



Commonwealth of Massachusetts
Board of Registration in Medicine
Quality and Patient Safety Division

Identification of High Risk Maternity Patients and Management of Obstetrical Emergencies

August 2015

This Advisory is issued in collaboration with the Massachusetts Department of Public Health (DPH) Bureau of Health Care Safety and Quality (BHCSQ). The BHCSQ and Quality and Patient Safety Division (QPSD) have received reports describing maternal morbidity and mortality events.¹ The goal of this Advisory is to support health care facilities in the review and development of their approaches to pre-delivery assessment of risk, staff training, response to obstetric emergencies and use of quality indicators. While some references are provided, this Advisory does not include a comprehensive review of the literature; nor is it intended to provide specific recommendations for evidence-based practice.

Publication of this Advisory does not constitute an endorsement by the Board or DPH of any studies or practices described in the Advisory and none should be inferred.

Overview of BHCSQ and QPSD Reports

For the time period 2011 through 2014, BHCSQ received reports of 20 maternal deaths, with 9 of these events occurring in low risk pregnancies.² Maternal age ranged from 22 to 42 years, with a mean of 32.6 years. Race was identified as Caucasian (11), and Other/Unknown (9). Proximate causes of death from the events reported to BHCSQ included HELLP, ovarian artery rupture, AV malformation rupture, peripartum cardiomyopathy, placenta accreta, metastatic squamous cell lung cancer, seizure and amniotic fluid emboli.

Maternal morbidity received by BHCSQ and QPSD included hemorrhage requiring transfusions and/or ICU stay, and hysterectomy. QPSD also received reports describing post cesarean section infection, neuropathy associated with prolonged labor and positioning, and complications associated with uterine rupture.

¹ Maternal mortality and morbidity events are reported through the BHCSQ's Serious Reportable Events and Serious Incident reporting program (105 CMR 130.332) and QPSD's Safety and Quality Review reporting program. (243 CMR 3.08)

² Low risk pregnancy is defined as a pregnancy occurring in a woman aged 18-39 who has no diagnosis of essential hypertension, renal disease, collagen-vascular disease, liver disease, pre-eclampsia, cardiovascular disease, placenta previa, multiple gestation, intrauterine growth restriction, smoking, pregnancy-induced hypertension, premature rupture of membranes, or other previously documented condition that poses a high risk of poor pregnancy outcome. (2012 SRE Guidance).

In addition to review of maternal events through its SRE reporting process, DPH facilitates two advisory committees consisting of experts from around the Commonwealth in obstetrics and perinatal care, the *Maternal Morbidity and Mortality Review Committee* and the *Perinatal Advisory Committee*. Both groups regularly review adverse events at their meetings through either a clinical chart review process or discussing trends observed in a particular injury type.

QPSD reviews individual maternal reports with the reporting hospitals and facilitates the sharing of lessons learned from the reports through its newsletters and advisories.

Cases Examples and Lessons Learned

In reported cases involving postpartum hemorrhage or hypertension/pre-eclampsia, health care facility review findings led to enhanced staff education and training on the identification and treatment of obstetric emergencies; improved processes for communication between providers, staff, blood banks and tertiary care facilities; and a recognition that contingency plans didn't always work as designed.

Examples of specific improvement measures implemented included:

- *Implementation of more frequent competency checks and training. For example, labor & delivery nurses at one facility are checked for fetal heart monitoring competency every three months.*
- *Enhanced electronic access by the hospital providers to obstetricians' office records and the development of a system for pre-admission identification of high risk patients.*
- *Twice daily staff and physician huddles on the labor and delivery unit to review the status of patients and any safety concerns.*
- *Clarification of criteria for nurse-midwife to notify obstetrician of changes in patient risk status during labor and delivery.*
- *Development of a more accurate process to measure blood loss post-delivery.*
- *Change in venue for high risk cesarean sections from the labor and delivery unit to the main operating room, with a well-defined protocol for defining high-risk.*
- *Creation of a multiservice equipment cart for the labor and delivery unit, filled with essentials for non-OB providers who may be called upon to provide assistance in emergencies, (e.g., trauma, general surgery, vascular, urology).*
- *Requirement for ACLS certification for all labor and delivery and post-partum staff.*
- *Implementation of a process for earlier notification of the anesthesia service for patients who are having greater than normal bleeding, so an anesthesia provider can assist the team with IV access and fluid management.*
- *Recognition of staff fatigue during prolonged management of OB emergencies - the implementation of a process for paging additional surgical back-up to assist with decision-making.*
- *Expansion of membership on the Code team to include Obstetric and Pediatric specialists.*
- *Review and revision of transfer agreement with the tertiary care facility to assure an expedited process for emergent transfer of obstetrical patients.*

Background

Many ongoing efforts are being made to reduce the maternal mortality rate in the United States but it remains consistently higher than Canada, most European countries and Australia.³ There are also significant disparities in pregnancy-related mortality; non-Hispanic black mothers are at more than three times the risk of dying when compared to non-Hispanic white mothers.⁴ Between 1987 and 2010, deaths from hemorrhage, hypertensive disorders of pregnancy, embolism and anesthesia complications declined, while those from cardiovascular conditions increased.⁵ While women 35 and older represent less than 15% of the live births, 27.5% of deaths occurred among this age group.⁶ Among women with known timing of death, 22.7% died before delivery, 16.6% died on the day of delivery or pregnancy termination, 20.8% died 1-6 days postpartum and 26.6% died 7-41 days postpartum.⁷ The most common causes of maternal mortality are shown in the *Center for Disease Control* graph below. (Figure 1)

Approximately half of cases of maternal mortality may be potentially preventable, varying by cause and geographic location.⁸

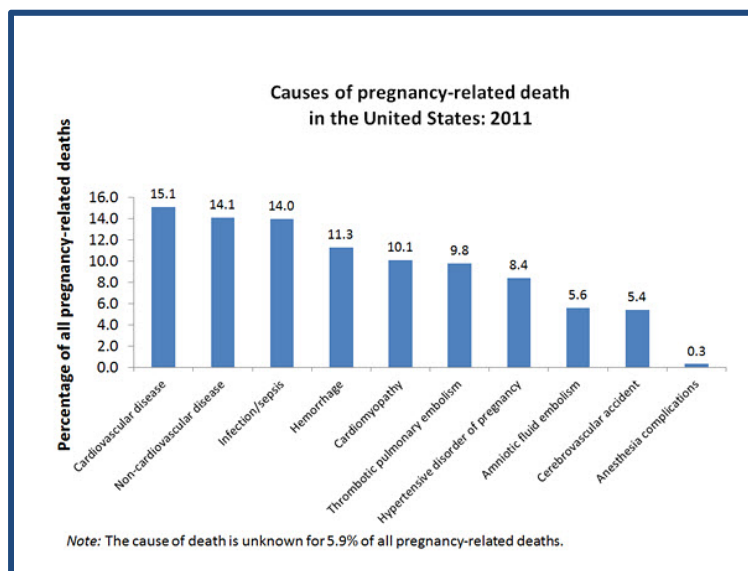


Figure 1. Causes of pregnancy-related death in the US, 2011.⁹

Severe maternal morbidity is increasing in frequency, now roughly 2.9/1,000 births, with more than two-thirds of the cases due to hemorrhage and hypertensive disorders.¹⁰ The probability

³ Trends in Maternal Mortality, 1990-2010, WHO, UNICEF, UNFPA and The World Bank Estimates. Accessed 7/15/15 at <http://www.unfpa.org/publications/trends-maternal-mortality-1990-2013>.

⁴ Creanga, AA, et al. *Pregnancy-Related Mortality in the United States, 2006-2010*. Obstet Gynecol 2015; 125:5-12.

⁵ *Ibid.*, 9.

⁶ Creanga, *op.cit.*

⁷ Creanga, *op. cit.*

⁸ D'Alton, ME, et al. The National Partnership for Maternal Safety. Obstet Gynecol 2014; 123(5):973-77.

⁹ CDC Pregnancy Mortality Surveillance System webpage. Accessed 7/15/15 at <http://www.cdc.gov/reproductivehealth/MaternalInfantHealth/PMSS.html>.

of experiencing severe morbidity has been shown to be related to multiple well-defined patient characteristics, which include placenta accreta, preterm delivery, antenatal anticoagulant or cigarette use, hypertension, diabetes mellitus, abruptio placenta and prior cesarean delivery.¹¹

Factors leading to maternal mortality or severe morbidity are diverse and variable. Ineffective communication is often found to play a major or compounding role in case reviews. In addition, emergency protocols may not operate as expected, and staff may not be adequately trained or prepared to manage a rare emergent event. A thoughtful case review from a Massachusetts academic medical center found that poor communication among staff and with the patient and family, inadequate conflict resolution, poor situational awareness and excessive physician workload were significant points of failure.¹²

Areas for Health Care Facility Systems Review

The areas described below provide topics and references as support for internal discussion and review of health care facility strategies regarding patient risk assessment, emergency guidelines, protocols and training.

General concepts for quality improvement

The collaborative efforts of multiple stakeholders are demonstrating success in improving perinatal care. For example, data recently published by *The Leapfrog Group* shows that in 2014 Massachusetts hospitals performed just over 2 percent of their deliveries on average as early elective deliveries before 39 weeks, compared with their 2010 statewide rate of 15 percent.¹³ The success in reducing early elective deliveries has been attributed to the efforts of multiple stakeholder groups, including the *Massachusetts Perinatal Quality Collaborative*.¹⁴

The *American College of Obstetricians and Gynecologists* and the *American College of Nurse-Midwives* recognize that quality of care is enhanced by collegial relationships and endorse a system of care that fosters interdisciplinary collaboration and communication.¹⁵ Multiple stakeholder professional organizations have jointly acknowledged the importance of working together to improve patient outcomes, emphasizing the need for mutual respect, patient-centered care, shared decision making, teamwork and effective communication at multiple levels of the organization.¹⁶ The *Institute for Healthcare Improvement*, in describing a systems-

¹⁰ Grobman, WA, et al. *Frequency and Factors Associated with Severe Maternal Morbidity*. *Obstet Gynecol* 2014; 123:804-10.

¹¹ Grobman, *op. cit.*, 806.

¹² Sachs, BP. *A 38-Year-Old Woman with Fetal Loss and Hysterectomy*. *JAMA* 2005; 294(7):833-40.

¹³ The LeapFrog Group. *Results of 2014 Hospital Rates of Early Scheduled Delivery*. Accessed 7/15/15 at <http://www.leapfroggroup.org/tooearlydeliveries>.

¹⁴ The Boston Globe. *Fewer Babies Born Before Full Term*. Accessed 7/15/15 at <http://www.bostonglobe.com/lifestyle/health-wellness/2014/03/04/dramatic-decline-early-scheduled-deliveries-mass-hospitals/DOXWjDRuMEX7qCrFeFo0pJ/story.html>

¹⁵ *Joint Statement of Practice Relations between Obstetrician-Gynecologists and Certified Nurse-Midwives/Certified Midwives*. February 2011. Accessed 7/15/15 at: <http://www.acog.org/-/media/Statements-of-Policy/Public/sop1102.pdf?dmc=1&ts=20150621T1752561643..>

¹⁶ *Quality Patient Care in Labor and Delivery: A Call to Action*. December 1, 2011. Accessed 7/15/15 at <http://www.acog.org/About-ACOG/ACOG-Departments/Patient-Safety-and-Quality-Improvement/Quality-Patient-Care-in-Labor-and-Delivery-A-Call-to-Action>.

focused, science-based approach to improving perinatal care, emphasizes the importance of involving multiple stakeholders, as well as a focus on leadership, reliability, teamwork and communication, and person-centered engagement.¹⁷

Numerous articles have assessed and summarized data and case reviews, and noted broadly accepted elements of maternal mortality and morbidity improvement strategies.^{18,19,20,21}

Recommendations for improvement strategies include:

- Plan for clinical emergencies and rapidly identify developing problems before the patient becomes unstable.
- Develop and maintain a structured patient hand-off process.
- Reduce variation in patient care through the use of protocols and checklists.
- Manage obstetrical provider workload to prevent excessive case load and fatigue.
- Empower all health care providers to identify problems and initiate corrective actions.
- Have a process for identifying patients with severe morbidity and review those cases through a multidisciplinary Severe Maternal Morbidity Committee. (The Joint Commission)²²
- Use a “systems-based” approach to quality improvement, rather than a punitive approach to those involved in adverse outcomes.

Priority bundles/toolkits

Bundles, first developed by the Institute for Healthcare Improvement, are a structured way of improving the processes of care through the use of a group or “bundle” of evidence-based practices that have been proven to improve patient outcomes.²³ Using the “bundle” concept, a number of obstetrical toolkits have been developed to address maternal hemorrhage, preeclampsia, venous thromboembolism, as well as other maternal complications or conditions. Robust toolkits have been developed by *California Maternal Quality Care Collaborative*²⁴ and have been adapted by other organizations to fit their needs. Toolkits may contain care guidelines, checklists, flowcharts, best practice articles and tools, and hospital level implementation guides.

The *National Partnership for Maternal Safety* has identified the following “Core Patient Safety Bundles” as key priorities for Maternal Safety: (1) obstetric hemorrhage; (2) severe hypertension

¹⁷ Bisognano, M, et al. *Applying a Science-Based Method to Improve Perinatal Care*. Obstet Gynecol 2014; 124:810-14.

¹⁸ *Standardization of Practice to Improve Outcomes*. Committee Opinion No. 526. American College of Obstetricians and Gynecologists. Obstet Gynecol 2012;119:1081–2.

¹⁹ Sachs, *op. cit.*

²⁰ *Preparing for Clinical Emergencies in Obstetrics and Gynecology*. Committee Opinion No. 590. ACOG. Obstet Gynecol 2014; 123:722-5.

²¹ Clark, SL. *Strategies for Reducing Maternal Mortality*. Semin Perinatol, 2012. 36:42-47.

²² The Joint Commission. *Reviewing Maternal Morbidity*. Quick Safety, 2014. Accessed 7/15/15 at http://www.jointcommission.org/assets/1/23/Quick_Safety_Issue_Six_Sep_2014_FINAL.pdf

²³ Resar R, et al. *Using Care Bundles to Improve Health Care Quality*. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare Improvement; 2012. (Available at www.IHI.org.)

²⁴ California Maternal Quality Care Collaborative (CMQCC). *Resources and Toolkits*. Accessed 7/15/15 at <https://cmqcc.org>

in pregnancy; and (3) venous thromboembolism in pregnancy.²⁵ Templates for these bundles are available at <http://www.safehealthcareforeverywoman.org/maternal-safety.html>.

Antepartum risk assessment

Risk assessment is a multi-layered process that must begin prior to the hospital setting. Psychosocial, family history, racial/ethnic and medical factors are some of the areas for pre-pregnancy and pre-delivery screening. Up-to-date prenatal records should be available at the time of admission, and handoffs from the office setting to hospitals should be standardized and robust. Patient risk factors identified during the prenatal period must be clearly communicated to the hospital providers. If the patient is low risk, that diagnosis should be made and documented, not inferred by a lack of prenatal information. A full review of the variety of available and recommended screening tools is beyond the scope of this advisory. Screening questions and guidelines are part of toolkits.

The *California Maternal Quality of Care Collaborative* is developing a toolkit for assessment and management of cardiovascular disease in pregnancy and postpartum, with publication planned for late 2015.²⁶

Communication

Breakdown in communication is a leading cause of medical error.²⁷ Poor or inadequate communication may involve patients and families, clinicians, hospital units, tertiary care centers and/or blood banks. Hierarchies within and between professions, incomplete or undocumented information, inadequate opportunity for interactive discussion and changes in personnel can all contribute to communication failures.

Effective patient handoffs are critical to good clinical care and require communication between disciplines, such as obstetrics, nursing, anesthesia and medicine. Ideally handoffs are standardized, convey clinical information in a clear and concise manner to providers, patients and families, and provide a written or electronic record for later review. There are a number of tools in use to improve handoffs.^{28,29}

- a. *SBAR* (Situation, Background, Assessment, Recommendation) was created by clinical staff at Kaiser Permanente in Colorado and provides an easily remembered format for clear information exchange. A SBAR toolkit is available online through the Institute for Healthcare Improvement at <http://www.ihl.org/resources/Pages/Tools/sbartoolkit.aspx>.
- b. The *TeamSTEPPS* system was developed by the Agency for Healthcare Research and Quality and the U.S. Department of Defense. It contains strategies to improve information exchange during transitions of care and to enhance communication and teamwork skills among clinicians. Information is available at <http://teamstepps.ahrq.gov>.

²⁵ D'Alton, *op. cit.*, 974-76.

²⁶ California Maternal Quality of Care Collaborative. Accessed 7/9/15 at <https://www.cmccc.org/projects/cardiovascular-disease-pregnancy-postpartum>.

²⁷ *Communication Strategies for Patient Handoffs*. Committee Opinion No. 517. ACOG. Obstet Gynecol 2012; 119:408-11. Accessed 7/15/15 at <http://www.acog.org/-/media/Committee-Opinions/Committee-on-Patient-Safety-and-Quality-Improvement/co517.pdf?dmc=1&ts=20150219T1613440826>

²⁸ *Ibid.*

²⁹ LaValley, D. *Reducing Risk During Handoffs*. CRICO/RMF Forum, 2007; 25(1):1-24. Accessed 7/15/15 at <https://www.rmff.harvard.edu/~media/Files/Global/KC/Forums/2007/forumMar2007.pdf>.

- c. The *I-PASS Handoff Bundle* is an evidence-based, standardized approach to teaching, evaluating, and improving handoffs. Information and tools are available at <http://ipasshandoffstudy.com>.

Communication is enhanced through the use of effective policies for escalation of care. Maternal Early Warning Criteria, a list of parameters that indicate the need for urgent bedside evaluation by the appropriate clinician, are being developed and tested. This is in response to the recognition of the need for more timely diagnosis and treatment of obstetric patients who develop critical illness.³⁰

Team Training/Crew Resource Management (CRM)

The use of structured systems to provide maternal and infant care are recommended for improved response to rapid changes in patient status.³¹ Training in principles of Crew Resource Management, drills and simulations, and debriefings and case reviews are some of the effective system elements. In the hospital setting, physicians, midwives, nurses, anesthesiologists and all other clinicians are equal partners in the team approach to quality obstetrical care.

- a. Mutual performance cross-checking, the concept that any clinician identifying a clinical care issue notifies a supervisor or attending physician, is a critical component of team work and improvement.
- b. Crew Resource Management has been used at *Beth Israel Deaconess Medical Center* and is recommended by The Joint Commission.³²
- c. Simulation centers allow clinicians to practice drills on infrequently encountered obstetric emergencies.
- d. Baseline and ongoing assessments of team function can provide feedback and monitoring on training activities.

Disparities

The causes of excess deaths, particularly among non-Hispanic black mothers (NHB), may include social determinants of health (including access to healthy food, housing and employment as well as higher exposure to environmental threats like violence or poor water and sanitation) and increased rates of preexisting medical conditions.³³ For example, the rates of hypertension, diabetes and heart disease are greater among NHB women of child-bearing age than in non-Hispanic white and Hispanic mothers. While addressing population-level racial and ethnic health disparities may be beyond the scope of an individual facility, it is important to understand in detail the health characteristics of the catchment population in order to improve antepartum risk assessment. Community outreach to help increase timely access to prenatal care and to collaborate with community stakeholders to address social determinants of health may serve to reduce racial and ethnic disparities.

³⁰ Mhyre, JM., et al. *The Maternal Early Warning Criteria: A Proposal from the National Partnership for Maternal Safety*. JOGNN, 2014;00(0):1-9.

³¹ *Quality Patient Care in Labor and Delivery: A Call to Action*. op. cit.

³² Pratt, SD, et al. *Impact of CRM-Based Team Training on Obstetric Outcomes and Clinician's Patient Safety Attitudes*. The Joint Commission J Quality Pt Safety, 2007; 33(12):720-25.

³³ Creanga, op. cit.

Quality Indicators and Data Measurement

There is a growing recognition by the obstetrical community that reliable measurement of performance is essential to improving the quality of patient care.³⁴ Health care facilities should have processes to systematically track and evaluate obstetrical care processes and outcomes. The use of a “trigger” methodology to review obstetrical records for potential adverse events can be an effective tool for identifying patient harm or potential harm.³⁵

A myriad of data points are collected in the course of each maternal admission. Because maternal mortality is rare in Massachusetts, and exceedingly rare for a given facility, severe maternal morbidity has been recommended as a more useful measure of quality health care.³⁶ Severe maternal morbidity has been defined to include unanticipated surgical intervention, intubation for more than 12 hours postpartum, admission to the ICU, transfusion of four or more units of blood products, or organ failure. There are efforts underway to standardize the definition for severe maternal morbidity to improve data collection and provide a foundation for quality improvement.³⁷ Sentinel event clarification and additional case reviews are available from *The Joint Commission* and *American College of Obstetricians and Gynecologists*.³⁸

The *Massachusetts Statewide Quality Advisory Committee* recently released the results of its research on quality measurement of obstetric care. The report includes a review of quality measures currently used by health care organizations and discusses issues relating to the feasibility of collecting and reporting hospital specific and individual provider data.³⁹ The *Massachusetts Perinatal Quality Collaborative* is working with maternity hospitals in Massachusetts to develop collaborative systems for data collection, collective review and assessment. (<http://www.mapqc.org/>)

Conclusion

Maternal mortality and severe morbidity are calamitous and often preventable events, affecting patients, their families and providers. Reduction in maternal mortality and morbidity requires leadership, teamwork and a commitment to patient-centered care. It is well-documented that adoption and consistent use of readily available obstetric toolkits, communication systems and team training can reduce the risk of human error and improve the function of obstetric teams and units. A collaborative approach to data assessment and quality improvement between facilities and key perinatal stakeholders allows for sharing of best practices and can promote rapid improvement.

Health care facility governing boards can demonstrate their commitment to assuring the highest quality maternity care by supporting the development of reliable systems for collection and

³⁴ Bisognano, *op. cit.*, 810.

³⁵ Institute for Healthcare Improvement. *IHI Perinatal Trigger Tool*. Accessed 7/15/15 at <http://www.ihl.org/resources/Pages/Tools/PerinatalTriggerTool.aspx>.

³⁶ The Joint Commission. *Reviewing Maternal Morbidity*, *op. cit.*

³⁷ Gropman, *op. cit.*

³⁸ *Severe Maternal Morbidity: Clarification of the New Joint Commission Sentinel Event Policy*. January 2015. Accessed 7/15/15 at <http://www.acog.org/About-ACOG/News-Room/Statements/2015/Severe-Maternal-Morbidity-Clarification-of-the-New-Joint-Commission-Sentinel-Event-Policy>

³⁹ Massachusetts Statewide Quality Advisory Committee. *Summary of Research and Stakeholder's Perspectives on Quality Measurement and Reporting of Obstetric Care in the Commonwealth*. June 2015. Accessed 7/22/15 at <http://www.chiamass.gov/assets/docs/r/SQAC-Final-OB-Brief-6-26-15.pdf>.

review of obstetric quality data (process and outcomes). Routine review of data allows for early identification of variations in practice, and can encourage recognition of those areas where performance positively exceeds benchmarks. Governing board, administrative and medical leadership should also support the development of an institution-wide, effective system for performing analyses of both patient harms and conditions that create the potential for patient harm.⁴⁰

When serious obstetric events do occur, it is expected that health care facilities will demonstrate, through their internal review findings, that all opportunities to prevent future similar events have been identified. A systems-based, patient-centered approach to maternity care, founded on current best practice should be evident in facilities' improvement measures and action plans.

Additional References/Resources

National and State Organizations

American Congress of Obstetricians and Gynecologists, <http://www.acog.org/>

American College of Nurse-Midwives, <http://www.midwife.org/>

Association of Women's Health, OB and Neonatal Nurses (AWHONN),
<https://www.awhonn.org/awhonn/>

California Maternal Quality Care Collaborative, <https://cmqcc.org>

Council for Patient Safety in Women's Healthcare,
<http://www.safehealthcareforeverywoman.org/>

Massachusetts Perinatal Quality Collaborative, <http://www.mapqc.org>

Massachusetts Department of Public Health Maternal Mortality and Mortality Program,
[http://www.mass.gov/eohhs/gov/departments/dph/programs/family-health/maternal-mortality-and-morbidity-prog-/](http://www.mass.gov/eohhs/gov/departments/dph/programs/family-health/maternal-mortality-and-morbidity-prog/)

National Partnership for Maternal Safety,
<http://www.safehealthcareforeverywoman.org/maternal-safety.html>

Neonatal Quality Improvement Collaborative of Massachusetts, <http://www.neogic.org/>

Society for Maternal-Fetal Medicine, <https://www.smfm.org/publications>

⁴⁰ The National Patient Safety Foundation recently published guidelines for developing effective systems for review of medical errors, adverse events and near misses, available at:
http://c.ymcdn.com/sites/www.npsf.org/resource/resmgr/PDF/RCA2_first-online-pub_061615.pdf

Additional Resources and References

How-to Guide: Prevent Obstetrical Adverse Events. Cambridge, MA: Institute for Healthcare Improvement; 2012. (Available at www.ihl.org)

Cherouny PH, et al. *Idealized Design of Perinatal Care*. IHI Innovation Series white paper. Cambridge, MA: Institute for Healthcare Improvement; 2005. (Available on www.IHI.org)

The Joint Commission. Sentinel Event Alert. *Preventing Maternal Death*. Issue 44. January 2010. Accessed 1/25/15 at http://www.jointcommission.org/assets/1/18/SEA_44.PDF

Main, E.K. *Perinatal Quality Collaboratives: State and National Projects*. Presentation 11/13/14. <http://www.mapqc.org/summit-presentations/>

Premier Hospital Engagement Network. “R” is for Readiness: *Developing and improving your hospital’s OB emergency simulation program*. Presentation, 9/11/14. <http://www.mapqc.org/app/download/961041789/improving+hospitals+OB+emergency+simulation+program.pdf>

Health Research and Educational Trust (HRET) resources useful for obstetrics are available at <http://www.mapqc.org/useful-resources/>

AHRQ Executive Summary: Likis FE, et al. Management of Postpartum Hemorrhage. Comparative Effectiveness Review No. 151. (2015) <http://effectivehealthcare.ahrq.gov/index.cfm/search-for-guides-reviews-and-reports/?productid=2077&pageaction=displayproduct>

Quantification of Blood Loss: AWHONN Practice Brief Number 1. JOGNN, 00, 1-3; 2014. Accessed 7/15/15 at http://www.pphproject.org/downloads/awhonn_qbl.pdf.

Arriaga, AF, et al. *Simulation-Based Trial of Surgical-Crisis Checklists*. N Engl J Med 2013; 368: 246-53. [Checklists for operating room crises, (e.g. cardiac arrest, massive hemorrhage) have potential to improve surgical care.]

Graves CR, et al. *The Initiation of Simulation Training at a Large Community Hospital*. Proc Obstet Gynecol 2012 May;2(3):1-2.

Management of Shoulder Dystocia Emergencies
Grobman, WA. *Shoulder-Dystocia: Simulation and a Team-Centered Protocol*. Semin Perinatol 2014; 38: 205-209.

Crofts, JF, et al. *Observations from 450 Shoulder Dystocia Simulations*. Obstet Gynecol 2008; 112(4):906-911.