹

The Geisinger Health System is an integrated health service organization in multiple states that implemented its ProvenCare model to decrease the variability and improve the utility of prenatal care. Twenty-two outpatient sites established 103 unique best-practice measures that were incorporated into a single standardized prenatal care pathway. This pathway was then implemented and tracked, with improvement seen on all clinical measures, including decreased rates of primary cesarean deliveries and NICU admissions.⁶²

The medical home model is designed to improve the quality of prenatal care, improve maternal and perinatal outcomes, and reduce cost. In North Carolina, 90%

of providers caring for the pregnant Medicaid population are part of a pregnancy medical home program. This program requires practitioners to have no elective delivery before 39 weeks; offer and provide 17alpha-hydroxyprogesterone (17-OHP) to patients with a prior spontaneous preterm birth; maintain a cesarean delivery rate less than 16% for term, nulliparous, vertex pregnancies; have a postpartum visit within 60 days of delivery; and coordinate with pregnancy care managers.⁶³ Although the results of this effort are still pending, they represent a substantive effort to address access to care and expanded services to improve maternal and perinatal outcomes.

Optimizing breastfeeding at hospital discharge

Quality improvement efforts to optimize breastfeeding at the time of hospital discharge have been linked to improved perinatal outcomes. The benefits of breast milk for infants include decreased infections, sudden infant death syndrome, asthma and atopy, childhood leukemia, obesity, and diabetes.^{64,65} A team of global experts developed an evidence-based guide called *Ten Steps to Successful Breastfeeding* to increase breastfeeding initiation and duration in the hospital setting.⁶⁶ Using this guide, San Francisco General Hospital saw an increase in rates of breastfeeding initiation from 81% in 2002 to 98% in 2010.⁶⁵

In 2010, the New York State Department of Health in collaboration with the Obesity Prevention Program and National Initiative for Children's Healthcare Quality engaged 12 hospitals in the New York State Breastfeeding Quality Improvement in Hospitals Learning Collaborative. The goal was to increase rates of exclusive breastfeeding and improve hospital practice and policies. Using a multistep Plan-Do-Study-Act improvement cycle, policies and process changes were implemented to comply with the recommendations of *The Ten Steps to Successful Breastfeeding* by the World Health Organization and the United Nations Children's Fund (UNICEF). Seven process measures were identified, including establishment of skin-to-skin contact after birth, efforts to room in (keep mother and baby together), and variations in work flow. The results showed increased rates of skin-to-skin (up to 90%), rooming in (from 0% to 70%), and exclusive breastfeeding (6% to 44%) by 24 months following implementation.⁶⁷

Recognizing that successful breastfeeding on hospital discharge is just 1 milestone on the way to exclusive breastfeeding for the first 6 months of life, the Washington State Department of Health piloted an adapted version of the *Ten Steps to Successful Breastfeeding* to the outpatient community setting to boost rates of continued breastfeeding postpartum in 8 health centers. Using provider-based assessment tools, adjustments to clinic process flow, and reference documents, participating centers implemented, on average, 7 of the 10 steps within the first 6 months.⁶⁸ The program's efficacy once fully operational is yet to be determined.

Maternal-Focused Quality Improvement

The care of mothers at the time of delivery has been a primary focus of obstetric quality improvement efforts. Leaders in maternal-fetal medicine have issued calls for improved efforts to address increasing maternal morbidity and mortality and to put the "M back into maternal-fetal medicine".^{69,70} This article highlights outcome data from quality improvement initiatives focused on reducing maternal morbidity and mortality, including reductions in primary cesarean section rates, surgical site infection, postpartum hemorrhage, and team-based training.

Safe reduction of primary cesarean section

One of the early focuses of obstetric quality improvement has been reduction of cesarean section rates. However, obstetricians have long recognized that cesarean

section rates alone are not an ideal measure of quality care. Although cesarean delivery is associated with adverse maternal health, rates can be affected by provider and hospital practice patterns as well as the baseline health of patient populations, making meaningful comparisons between hospitals and health systems potentially challenging.⁷¹ As such, there has been a transition in quality improvement work from simple reduction of cesarean section rates to promoting vaginal birth, reducing the first cesarean, and appropriate use of the cesarean procedure.

Two San Francisco–based hospitals starting in the late 1980s showed the impact of large-scale data collection, review, and provision to hospitals and providers to inform them of process measures and balancing measures relative to each other regarding cesarean section rates. Focusing on individual and coded group comparison statistics, the Perinatal Data Center (and outcomes and report-generating software) was used to implement policies and guidelines such as checklists and indications for cesarean section that made identification of appropriate process and balancing measures easier. The results of this work showed decreases in overall cesarean section rates from 25% to 18.5% collectively at both centers.⁷² Similar declines were also seen with hospital-level quality improvement work at Cedars-Sinai in Los Angeles, California, and state-level work in Michigan through the Michigan Patient Outcome Measures Project. These two quality improvement projects also showed the importance of data collection using process, balancing, and outcome measures and dissemination to compare measures across sites. They showed reductions of overall cesarean rates of between 3% and 6.5% by evaluating provider variation and using oxytocin protocols and vaginal birth after cesarean section (VBAC).^{73,74}

Since 2000, attention has focused on reducing the cesarean section rate of vertex, nulliparous women at term and the safe prevention of the first cesarean section. Originally developed as a potential process measure for affecting cesarean section rates, health system–level quality improvement work at Sutter Health System in northern California in 2000 sought to look for approaches to improve the outcomes of vertex, term, nulliparous mothers while using appropriate clinical tools to effect provider delivery of care through effective measures and data collection systems. Labor practices, including early labor admission and elective induction of labor with an unfavorable Bishop score, were strongly correlated with higher rates of cesarean section in nulliparous, term, singleton, vertex patients. Five-minute Apgar scores less than 7 at term were not correlated with cesarean section rates.^{75,76} These findings provided a unique consideration that balanced the need for cesarean sections in certain cases, but taking appropriate and safe evidence-based actions to avoid excessive use.

Since that time there have been ongoing efforts to better promote safe reduction of cesarean delivery. Published in 2014, “Obstetric Care Consensus No. 1: Safe Prevention of the Primary Cesarean Delivery” outlined practices that could be incorporated into labor and delivery care to safely prevent primary cesarean section.⁷⁷ Penn State University between 2013 and 2014 showed an overall cesarean section rate reduction of 26.9% to 18.8% with significant gains through reduced cesarean rates following induction or augmentation (35.0%–24.5%).¹¹

Finding differences in neonatal outcomes, as a balancing measure for initiatives reducing cesarean rates, has proved particularly vexing for these single-institutional studies. It is possible that state-based PQCs may be able to better characterize the neonatal impact by aggregating larger numbers. The California Maternal Quality Care Collaborative in 2016 initiated a project entitled Support Vaginal Birth and Reduce Primary Cesarean Sections, designed to further address this issue.⁷⁸

Reduction of surgical site infection

Another effort that arose from optimizing cesarean section has been the reduction in surgical site infections for cesarean deliveries. Taking the existing literature that has showed the effectiveness of antibiotic prophylaxis and surgical site preparation with chlorhexidine, multiple groups have been able to show a reduction in infection rates through hospital-level quality improvement initiatives. At the University of California, Los Angeles Medical Center, a quality improvement initiative reduced infection rates following cesarean delivery from 10.8% to 2.3% from 2005 to 2008.⁷⁹ Components of the initiative included efforts to observe operating room functioning, surveys to assess knowledge gaps and attitudes about infection control, development of process measures such as handwashing compliance and antibiotic administration, and interventions to affect the delivery of care. Similar findings were noted at University of Minnesota and Johns Hopkins University.^{9,80}

Management of postpartum hemorrhage

Postpartum hemorrhage is the primary driver of maternal morbidity and mortality both in the United States and worldwide and generated substantive quality improvement work. New York Hospital Medical Center highlighted their response to maternal deaths related to hemorrhage that occurred from 2000 to 2005. Process changes were implemented following recommendations from a multidisciplinary patient safety team including a rapid-response model. Protocols that led to early diagnosis, assessment, and management of patients at high risk for hemorrhage were associated with a reduction in cases of maternal mortality and no increase in rate of cesarean hysterectomy despite increasing their cases of major obstetric hemorrhage 4-fold from 2000 to 2005 (defined as estimated blood loss >1500 mL, need for blood transfusion, need for operative procedure to control bleeding, and hysterectomy).⁸¹

Similar hospital-level work has confirmed the impact of protocols for hemorrhage management to improve patient care. Marian Medical Center in Santa Barbara, California between 2008 and 2010 showed that implementation of hemorrhage protocols led to improved outcome measures such as fewer blood products for transfusion (16.7 vs 6.3 units/mo, $P < .01$, before and after the protocol, respectively) and a 64% reduction in the incidence of disseminated intravascular coagulation.⁸² Moreover, these protocols were perceived by providers as improving patient safety. The introduction of a hemorrhage protocol at Northwestern University between 2007 and 2011 saw improvement in process measures related to management of postpartum hemorrhage with increased use of proven interventions including uterotonic medications (47% before vs 64.8% after, $P < .001$), intrauterine balloon tamponade (2.9% before vs 6.2% after, $P = .002$), B-Lynch suture placement (3.9% before vs 6.0% after, $P = .042$), uterine artery embolization (0.7% before vs 1.8% after, $P = .05$), and cryoprecipitate (1.9% before vs 3.8% after, $P = .022$), which led to a decreased frequency of intensive care unit (ICU) admission over the same time period.⁸³

State-level PQCs have been essential to education and dissemination efforts within their respective states as well as nationally. New York and California and their associated maternal quality collaboratives have published online safety bundles and toolkits that show how to operate, develop, and execute statewide hemorrhage quality improvement work.^{84–86} The Association of Women's Health, Obstetric, and Neonatal Nurses has also created useful resources and data collection strategies to support hemorrhage initiatives with participating hospitals and states.⁸⁷

Team-Based Training

Hospitals and practitioners may have difficulty adopting new protocols and multiple efforts simultaneously.^{88,89} Team-based training seeks to address these difficulties through the use of safety programs, expert review, protocols and guidelines, simulation and drills, alterations in nursing and provider staffing, event reporting, and safety committees to affect how medical team members approach clinical care. Although initial efforts did not seem to suggest substantive effects when used across multiple hospital centers in New England,⁸⁶ later results from other multiple hospital efforts showed that team-based efforts could be effectively used to enhance patient safety and quality improvement and improve outcomes.^{88,90}

The use of composite measures of adverse maternal and neonatal outcomes (such as ICU admission and traumatic birth injury, in addition to traditional maternal and neonatal mortality) has been particularly helpful toward team-based training efforts. Beth Israel Deaconess Hospital showed the impact of changing the teamwork practices. They found that using communication, situation monitoring, mutual support, and leadership led to a reduced composite measure of adverse maternal and neonatal outcomes.⁹¹ Similar findings were seen at several other hospital-level initiatives.^{89,92–94}

Team-based training initiatives have shown economic impact, particularly with regard to liability claims. Working with the 120 hospitals that comprise the Hospital Corporation of America between 1996 and 2006, an emphasis on uniform processes and procedures, development of unambiguous practice guidelines, and effective peer review showed a decrease in malpractice claims from a high of 13 per 10,000 deliveries (1998) to 6 per 10,000 deliveries (2006).⁸⁸ Similar decreases in claims and payments at Yale New Haven Hospital occurred between 1998 to 2002 and 2003 to 2007 following the implementation of a comprehensive safety program. Claims decreased from 30 to 14 and payments from \$50.7 million versus \$2.9 million over each time period, whereas overall claims across the state of Connecticut were stable with increased costs per claim.⁹⁵

Team-based training has also begun to transition to the state-level PQCs. California and New York have both been actively developing methods to train and educate providers with patient safety bundles for the reduction of morbidity. California's focus has been on hemorrhage and hypertension in pregnancy through the California Partnership for Maternal Safety with conclusion of their work in 2016.⁹⁶ Through its Safe Motherhood Initiative, New York has focused on hypertension, hemorrhage, and thromboembolism with protocols addressing diagnosis, prevention, and management and is in the midst of an ongoing effort that commenced in 2011.⁹⁷ When this work is published it will provide additional understanding of the challenges and benefits of hospital team-based training supported by a state-level collaborative.

Emerging Topics

The immediate future for obstetric quality collaboratives and PQCs is exciting. At the hospital and state levels, work in hypertension in pregnancy, hemorrhage, neonatal abstinence syndrome, reduction of primary cesarean section, provision of 17-OHP for preterm birth prevention, long-acting reversible contraception placement immediately postpartum, and birth certificate accuracy projects are all currently in process. These major projects will shed light on timely and important considerations for perinatal care in the United States.¹⁴

Multiple states are working on reducing maternal morbidity associated with pre-eclampsia and severe hypertension in pregnancy and the postpartum period.

California and New York have led the way with initiatives directed at improving care for maternal hypertension. Their toolkits and resources are available on their Web sites and have contributed to the development of the AIM Hypertension Bundle. California is showing preliminary reduction in population-level maternal mortality, whereas other states, including Michigan, Oklahoma, Illinois, Florida, and North Carolina, have embarked on similar work reducing time to treatment of severe hypertension, appropriate preeclampsia management, patient education and follow-up, and decrease in incidence of associated maternal morbidity.^{14,98,99} Incorporating work with hypertension, the development of maternal early warning triggers (MEWTs) and similar tools designed to use maternal vital signs to identify patients at risk of clinical deterioration and subsequent morbidity have emerged.^{100,101} Work from California using MEWTs has shown substantive reductions in maternal morbidity and provides a model for implementation and further testing by other hospital-level and PQC efforts.¹⁰⁰ Neonatal abstinence syndrome has the attention of numerous states (Ohio, Illinois, Massachusetts, New York, West Virginia, Kentucky, Michigan, Tennessee, Utah, Vermont, New Hampshire) across the country with projects reflecting the national opioid epidemic. Initiatives to increase use of 17-OHP for recurrent preterm birth prevention with hospital-level initiatives in Massachusetts and the state PQC in Ohio expand PQC work into the prenatal care setting to identify at-risk women and increase rates of timely and sustained 17-OHP use.¹⁴ Placement of long-acting reversible contraception (LARC), including an intrauterine device or implantable contraceptive such as etonorgestrel implant, immediately after delivery has been recognized for its potential to increase usage rates for effective, reliable postpartum birth control. State PQC work in South Carolina has made that state a prominent leader in quality improvement work to increase the use of LARC with Medicaid backing.¹⁰² Ohio and Illinois have performed substantive work in optimization of birth certificate accuracy, making a notoriously inaccurate data source increasingly accurate and reliable.¹⁴

The state-based nature of these efforts has the potential to affect outcomes, cost, and resource allocation within states and nationally. The foundation of state PQCs occurs through hospital-level improvement teams. Improved patient outcomes occur through individual hospitals' efforts to use collaborative resources, collaborative learning, and shared data to drive quality improvement strategies that create sustainable systems-level and team culture change driven by providers and nurses.

Future Considerations

To achieve expanded and sustained quality improvement, hospital, state, and national level quality improvement efforts need perinatal provider champions. Physicians, midwives and nurses, and other staff need quality improvement training to contribute their clinical and systems expertise to the quality improvement process. With education comes improved understanding by staff and providers of the importance of quality improvement work to improve patient care and outcomes. Hospital teams need institutional support for their quality improvement work. Patient and family engagement in hospital-level quality improvement teams helps initiatives to better understand the patient perspective and is associated with faster improvement and improved outcomes overall. State PQCs support hospital-level initiatives with rapid-response data, opportunities for collaborative learning, and quality improvement strategies and support. National initiatives and organizations provide resources, bundles, and toolkits to support state PQCs and their initiatives, assist development, expansion and sustainability

of PQCs nationwide, and opportunities for sharing and support across initiatives and collaboratives.

State PQCs require resources, particularly reliable and responsive data collection and reporting processes and funding. Low-burden data collection processes and easily interpreted reports help hospitals direct their quality improvement efforts and allow state PQCs to track progress and provide resources to support hospital teams' work toward improvement goals.¹ Government funding sources of state PQCs include CDC and Division of Reproductive Health, IM CoIIN, Agency for Healthcare Research and Quality (AHRQ), Centers for Medicare Services (CMS), Title V Maternal and Child Health Block Grant Program, state departments of public health, and Medicaid. Private funding sources of state PQCs include insurers, March of Dimes, ACOG, and pharmaceutical company foundations such as Merck for Mothers. The March of Dimes supports the NNPQC.^{14–18,97} A mix of public and private funding is essential to foster, develop, and sustain perinatal quality collaborative work into the future.

Despite the significant advances by perinatal and obstetric quality initiatives over the years and their increasing prominence and recognition, there is still much work to be done. There are resources available at the state and national levels to support this work by providing evidence-based toolkits, bundles, and standardized measures to assist the start-up of quality initiatives. At present, many quality collaboratives have comprehensive and detailed resources, including safety bundles and toolkits for implementation of quality improvement work, available on their Web sites.^{14–18,97} In addition, the Council on Patient Safety in Women's Healthcare with the AIM in collaboration with ACOG and other partners has laid out comprehensive safety bundles and tools. Available bundles include reduction of primary cesarean birth, obstetric hemorrhage, prevention of preterm birth, severe hypertension in pregnancy, prevention of neonatal abstinence syndrome, venous thromboembolism, mental health, reduction of peripartum racial/ethnic disparities, and support after a severe maternal event.¹⁸ Further publication and dissemination of the findings and work of these organizations should help to highlight these resources and familiarize providers and staff with quality improvement methodology. The expansion of PQCs will need to continue to be sustained and supported. Physician leaders should use organizations at the state (departments of health and Medicaid) as well as national levels (NNPQC, Medicaid, Title V, ACOG, and CDC) to determine available resources and support for their work. Such support includes, but is not limited to, effective data systems, collaborative teams, and advisory groups to allow for effective engagement in ongoing quality initiatives.^{1,15}

The work that quality improvement initiatives have achieved is significant. The maternal-focused and perinatal-focused quality improvement initiative results reviewed earlier offer strong examples of the impact that perinatal quality improvement and safety work has in improving the delivery of care. Expanded work at the hospital, state, and national levels is essential to drive sustainable quality improvement and patient safety efforts that will make every hospital a safer and better place to give birth and be born.

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