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Maternal Morbidity and Mortality

Identifying Opportunities to Improve Clinical Outcomes

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ABSTRACT

A better understanding of why women die during pregnancy, childbirth, or postpartum offers valuable insight into strategies aimed at preventing maternal deaths and arresting the progression in the severity of a complication. The rate of severe maternal morbidity and maternal mortality in the United States has been trending upward in recent years and has garnered national attention with concentration on bolstering reviews of maternal deaths and implementing patient safety initiatives. The obstetric nurse is in a unique position to improve maternal outcomes through the anticipation, recognition, and communication of the early warning signs of impending deterioration in maternal condition. Presented in the context of the conceptual model of Stephen Covey's Circle of Influence, the professional nurse can proactively influence maternal outcomes directly, with actions defined by the scope of professional nursing practice or indirectly through professional interactions with others. Advancing one's education, knowledge, and technical skills broadens the influential capacity.

Key Words: deaths, maternal, morbidity, mortality, pregnancy

Reduction in the maternal mortality ratio by 75% by 2015 is the fifth of 8 Millennium Development Goals, adopted by the United Nations General Assembly in 2000.[1] To date, the United States has not achieved this goal. The number of reported pregnancy-related deaths in the United States has steadily increased since the Centers for Disease Control and Prevention (CDC) Pregnancy Mortality Surveillance System first reported pregnancy-related mortality ratios beginning in 1987.[2] Pregnancy-related deaths have steadily increased from a ratio of 7.2 deaths per 100 000 live births in 1987 to 17.8 deaths per 100 000 live births in 2009. The most recently reported pregnancy-related morality ratio is 16.7 deaths per 100 000 live births in 2010. The trend in pregnancy-related mortality in the United States from 1987 to 2010 is illustrated in Figure 1.[2]

The continued rise in pregnancy-related deaths has generated a national focus on identifying interventions that might prevent maternal deaths. Even with the increasing trend of pregnancy-related deaths, maternal death remains a rare event, making it difficult to pinpoint precisely how multiple variables interact to culminate in a maternal death. The purpose of this article is to provide a comprehensive review of recent trends in pregnancy-related deaths in the United States as a foundation for introducing those areas most likely to be amenable to intervention in the clinical area. A proactive approach to positively influencing maternal outcomes is presented in the context of the conceptual model of Stephen Covey's Circle of Influence.[3]

ASCERTAINMENT AND REPORTING OF MATERNAL DEATHS

Maternal deaths are reported as a ratio of the number of deaths per 100 000 live births.[2] The definitions relevant to maternal mortality have changed throughout the later years of the 20th century,[4] which has impacted statistical reporting. For most of the 1900s, a death during the pregnancy or within 1 year after the termination of pregnancy from any "maternal cause" was classified as a maternal death. In 1979, the implementation of *International Classification of Diseases, Ninth Revision*

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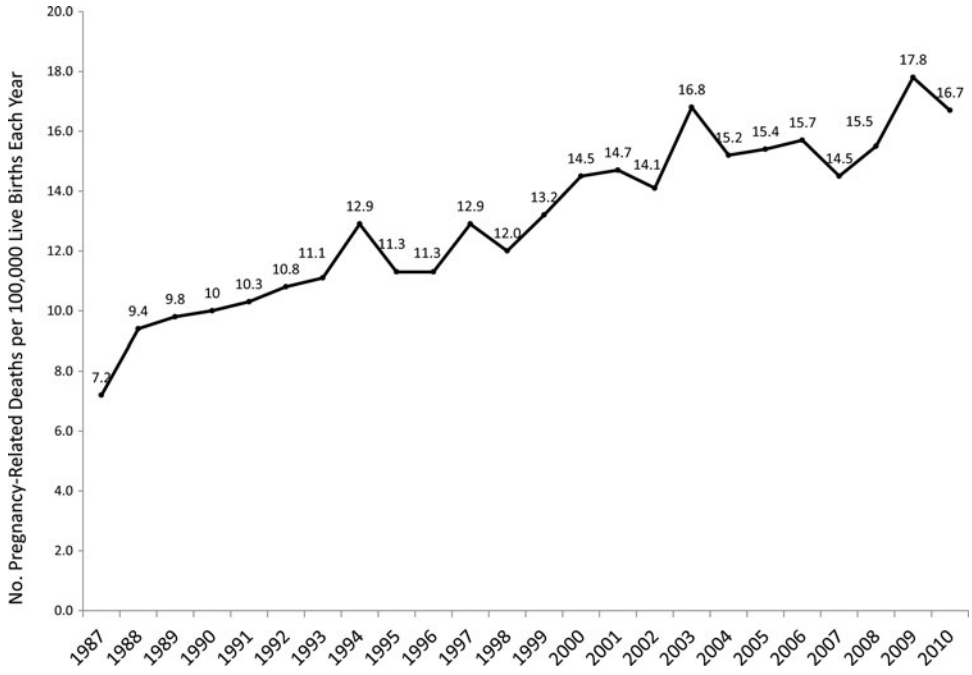

Figure 1. Trends in pregnancy-related mortality in the United States. Adapted from the Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion.[2]

(*ICD-9*), resulted in classification of maternal deaths as any death during the pregnancy or within 42 days of the pregnancy. A significant impact of the implementation of *ICD-9* was to include additional, indirect causes of death as maternal, thereby increasing the maternal death ratio by 10% during the latter part of the 1970s.[4] Beginning in 1986, the Pregnancy Mortality Surveillance System was implemented by the CDC's Division of Reproductive Health because more clinical information was needed to determine the causes of maternal death that are voluntarily reported to the CDC by the US states, New York City, and Washington, District of Columbia.[2]

The National Center for Health Statistics at the CDC calculates the official maternal mortality ratio for the United States as the ratio of pregnancy-related deaths per 100 000 live births.[5] A pregnancy-related death is defined by the CDC as a death during pregnancy or within 1 year of the termination of pregnancy that was caused by a pregnancy complication, a chain of events initiated by the pregnancy, or a condition or event unrelated to pregnancy that was aggravated by the physiologic effects of pregnancy.[5,6] For reporting purposes, accidental or incidental causes of pregnancy-related death are excluded from the diagnosis.[2] The cause of death, the pathophysiologic relationship between the pregnancy and the condition or event, and the time interval between the event or condition and the death determine the classification of the death as pregnancy-related.[7] When the death occurs during the pregnancy or within 1 year of the pregnancy and the pregnancy was unlikely to impact the course of the condition or event, it is termed a pregnancy-associated death.[8] The changes in the definitions that have impacted the reporting of maternal deaths are summarized in Figure 2.[2,4,6]

Pregnancy-related deaths are attributed to direct and indirect causes. Direct obstetric deaths are those resulting from complications of pregnancy or events from treatment or lack of treatment during the pregnancy, labor, or puerperium. Indirect obstetric deaths are those resulting from preexisting disease or a condition or event that is not obstetric in nature but may be aggravated by the physiologic effects of pregnancy.[4] Almost all pregnancy-related deaths that are attributed to direct causes (hemorrhage, anaphylactoid syndrome of pregnancy, or hypertensive diseases of pregnancy) occur within 42 days of pregnancy. A significant proportion of deaths attributed to indirect causes (such as infection, thrombotic pulmonary embolism, cerebrovascular accident, cardiovascular disease, noncardiovascular medical conditions, or cardiomyopathy) occur more than 42 days after termination of pregnancy but within 1 year of the pregnancy.[9] Changes in coding practices have enhanced ascertainment of indirect obstetric causes of death and late maternal deaths. The *International Classification of Diseases, Tenth Revision*, which is more inclusive of maternal deaths, in particular those resulting

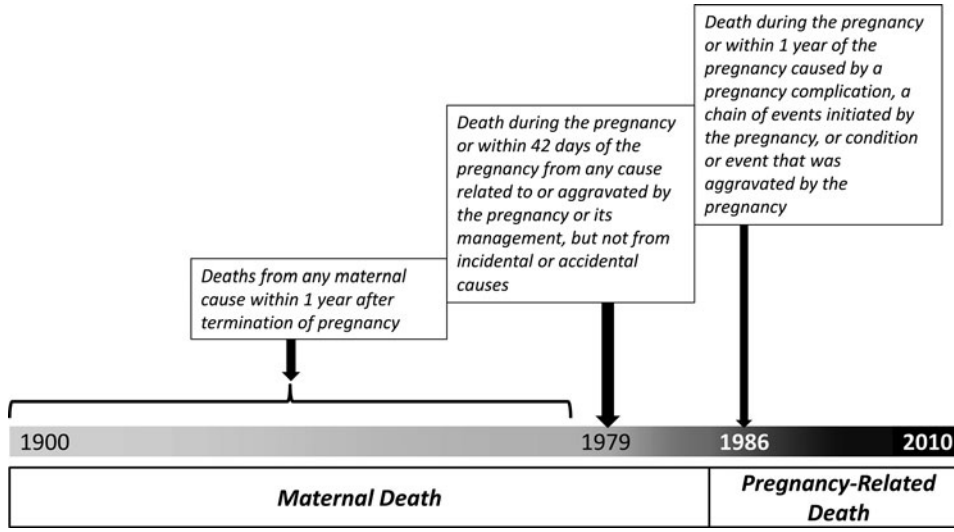

Figure 2. Changes in the reporting of maternal deaths in the United States in the 20th century. Adapted from the Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion,[2] Hoyert,[4] and Berg.[5]

from indirect causes up to 1 year from the end of pregnancy, was implemented in 1999. In addition, in 2003, some states implemented the US Standard Certificate of Death, which includes a method for indicating that the death occurred at the time of pregnancy, within 42 days of the pregnancy, or within 1 year of the pregnancy.[10]

LEADING CAUSES OF PREGNANCY-RELATED DEATHS

Hemorrhage and hypertensive disorders of pregnancy were the leading causes of pregnancy-related death in 1987 to 1997. The proportion of pregnancy-related deaths attributed to hemorrhage declined after 1997 despite an increase in the incidence of hemorrhage. Between 1999 and 2005, the proportion of pregnancy-related deaths attributed to indirect causes, such as infection, cerebrovascular accident, cardiovascular conditions, noncardiovascular medical conditions, and cardiomyopathy began to emerge as the leading causes, replacing the more traditional pregnancy-related causes of hemorrhage and hypertension.[5] Cardiovascular conditions, encompassing a wide range of diagnoses such as acute myocardial infarction, valvular disease, and congenital heart disease, among others, constituted the leading cause of death in the United States from 1998 to 2011,[2,5,9] which is consistent with trends in the United Kingdom from 1998 to 2005.[5]

Besides cardiovascular disease and noncardiovascular medical conditions, infection has emerged as the third leading cause of death,[2] rising from 10.7% of all pregnancy-related deaths in 1998-2005[9] to 14% of deaths in 2011.[2] The highest pregnancy-related death ratio due to infection was most notable during the time frame of 2009 to 2010, which coincides with the 2009 H1N1 influenza epidemic, which disproportionally affected pregnant women.[9,11] Prior to 2009, a review of data from the Nationwide Inpatient Sample, a large national administrative database maintained by the Agency for Healthcare Research and Quality as a part of the Healthcare Cost and Utilization Project, demonstrated a 10% increase in severe sepsis and sepsis-related deaths each year for admissions during 1998 to 2008 despite a stable rate of the frequency of sepsis complicating childbirth.[12] Pregnancy-related deaths by cause are illustrated in Figure 3.[2]

Non-Hispanic black women have a 3 to 4 times higher risk of dying during pregnancy or within 1 year of birth than Hispanic women and non-Hispanic white women.[5,7,13] In the most recent 5-year reporting period (2006-2010), the pregnancy-related death ratios by race and ethnicity were 38.9, 12.0, 11.7, and 14.2 per 100 000 live births for non-Hispanic black women, non-Hispanic white women, Hispanic women, and women of other races, respectively.[9] The reasons for this disparity are unclear but have been attributed to a number of factors such as lack of prenatal care or later access to prenatal care and a higher incidence of preexisting medical conditions among black women.[13] Creanga and colleagues[7] reported the highest pregnancy-related mortality ratio among both US-born black women and black women who were born outside of the US during the study period from 1993 to 2002. White women born outside of the United States and US-born Asian and

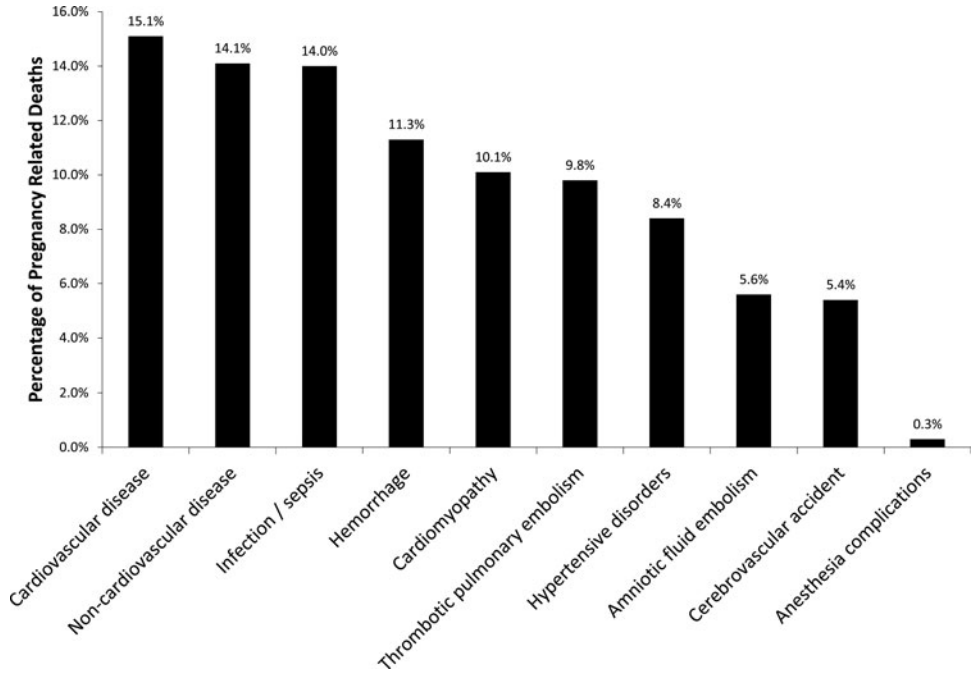

Figure 3. Causes of pregnancy-related deaths in the United States in 2011. The cause of death was unknown for 5.9% of all pregnancy-related deaths. Adapted from Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion.[2]

Pacific Islanders had the lowest pregnancy-related mortality ratios compared with all other races. Cardiovascular disorders, cardiomyopathy, and other medical conditions were observed with a higher frequency among US-born women (40.8%) than among foreign-born women (24.7%). Preexisting conditions are more prominent in women of all races, with increasing age and pregnancy-related mortality ratios are higher in women older than 35 years.[2] In the study period 2006 to 2010, 27.4% of all women who died of pregnancy complications were 35 years or older.[9] The contribution of age is unlikely to be impacted in the ensuing years as birth rates continue to increase among women aged 30 to 44 years.[14]

The rising number of cesarean births may also contribute to the increased pregnancy-related mortality ratio. Although cesarean births may be performed to preserve the life of the woman and the fetus, they are associated with morbidities, among which include hemorrhage, venous thromboembolism (VTE), and infection. Prior cesarean birth, especially 3 prior cesarean deliveries, contributes to significant adverse events in subsequent pregnancies from abnormal placentation, primarily placenta previa and placenta accreta, which may necessitate lifesaving measures such as massive blood transfusion and/or hysterectomy.[15] The rate of cesarean births rose by nearly 60% from 1996 to 2009,[14] which has stimulated a nationwide effort to reduce the number of births by cesarean delivery, especially the primary cesarean birth[16] through strategies, published in other sources.[15,17,18]

MATERNAL MORBIDITY

An understanding of why women die during pregnancy or within the first year after birth is a preliminary step in taking corrective action to reduce the number of deaths. Preexisting medical conditions such as hypertension and diabetes often with concomitant obesity and other complications of pregnancy are major contributors to maternal mortality[19,20] that necessitate a broadened focus on the conditions that have an adverse effect upon pregnancy outcomes. Severe complications, such as acute renal failure, cardiac events, thromboembolism, and hemorrhage, have become more prevalent in recent years,[21] increasing attempts to identify maternal complications with the greatest risk for maternal death[20–24] that are possibly amenable to intervention.

Morbidity generally encompasses pregnancy complications or preexisting health conditions, with severe maternal morbidity defined by the presence of at least one condition that may progress to end-organ injury or that is potentially life-threatening.[20,21] Recently,

maternal morbidity has been identified through *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*), administrative diagnosis and procedure codes that identify severe complications associated with an increased risk for maternal death.[20,22–24] An analysis of pregnancy and postpartum hospitalizations with at least one of the 25 *ICD-9-CM* diagnosis or procedure codes that indicate a potentially life-threatening maternal condition or complication (ie, blood transfusion with ≥4 units of blood products, acute renal failure, pulmonary edema) using the Nationwide Inpatient Sample database[22,23] demonstrated a statistically significant increase in severe complications. Severe complications rose by 75% and 114% in pregnancy and postpartum hospitalizations, respectively, from 1998-1999 to 2008-2009.[22] The severe maternal morbidity rate, now defined by the CDC by the presence of one of these 25 *ICD-9-CM* diagnosis or procedure codes, increased by an additional 26.1% from the 2-year time period, 2008-2009 to 2010-2011, which is also clinically and statistically significant.[23]

Use of administrative coding may not correctly identify all causes of death, in part, as a result of variability in coding across organizations,[21] thus necessitating medical record review. Clark and colleagues[25] conducted a blind review of medical records of pregnant and postpartum women in a large healthcare system to determine whether the causes of death were accurately captured by diagnosis and procedure coding. Medical record coding identified the causes of death only 52% of the time when compared with those that were ascertained by a review of the actual medical records. A comprehensive review of medical records by medical experts remains optimal for any conclusions about the quality of care rendered and/or opportunities to prevent maternal deaths.

PREVENTABILITY OF MATERNAL DEATH

About 40% to 50% of overall maternal deaths are preventable.[9,19,26] A death is considered potentially preventable if it could have been averted by changes in the healthcare system or by a patient's actions[19] or if the severity of the condition could have been lessened before it progressed to an adverse outcome.[27] Preventability factors include a broad range of clinical management issues, such as recognition of high-risk conditions or progression in severity of conditions or complications; care decisions and processes; communication between healthcare providers; or knowledge and skill of healthcare providers. Patient factors (ie, adherence to medical plan of care or refraining from pregnancy when preexisting conditions are likely to deteriorate because of pregnancy) and healthcare systems factors (ie, resources, equipment, or availability of consultants) are other aspects that influence the preventability of maternal deaths.[19]

A statewide committee of medical experts[19] reviewed maternal deaths in North Carolina from 1995 to 1999 and determined that of the 105 deaths with an identifiable cause about 8% could have possibly been prevented by preconceptual counseling, 13% could have been prevented by patients' actions, about 4% could have been prevented through resolution of systems issues, and about 21% could have been potentially prevented had the care conformed to recognized standards. The specific causes of death with potential preventability of maternal deaths, in order from greatest to lowest percentage by clinical cause of death, were hemorrhage (93%), chronic medical conditions (89%), preeclampsia (60%), and infection (43%). Forty percent of deaths from cardiovascular conditions and 22% of deaths from cardiomyopathy could potentially have been prevented. The wide range of diagnoses within the category of cardiovascular disease makes it difficult to identify opportunities to decrease maternal deaths from this category, which is unfortunate in light of the predominance of cardiovascular disease as a leading cause of maternal death.

Clark and colleagues[28] determined that 18% of deaths in their review of all maternal deaths in the nations' largest healthcare delivery system could have been prevented with more appropriate medical care. Specifically, these deaths were related to postpartum hemorrhage, preeclampsia, medication error, and infection. A subsequent publication[25] elaborated upon implementation of best practices with the greatest opportunity to prevent maternal deaths that incorporated universal application of pneumatic compression devices for cesarean birth and checklist-based protocols guiding prompt recognition and treatment of acute hypertensive crisis, preeclampsia-related pulmonary edema, and postpartum hemorrhage. There was a significant decline in the rate of deaths attributed to pulmonary embolism following cesarean birth and from preeclampsia, and there were no deaths attributed to untreated in-hospital pulmonary edema or hypertensive crisis in this follow-up study.

STRATEGIES FOR IMPROVING MATERNAL OUTCOMES: THE NURSE'S ROLE

A percentage of adverse outcomes may be potentially prevented when an organization embraces a culture of safety.[26,29] A professional environment characterized by mutual trust and respect within the healthcare team and with administrative leadership strengthens the culture of safety through effective collaboration. In reality, not

all nurses are fortunate enough to experience the benefits of working in such an environment, potentially increasing the tendency to focus energy on the actions or inactions of others that are outside of one's control rather than on those opportunities that are within one's control and realm of influence. As a result, frustration with the surrounding circumstances may lead to an underestimation of one's ability to affect change. A conceptual model adapted from Covey's[3] Circle of Concern and Circle of Influence illustrates a proactive approach for influencing changes in the healthcare environment directed at improving patient outcomes.

In the adapted model (illustrated in Figure 4), the Circle of Control represents direct actions that may be initiated by the nurse on the basis of his or her knowledge, skill, and abilities. The Circle of Control is determined by the scope of professional nursing practice, typically defined by the states' nurse practice acts, nursing education, and institutional policies and procedures. The Circle of Concern encompasses those elements that most people care about but may be outside of the individual's control. The greatest potential to impact change and improve outcomes lies within the Circle of Influence, which consists of behaviors and actions that indirectly influence others. Rather than focusing on the actions and behaviors of others that fall outside of one's control and persuasive influence, a proactive approach focuses on activities that one can control and influence. As a result, the ability to collaborate with others expands in order to positively affect change. Interventions dependent upon the providers' orders or institution-derived protocols are often outside the nurse's control.

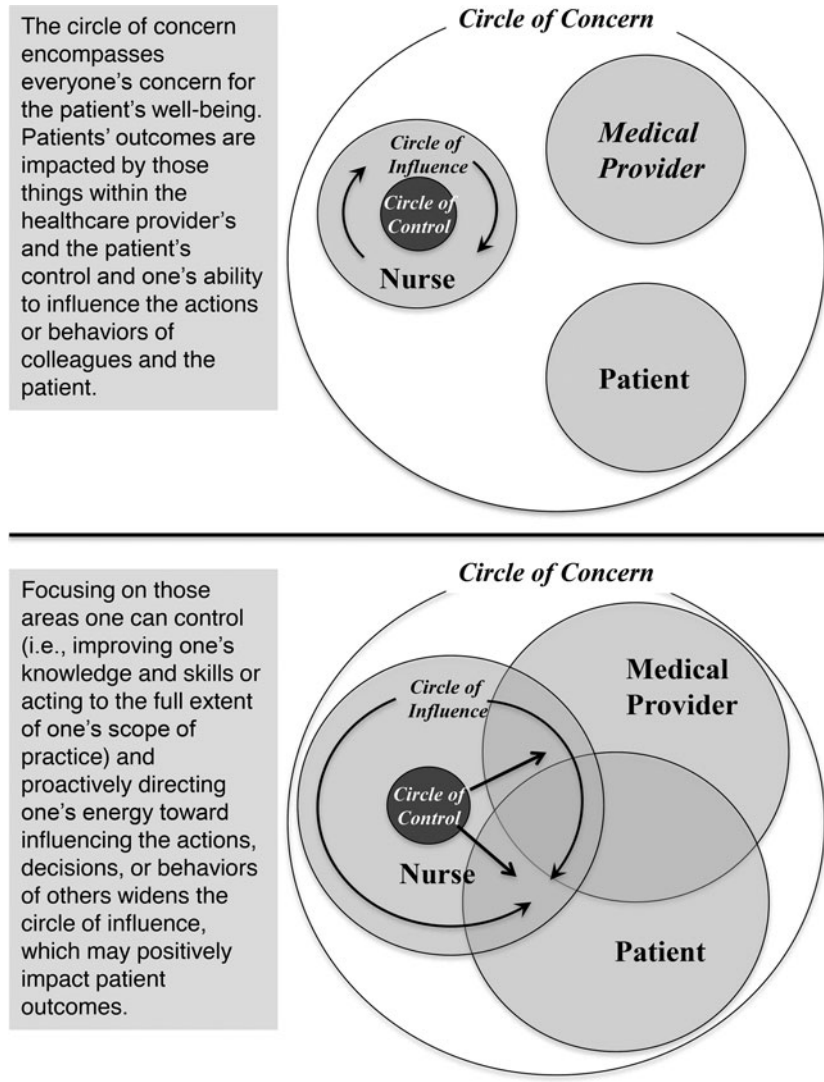

Figure 4. Proactive approach to improving patient outcomes by maximizing one's influence. Adapted from Covey.[29]

However, the nurse may influence these decisions through proficient technical skills and cognitive and social abilities exerted amid personal interactions and committee participation. Strategies for expanding one's influential capacity do not define the standard of care but represent an ideal level for identifying those areas within the nurse's sphere of control and influence with the potential to positively impact clinical outcomes. Anticipation and early identification of clinical deterioration, development of and adherence to evidence-based practice guidelines, and effective communication are elements that are within the nurse's realm of control and influence.

Recognizing significant clinical problems early in the course of development through the use of objective parameters (ie, abnormal vital sign parameters, quantified blood loss [QBL] above a prespecified threshold) offers one strategy for averting the progression in clinical deterioration. Clinical triggers warrant escalation in the level of monitoring or summoning additional resources to the bedside, such as a rapid response team or physicians.[30] The modified early obstetric warning system[31] is one such system that identifies specific ranges for temperature, blood pressure, heart rate, respiratory rate, hemoglobin arterial oxygen saturation (Sao_2), pain score, and neurologic response that warrant escalation of care based upon the severity of the defined value. Quantified blood loss is another clinical trigger that replaces subjective estimation of blood loss with weighing blood-soaked linens or pads (1 g = 1 mL), or measurement of vaginal bleeding with calibrated underbuttocks drapes or graduated suction containers.[32] Predefined thresholds for blood loss, combined with predefined abnormal vital signs, optimize the determination of further interventions and/or request for other care providers to the bedside. Interpreting the significance of clinical manifestations and clinical triggers is ideally based on an understanding of risk factors for adverse outcome, normal physiology of pregnancy, and pathophysiology of comorbid conditions.

In addition to taking corrective action within the nurse's defined scope of practice and/or institutional protocols or guidelines, the professional nurse may also influence the improvement of outcomes by evaluating the appropriateness of nursing actions based upon published sources or institutional guidelines rather than based on personal experiences in the clinical practice setting. Communicating significant findings to medical providers and other members of the healthcare team accurately, appropriately, and timely is focal to influencing subsequent coordination of care necessary for achieving positive outcomes. Conflict is inevitable in the healthcare environment, especially when healthcare providers share responsibility for monitoring and interpretation of data. When the nurse desires corrective action to be taken by another individual who ultimately controls the final decision or action, engaging in thoughtful dialogue with other members of the healthcare team, including the medical provider, involves asking the medical provider for a working diagnosis and the plan of care when resolution of the problem requires multiple interventions and ongoing assessments. The nurse may also suggest that consultation be obtained with providers within or outside the obstetric specialty when confronted with uncommon situations that could potentially become catastrophic.[29]

INITIATING BEST PRACTICES FOR PREVENTABLE CAUSES OF MATERNAL DEATH

Some of the most critical elements guiding patient safety initiatives include reduction in practice variation through standardized protocols, checklists for critical procedures, and quality improvement that focuses on systems improvements through peer review.[29] It is reasonable to apply these critical elements to those clinical conditions that are leading causes of maternal death with the greatest potential to prevent adverse outcomes. Postpartum hemorrhage and hypertensive disorders of pregnancy account for the majority of primary underlying maternal morbidity[26,33] and together with pulmonary thromboembolism represent the most common clinical conditions in which death is most likely preventable.[25,26,34] In addition, the increasing trend in the incidence of severe sepsis and sepsis-related deaths[12] warrants the incorporation of best practices on initial stabilization of the obstetric patient with severe sepsis or septic shock.[35,36] Although cardiovascular disease is the leading cause of pregnancy-related deaths,[2,5,9] the varied conditions within this category along with the multitude of variables that influence its contribution to pregnancy-related deaths[19] prohibit sound conclusions about opportunities to reduce maternal deaths for this particular category. In-depth discussion of clinical guidelines and patient safety initiatives directed at achieving a decline in maternal morbidity and pregnancy-related deaths is beyond the scope of this article. Rather, key elements of clinical guidelines are identified.

Obstetric hemorrhage

Recognizing the significance of excessive blood loss and/or hemodynamic instability optimizes outcomes for women experiencing obstetric hemorrhage. Excessive blood loss is best determined when bleeding is quantified. Quantified blood loss begins after the birth of the

infant by weighing blood-soaked linens and pads (1 g = 1 mL) or measurement with calibrated underbuttocks drapes or graduated suction containers.[32] Although normal blood loss is arbitrarily defined for vaginal and cesarean births, escalation in the level of care is typically required when QBL extends beyond what is typically encountered and/or that is associated with abnormal vital sign parameters. Physiologic compensatory mechanisms directed at the redistribution of blood flow precede overt hemodynamic instability. Tachycardia, narrowed pulse pressure, or decreased urine output often precedes a decline in maternal cardiac output, often manifested by hypotension, which may not manifest until the blood volume deficit approaches 25%.[37] Early detection of signs of physiologic compensation to increased blood loss before the patient sustains a decrease in cardiac output, with or without QBL, may avert adverse outcome. Hemodynamic instability, regardless of QBL, generally requires initiation of aggressive interventions directed at hemodynamic stabilization, which include intravascular volume expansion with crystalloids, blood and blood component therapy, or surgical management and further assessment of the effectiveness of interventions used (ie, measurement of urine output with a urinary retention catheter and urimeter, frequent vital signs, and continued QBL). Optimally, anticipation of risk factors for obstetric hemorrhage expedites interventions such as type and crossmatch for blood or intravenous access with a second intravenous catheter prior to significantly increased blood loss. The management of obstetric hemorrhage is beyond the scope of this article but may be found in other excellent resources that provide clinical recommendations based upon a comprehensive review of the literature.[38–40]

Preeclampsia

Vigilance in detecting severe features of preeclampsia (defined by the American College of Obstetricians and Gynecologists' Task Force on Hypertension in Pregnancy)[41] that necessitate heightened surveillance in the hospital is a key element in forestalling undesirable outcomes associated with hypertensive disorders of pregnancy. Early detection and treatment of acute hypertensive emergencies and prompt recognition and appropriate treatment of pulmonary edema have also been identified as key initiatives in preventing maternal deaths from complications of preeclampsia.[29] Assessment of severe hypertension (either a systolic blood pressure of ≥160 mm Hg or a diastolic blood pressure of ≥110 mm Hg, sustained for 15 minutes)[42] is dependent upon the accuracy of blood pressure measurement and optimized when repositioning is avoided to obtain a lower blood pressure value.[38] Severe elevations in either the systolic or diastolic blood pressure sustained for 15 minutes require immediate provider notification to obtain an order for intravenous antihypertensive therapy, which should be administered as soon as intravenous access is obtained and the medication can be retrieved. Detailed recommendations for assessment and management of hypertensive emergencies can be found elsewhere.[41,42]

In addition to monitoring the woman for severe features of preeclampsia, recognition that the woman with preeclampsia is at risk for pulmonary edema postpartum[29] supports frequent assessment of lung sounds in addition to cumulative measurement of intake and output. Signs and symptoms consistent with pulmonary edema, such as shortness of breath or cough, decreased Sao_2, or increased respiratory rate, necessitate further examination by the medical staff, which often includes chest radiographs.[29,43]

Venous thromboembolism prophylaxis

Obstetric-based specialty recommendations for VTE prophylaxis is typically confined to universal use of pneumatic compression devices for cesarean births, usually placed on the patient and activated prior to cesarean delivery and continued until the patient is fully ambulatory.[28] For nonsurgical patients, VTE prophylaxis is currently recommended for certain patients with thrombophilia and/or history of VTE event.[44] Guidelines for VTE prophylaxis in the obstetric setting are forthcoming[34] and will hopefully incorporate risk factors identified for VTE in the nonobstetric population.

Infection, sepsis, and septic shock

Influenza infection contributed significantly to pregnancy-related death in recent years, most notably during 2009 to 2010.[9] A large number of hospitalizations of young adults for influenza prompted a review[45] of outcomes among pregnant and postpartum women hospitalized for influenza during the 2013-2014 influenza season in California. Despite recommendations for vaccination of all pregnant women, only one of the women who required critical care or died in this review had been vaccinated for influenza among the 93% of patients who received prenatal care. Hospitals have a tremendous opportunity to help prevent influenza infection among pregnant or postpartum women by verifying vaccination history during the influenza season, and, if influenza vaccination cannot be documented during the influenza season, offering the vaccination on-site during the hospitalization for pregnancy, birth, or readmission within 6 weeks postpartum.

The rise in sepsis-related deaths complicating childbirth[12] stresses the need for guidelines adapted for the obstetric setting directed at recognizing impending sepsis before the patient progresses to severe sepsis (decreased end-organ perfusion and/or hypotension) and septic shock (hypotension, lactic acidosis, or end-organ dysfunction that persists despite intravenous fluid resuscitation).[36] The clinical manifestations of severe sepsis are variable during pregnancy and together with the physiologic adaptations of pregnancy, including significant hemodynamic and respiratory changes, make it challenging to recognize early onset of sepsis in the pregnant woman, especially during labor or in the setting of other physiologic events, such as increased blood loss that present with similar vital sign derangements. Early recognition and aggressive hemodynamic stabilization are instrumental in potentially preventing organ system dysfunction and further adverse outcome.[36] The most common presenting symptom of sepsis in pregnancy is an elevated body temperature (>38°C or 100.4°F) with tachycardia (heart rate >110 beats per minute) and tachypnea (respiratory rate >24 per minute). Although not as common as fever, hypothermia may also be manifested (body temperature <36°C or 96.8°F).[35] Timely measurement of serum lactate provides information on severity of sepsis, as indicated by the degree of metabolic acidemia from compromised end-organ perfusion, with a value of 4 mmol/L or higher representing a critical value. The onset of these clinical manifestations is best followed by initiating aggressive intravenous volume expansion at a rate of 20 mL/kg over the first hour to achieve a mean arterial pressure of 65 mm Hg or higher and urine output of at least 0.5 mL/kg/h, among other indices provided by invasive hemodynamic monitoring. Obtaining blood cultures and administering broad-spectrum antibiotics in accordance with the physician's order within 3 hours of the onset of symptoms may also positively impact outcomes. As the obstetric team commences with initial resuscitation measures, summoning assistance from healthcare providers adept at hemodynamic stabilization in the setting of sepsis, and collaborating with the physician on the initiation of best practices for the initial stabilization of the patient with sepsis outlined in the Surviving Sepsis Campaign guideline,[36] will further optimize outcomes.

NATIONAL AND STATEWIDE RESPONSES TO PREVAILING PREGNANCY-RELATED DEATHS AND SEVERE MATERNAL MORBIDITY

Although the Institute of Medicine[46] has suggested areas for research in women's health directed at improving maternal outcomes and organizations such as the US Department of Health and Human Services and the National Quality Forum[47] have introduced quality outcome measures directed at promoting more accountability within healthcare organizations, it is only recently that specific maternal safety initiatives have been identified. The American College of Obstetricians and Gynecologists and the Society for Maternal-Fetal Medicine have combined resources with other professional organizations to establish a Maternal Safety Action Coalition to create safety bundles for maternity care.[26,48] Public health leaders have come together to strengthen the review of maternal deaths at the state level and develop resources for the community and healthcare providers. Examples of these coalitions include the National Maternal Health Initiative, through the Maternal and Child Health Bureau[26] and Every Mother Initiative, by the Association of Maternal & Child Health Programs.[48]

More than half of the United States and the District of Columbia[49] now have state maternal mortality review committees that work in collaboration with professional organizations such as state medical societies and the state's health department that review pregnancy-related and pregnancy-associated deaths. Some states, such as California, Florida, New York, North Carolina, and Ohio, have already established perinatal quality improvement initiatives based upon their reviews of contributors to maternal death.[26] The purpose of the state committee's review is to establish whether maternal deaths are pregnancy-related or pregnancy-associated as well as identify missed opportunities in the care of women during pregnancy, childbirth, and following birth to improve healthcare. Because a maternal death is a rare event for each hospital, a review of deaths across the state allows for a more robust analysis[6] that may generate opportunities for quality improvement enacted through education, development and distribution of resources, and possibly legislation.

Hospitals' reviews of mortality and severe morbidities complement the national and state reviews. Significant complications during pregnancy exceed the number of deaths, which has generated recent recommendations for hospitals to implement a standardized process for identifying and analyzing severe maternal morbidity cases within each birthing facility[50–52] with the hope that insights gained through such a review will improve the quality of care. Indicators of severe maternal complications include diagnoses associated with organ system injury or critical care interventions (ie, mechanical ventilation or hemodynamic support). One approach is to identify maternal critical care admissions and patients who have received 4 or more units of blood products and to systematically review those cases in order to determine whether there are any improvements in the care that could lead to quality

improvement initiatives.[21,50,51] Review of cardiopulmonary resuscitations may also identify life-threatening conditions or events. Key attributes of a successful maternal mortality and morbidity review committee include conduct of the review within a culture of safety by identifying and improving systems, processes, and knowledge of the care providers involved using standardized methodology; utilization of expert reviewers from multiple disciplines including nursing; ready access to information from medical records and/or interviews; ability to organize, evaluate, and disseminate data; proximate timing of review soon after an event; and the provision of confidentiality and protection from discovery in the event that legal action ensues.[50,51]

CONCLUSION

Better understanding of why women die during pregnancy, childbirth, or postpartum offers valuable insight into strategies aimed at preventing maternal deaths and arresting the progression in severity of complications. Focusing on those behaviors and actions that are within one's control and broadening one's influence within the surrounding system will extend the professional nurse's opportunities for producing significant improvements in the quality of care provided to childbearing women on an individual and global level. Advancing cognitive understanding of maternal healthcare issues and further refining technical and social skills bolster's the nurse's influence at the level of the patient and at the state and national levels.

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