

# The Maternal Early Warning Criteria

## A Proposal From the National Partnership for Maternal Safety

Jill M. Mhyre, MD, Robyn D'Oria, MA, RNC, APN, Afshan B. Hameed, MD, Justin R. Lappen, MD, Sharon L. Holley, CNM, DPN, Stephen K. Hunter, MD, PhD, Robin L. Jones, MD, Jeffrey C. King, MD, and Mary E. D'Alton, MD

Case reviews of maternal death have revealed a concerning pattern of delay in recognition of hemorrhage, hypertensive crisis, sepsis, venous thromboembolism, and heart failure. Early-warning systems have been proposed to facilitate timely recognition, diagnosis, and treatment for women developing critical illness. A multidisciplinary working group convened by the National Partnership for Maternal Safety used a consensus-based approach to define The Maternal Early Warning Criteria, a list of abnormal parameters that indicate the need for urgent bedside evaluation by a clinician with

the capacity to escalate care as necessary in order to pursue diagnostic and therapeutic interventions. This commentary reviews the evidence supporting the use of early-warning systems and describes The Maternal Early Warning Criteria, along with considerations for local implementation.

(*Obstet Gynecol* 2014;124:782–6)

DOI: 10.1097/AOG.0000000000000480

From the Department of Anesthesiology, University of Arkansas for Medical Sciences, Little Rock, Arkansas; the Central Jersey Family Health Consortium, Inc., North Brunswick, New Jersey; the Departments of Cardiology and Maternal-Fetal Medicine, University of California, Irvine, Irvine, California; the Department of Reproductive Biology, Case Western Reserve University School of Medicine and the Department of Obstetrics and Gynecology, University Hospitals Case Medical Center, Cleveland, Ohio; the School of Nursing, Vanderbilt University, Nashville, Tennessee; the Department of Obstetrics and Gynecology, Maternal-Fetal Medicine, University of Iowa Hospitals and Clinics, Iowa City, Iowa; the Department of Obstetrics and Gynecology, Rush University Medical Center, Chicago, Illinois; the Division of Maternal-Fetal Medicine, Department of Obstetrics, Gynecology and Women's Health, University of Louisville, Louisville, Kentucky; and the Department of Obstetrics & Gynecology, Maternal-Fetal Medicine, Columbia University Medical Center, New York, New York.

This article is being published concurrently in the November/December 2014 issue (Vol. 43, No. 6) of *Journal of Obstetric, Gynecologic, & Neonatal Nursing*.

Presented at the Annual Clinical Meeting of the American College of Obstetricians and Gynecologists on May 5, 2013, in New Orleans, Louisiana, and as part of two webinars for the Hospital Engagement Network on August 8, 2013, and March 17, 2014.

The authors thank Janet A. Meyers, RN, MPH, from The Hospital Corporation of America and Tammy L. Witmer, CNM, MSN, from The Reading Health Physician Network Reading Birth Center for serving as subcommittee members and contributing to the consensus document.

Corresponding author: Jill M. Mhyre, MD, Department of Anesthesiology, University of Arkansas for Medical Sciences, 4301 West Markham Street, Slot 515, Little Rock, AK 72205; e-mail: jmmhyre@uams.edu

### Financial Disclosure

The authors did not report any potential conflicts of interest.

© 2014 by The American College of Obstetricians and Gynecologists. Published by Lippincott Williams & Wilkins.

ISSN: 0029-7844/14

Maternal mortality surveillance in the United States, France, and the United Kingdom suggests that 40–50% of maternal deaths are potentially preventable.<sup>1–4</sup> Delays in recognition, diagnosis, and treatment precede a majority of deaths from hemorrhage, hypertension, infection, and venous thrombosis.<sup>1,4</sup> In obstetric patients, the early signs of life-threatening illness can be difficult to recognize because critical illness is relatively rare, normal pregnancy and childbirth can generate significant changes in maternal vital signs,<sup>5</sup> and healthy women have substantial physiologic reserve to compensate for pathologic derangements.

The National Partnership for Maternal Safety aims to reduce preventable maternal morbidity and mortality in the United States by identifying and addressing opportunities to improve maternal safety.<sup>6,7</sup> In order to facilitate timely diagnosis and treatment for women developing critical illness, the Subcommittee on Vital Sign Triggers sought to ascertain tested examples of obstetric warning systems, define considerations for local implementation, and organize lists of differential diagnoses to facilitate timely and accurate diagnosis. Multidisciplinary subcommittee members represented eight different women's health care organizations, listed in Appendix 1 online at <http://links.lww.com/AOG/A550>. This article presents the findings and conclusions of that subcommittee.



Monitoring forms the cornerstone of timely diagnosis and treatment. Monitoring, also known as clinical surveillance, is “the ongoing assessment of a patient with the intention of [both] detecting abnormality and triggering a response if an abnormality is detected.”<sup>8</sup> Effective warning systems include clear expectations for observation, predefined criteria for an abnormality, and a protocol to trigger a response if an abnormality is detected.<sup>9</sup> As of 2010, The Joint Commission requires hospitals in the United States to “develop written criteria describing early warning signs of a change or deterioration in a patient’s condition and when to seek further assistance,” and to “have staff seek additional assistance when they have concerns about a patient’s condition.”<sup>10</sup>

Several types of early-warning systems have been described.<sup>11</sup> Single parameter systems define abnormal thresholds for a list of physiologic parameters (eg, heart rate); bedside medical evaluation is indicated when any single parameter is measured as abnormal. In contrast, aggregate-weighted scoring systems are multiparameter assessment tools in which nurses assign a score based on the degree of physiologic derangement for each measured parameter; the total score for all measured parameters is used to determine the likelihood of deterioration and the need for bedside medical evaluation. Some<sup>12</sup> but not all<sup>13,14</sup> evidence suggests that aggregate-weighted scoring systems are more sensitive to detect early deterioration because multiple minor derangements may develop before a single parameter deviates substantially from normal. In addition, the aggregate-weighted scoring systems require a full set of observations in order to calculate the score; individual measurements (particularly the respiratory rate) are more likely to be captured when parameters are collected as a bundle in order to calculate an aggregate-weighted score. Finally, the exercise of recording a full set of physiologic measurements and calculating an overall score may itself focus attention on the mother’s well-being to a degree that nonintegrated periodic vital sign measurement cannot.

Early-warning systems have been recommended for nonobstetric patients for over 2 decades to ensure timely recognition of patients who are developing an acute illness.<sup>12</sup> The evaluation and triggering criteria that underlie these early-warning systems do not account for the physiologic changes of pregnancy, and do not perform well in obstetric populations.<sup>5</sup> More recently, early-warning systems specific for obstetric patients have been proposed.

The 2003–2005 Saving Mothers’ Lives report recommended implementation of a Modified Early Obstetric Warning System and reproduced a chart that could be used by bedside nurses to both document and

interpret vital signs.<sup>15–17</sup> The chart defines moderately and severely abnormal parameters and suggests bedside physician evaluation if the patient demonstrates one severely abnormal (red) or at least two moderately abnormal (yellow) parameters. Subsequently, the Modified Early Obstetric Warning System was added to the list of auditable maternal safety standards for the National Health System in the United Kingdom.<sup>14</sup>

Several studies have evaluated the performance of the Modified Early Obstetric Warning System. Singh et al prospectively followed 676 obstetric patients for the Modified Early Obstetric Warning System, and found that 30% of patients met the criteria for evaluation.<sup>16</sup> Of these, 43% experienced some form of morbidity (eg, hemorrhage). The data demonstrated a sensitivity of 89% and a specificity of 79%. In this population with a 13% incidence of serious maternal morbidity, the tool yielded a positive predictive value of 39% and a negative predictive value of 98%.

In order to empirically derive an early-warning score to predict maternal death, Carle et al<sup>18</sup> analyzed physiologic data collected from obstetric patients receiving intensive care in the United Kingdom between 1995 and 2008. The authors identified the most extreme vital signs during the first 24 hours of intensive care for over 4,000 women admitted for a condition directly related to pregnancy, almost half of whom had suffered obstetric hemorrhage. In this high-risk sample, one out of every 60 women died. While the authors were able to propose a scoring system that was highly accurate when applied to a validation cohort of intensive care patients, they concluded that its complexity precluded routine use and that a simplified clinical score demonstrated comparable accuracy to existing scoring systems.

Several considerations suggest the benefits of a single-parameter risk assessment system that favors simplicity and specificity over complexity and sensitivity. First, maternal mortality reviews indicate that among women who died, a disproportionate number demonstrated frankly abnormal vital signs, suggesting that a single-parameter system should maximize specificity for patients who are developing critical illness. Second, current multiparameter early-warning scoring systems rely on nurses to document, calculate, and interpret the scores. Because few healthy parturients experience complications, midwifery and obstetrics staff in the United Kingdom have questioned the value of additional documentation and the workload required to implement the Modified Early Obstetric Warning System.<sup>14</sup> This led to discretionary use of the tool, limiting its significance and potential to detect worsening physical status. Third, excess false



alarms contribute to desensitization, mistrust, and lack of caregiver response. Positive predictive value depends on the prevalence of the condition, so any surveillance tool for a rare complication will have a low positive predictive value, particularly if the specificity of the surveillance tool is low. Ethnographic analysis suggests that delays in diagnosis may reflect local culture in which nurses either do not believe the physiologic significance of a particular abnormal parameter, or face hierarchical barriers to requesting medical evaluation.<sup>14</sup> In this context, a standardized set of abnormal parameters and the normative expectation for escalation of care may have greater effects than a highly sensitive tool that detects all women who may benefit from bedside medical evaluation.

Given these considerations and the goal to implement an early warning system in antepartum, intrapartum, and postpartum settings throughout the United States, a single-parameter scoring system may be more practical than an aggregate-weighted scoring system. Through a process of iterative review and discussion to reach consensus, members of the Subcommittee on Vital Sign Triggers generated The Maternal Early Warning Criteria, a list of critical parameters listed in Table 1.

The Maternal Early Warning Criteria were drawn from the Modified Early Obstetric Warning System Red Triggers.<sup>16</sup> Temperature was deleted from the criteria given the panel's impression that fever is common, accompanied by other vital sign abnormalities, and unlikely to be missed or dismissed in routine clinical care. Pain was deleted given the poor relationship between pain and severe morbidity.<sup>16</sup> Both indicators remain important elements of the bedside medical evaluation. Conversely, a measure of oliguria was added, given its importance as a sign of clinical progression for women with preeclampsia with severe

features; quantitative monitoring for oliguria is only recommended for women with a clear clinical indication for urine volume measurement (eg, preeclampsia with severe features, major abdominal surgery in the immediate perioperative period, or suspected hemorrhage or sepsis). The cut-off point for bradycardia was increased from 40 beats per minute to 50 beats per minute. An increasing requirement for supplemental oxygen to maintain a normal oxygen saturation appears to be a more specific measure of respiratory deterioration than absolute oxygen saturation.<sup>18</sup> Finally, critical neurologic signs were expanded to include agitation, confusion, and unremitting headache in the presence of hypertension.<sup>19</sup> The frequency of vital sign monitoring should be based on the woman's medical and obstetric condition, in accordance with existing clinical guidelines.

All women who meet any of The Maternal Early Warning Criteria should receive prompt bedside evaluation by a physician or other clinician with the ability to activate resources in order to initiate emergency diagnostic and therapeutic interventions as needed. Specific processes to request bedside evaluation should be established at a local level. Critical components of an effective communication policy should define: 1) who to notify, 2) how to notify them, and 3) when and how to activate the clinical chain of command in order to ensure an appropriate response.<sup>16,17,20</sup> Barriers to prompt notification, such as a fear of offending or disturbing more senior personnel, may need to be identified and addressed.<sup>21</sup> Supervisors, service leaders, and hospital administrators must ensure that nurses and other clinicians are rewarded rather than punished or ignored when they call for bedside evaluations, regardless of the clinical outcome. Likewise, strong organization leadership may be required to establish the normative expectation for prompt bedside evaluation.

The timeliness of response will depend on local resources and the severity of the patient's clinical condition. When the patient's responsible clinician is not immediately available, a bedside evaluation by a covering clinician is indicated. For women with rapid clinical deterioration, or when neither the primary clinician nor a covering clinician is available, it will be appropriate to activate an obstetric medical emergency team<sup>22</sup> or hospital rapid response team. In some circumstances (eg, home birth), transfer to a hospital will be necessary.

A single abnormal vital sign can reflect measurement artifact. It is important to verify isolated abnormal measurements, particularly for blood pressure, heart rate, respiratory rate, and oxygen

**Table 1. The Maternal Early Warning Criteria**

Systolic BP (mm Hg)	<90 or >160
Diastolic BP (mm Hg)	>100
Heart rate (beats per min)	<50 or >120
Respiratory rate (breaths per min)	<10 or >30
Oxygen saturation on room air, at sea level, %	<95
Oliguria, mL/hr for $\geq 2$ hours	<35
Maternal agitation, confusion, or unresponsiveness; Patient with preeclampsia reporting a non-remitting headache or shortness of breath	

BP, blood pressure.

These triggers cannot address every possible clinical scenario that could be faced by an obstetric clinician and must not replace clinical judgment. As a core safety principle, bedside nurses should always feel comfortable to escalate their concerns at any point.



saturation. Urgent bedside evaluation is usually indicated if any of these values persist for more than one measurement, present in combination with additional abnormal parameters, or recur more than once.

While awaiting the arrival of the evaluating clinician, the bedside nurse should follow basic resuscitation principles to ensure patient safety. For example, resources should be activated to achieve free-flowing and appropriate venous access. In the event of a decline in the woman's condition, it is always appropriate to increase the frequency of vital sign collection to establish any trends. If the patient is pregnant, left uterine displacement or the full left lateral decubitus position will help to optimize cardiac output. In women with hypoxemia, supplemental oxygen therapy may help to restore normal pulse oximetry measurements, but it is important to recognize that an increasing requirement for supplemental oxygen is itself worrisome, and that bedside medical evaluation is still indicated for the conditions that underlie hypoxemia. Appropriate standing orders are needed to allow the bedside nurse to administer these resuscitative measures.

To facilitate initial clinical evaluation, the committee developed a series of differential diagnoses for each of the physiologic derangements listed in The Maternal Early Warning Criteria. These lists are divided into common conditions, and rare but serious conditions, and are presented in Appendix 2 online at <http://links.lww.com/AOG/A551>. Occasionally, an abnormal criterion may reflect normal physiology for that patient, and the team should establish a plan for subsequent monitoring, notification, and review.<sup>16</sup> Recurrent abnormal Maternal Early Warning Criteria in a patient with normal baseline values, or an accumulation of more than one criterion, should prompt increases in the intensity and frequency of monitoring, as well as the frequency of clinical evaluation to carefully consider the appropriate differential until a diagnosis is confirmed, or until the criteria resolve.<sup>20</sup>

The recommendations and specific triggers in this document are based on limited clinical and scientific evidence. Specific cut-off points may evolve as future evidence develops. The optimal balance between sensitivity and specificity may vary between clinical environments and patient populations. The single-parameter scoring system was selected to facilitate widespread implementation; however, no study has demonstrated that such a system improves outcomes for obstetric patients. In the nonobstetric setting, aggregate-weighted scoring systems are supported by randomized controlled trials, but such evidence does

not exist for single-parameter systems.<sup>12</sup> Any surveillance system depends on reliable nursing documentation; the potential exists for overnight documentation quality to decrease if nurses prioritize patient comfort and sleep.<sup>13</sup> Local implementation considerations include the protocol to request a clinical evaluation, the expectations for response, and the procedure to escalate the concern to ensure an appropriate response. Each of these factors will affect the effectiveness of any early-warning system.

An effective early-warning system should facilitate timely diagnosis and treatment, and thereby limit the severity of any morbidity. Randomized controlled trials are needed to evaluate whether The Maternal Early Warning Criteria help teams to achieve these objectives. Barriers that interfere with workflow can influence the timeliness of documentation and communication of a patient's condition and should be studied. Human factors, ethnographic, and workflow studies will provide additional data to guide and evaluate the effectiveness of implementation, and to understand the complexities of implementation in different health care environments. Ideally in the future, smart monitors will collect vital signs at scheduled intervals without disturbing sleeping patients, process physiologic trends over time, and alert clinicians to decompensating patients with a high degree of accuracy. For now, The Maternal Early Warning Criteria may serve as a practical tool to facilitate timely recognition and response for women developing serious acute illness, and may also provide a framework for consistent data acquisition for epidemiologic health systems research and quality improvement in the obstetric environment.


## REFERENCES

1. California Department of Public Health, Maternal, Child and Adolescent Health Division. The California pregnancy-associated mortality review: report from 2002 and 2003 maternal death reviews. 2011. Available at: <http://www.cdph.ca.gov/data/statistics/Documents/MO-CA-PAMR-MaternalDeathReview-2002-03.pdf>. Retrieved July 22, 2014.
2. Cantwell R, Clutton-Brock T, Cooper G, Dawson A, Drife J, Garrod D, et al. Saving mothers' lives: reviewing maternal deaths to make motherhood safer: 2006–2008. The Eighth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom. *Br J Obstet Gynaecol* 2011;118(suppl 1):1–203.
3. Farquhar C, Sadler L, Masson V, Bohm G, Haslam A. Beyond the numbers: classifying contributory factors and potentially avoidable maternal deaths in New Zealand, 2006–2009. *Am J Obstet Gynecol* 2011;205:331.e1–8.
4. Saucedo M, Deneux-Tharaux C, Bouvier-Colle MH. Ten years of confidential inquiries into maternal deaths in France, 1998–2007. *Obstet Gynecol* 2013;122:752–60.
5. Lappen JR, Keene M, Lore M, Grobman WA, Gossett DR. Existing models fail to predict sepsis in an obstetric population



- with intrauterine infection. *Am J Obstet Gynecol* 2010;203:573.e1-5.
6. D'Alton ME, Main EK, Menard MK, Levy BS. The national partnership for maternal safety. *Obstet Gynecol* 2014;123:973-7.
  7. Main EK, Menard MK. Maternal mortality: time for national action. *Obstet Gynecol* 2013;122:735-6.
  8. DeVita MA, Smith GB, Adam SK, Adams-Pizarro I, Buist M, Bellomo R, et al. "Identifying the hospitalised patient in crisis"—a consensus conference on the afferent limb of rapid response systems. *Resuscitation* 2010;81:375-82.
  9. Ivory CH. Standardizing the words nurses use to document elements of perinatal failure to rescue. *J Obstet Gynecol Neonatal Nurs* 2014;43:13-24.
  10. The Joint Commission. Preventing maternal death. Sentinel Event Alert 2010;1-4.
  11. Patterson C, Maclean F, Bell C, Mukherjee E, Bryan L, Woodcock T, et al. Early warning systems in the UK: variation in content and implementation strategy has implications for a NHS early warning system. *Clin Med* 2011;11:424-7.
  12. McNeill G, Bryden D. Do either early warning systems or emergency response teams improve hospital patient survival? A systematic review. *Resuscitation* 2013;84:1652-67.
  13. Hands C, Reid E, Meredith P, Smith GB, Prytherch DR, Schmidt PE, et al. Patterns in the recording of vital signs and early warning scores: compliance with a clinical escalation protocol. *BMJ Qual Saf* 2013;22:719-26.
  14. Mackintosh N, Watson K, Rance S, Sandall J. Value of a modified early obstetric warning system (MEOWS) in managing maternal complications in the peripartum period: an ethnographic study. *BMJ Qual Saf* 2014;23:26-34.
  15. Lewis G. The Confidential Enquiry into Maternal and Child Health (CEMACH). Saving mother's lives: reviewing maternal deaths to make motherhood safer—2003-2005. The Seventh Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. London: CEMACH; 2007:1-266.
  16. Singh S, McGlennan A, England A, Simons R. A validation study of the CEMACH recommended modified early obstetric warning system (MEOWS). *Anaesthesia* 2012;67:12-8.
  17. Swanton RD, Al-Rawi S, Wee MY. A national survey of obstetric early warning systems in the United Kingdom. *Int J Obstet Anesth* 2009;18:253-7.
  18. Carle C, Alexander P, Columb M, Johal J. Design and internal validation of an obstetric early warning score: secondary analysis of the Intensive Care National Audit and Research Centre Case Mix Programme database. *Anaesthesia* 2013;68:354-67.
  19. Clark SL, Hankins GD. Preventing maternal death: 10 clinical diamonds. *Obstet Gynecol* 2012;119:360-4.
  20. The Maternal Critical Care Working Group. Providing equity of critical and maternity care for the critically ill pregnant or recently pregnant woman: the Royal College of Anaesthetists; 2011. Available at: [http://www.rcog.org.uk/files/rcog-corp/Prov\\_Eq\\_MatandCritCare.pdf](http://www.rcog.org.uk/files/rcog-corp/Prov_Eq_MatandCritCare.pdf). Retrieved July 22, 2014.
  21. Considine J, Botti M. Who, when and where? Identification of patients at risk of an in-hospital adverse event: implications for nursing practice. *Int J Nurs Pract* 2004;10:21-31.
  22. Gosman GG, Baldisseri MR, Stein KL, Nelson TA, Pedaline SH, Waters JH, et al. Introduction of an obstetric-specific medical emergency team for obstetric crises: implementation and experience. *Am J Obstet Gynecol* 2008;198:367.e1-7.

OBSTETRICS & GYNECOLOGY



Be Social. Connect with *Obstetrics & Gynecology*  
on Facebook, Twitter, LinkedIn®, and YouTube.

Visit us on **Facebook**: <http://www.facebook.com/greenjournal>

Follow us on **Twitter**: <http://twitter.com/greenjrnl>

Join our **LinkedIn** group: <http://www.linkedin.com> [Groups: *Obstetrics & Gynecology* (Green Journal)]

Subscribe to our **YouTube** channel: <http://www.youtube.com/user/greenjrnl>

rev 7/2013

