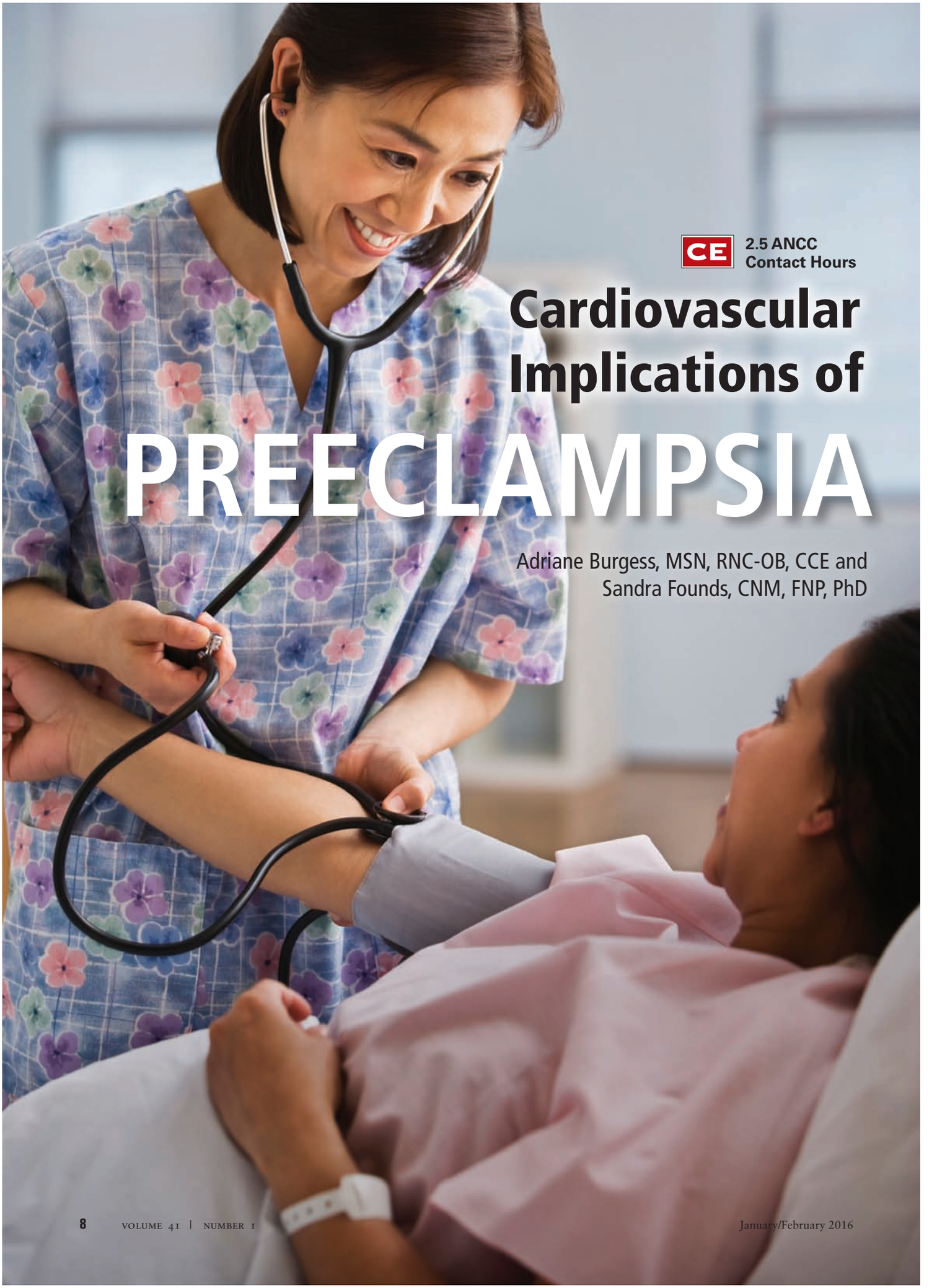

CE 2.5 ANCC Contact Hours

Cardiovascular Implications of PREECLAMPSIA

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Abstract
Cardiovascular disease (CVD) is the leading cause of death of women in the United States. Many healthcare providers are unaware of sex-specific factors that affect the development of CVD. Nursing care for women with a history of preeclampsia and their children is presented. Preeclampsia affects 4% to 8% of all pregnancies. Rates have increased by 25% over the past 2 decades. Research supports the link between preeclampsia and risk of future CVD in women and the children of affected pregnancies. Appropriate preconception, prenatal and postpartum education, and surveillance are necessary to improve the long-term health of both mother and infant. Currently, there are no evidence-based interventions specific to the prevention of CVD for women and their children who have been affected by preeclampsia. However, women who have had preeclampsia may require yearly risk factor assessment and education regarding cardiovascular prevention strategies such as smoking cessation, increased physical activity, importance of a healthy diet, and maintenance of a healthy weight. Preeclampsia should be acknowledged by healthcare providers as a CVD risk factor. Appropriate monitoring, education, and CVD preventive strategies need to be implemented with this population and their children.
Key words: Cardiovascular disease; Nursing; Preeclampsia; Women's health.

Cardiovascular disease (CVD) is the leading cause of death in women in the United States, with heart attack and stroke as leading causes of cardiovascular mortality (Bushnell et al., 2014; Fraser et al., 2012). For many years, CVD was socially constructed as a male illness; however, since 2000, there have been increasing efforts to raise women's awareness of their risk for this disease (Long, Taubenheim, Wayman, Temple, & Ruoff, 2008; Mosca, Hammond, Mochari-Greenberger, Towfighi, & Albert, 2013). The American Heart Association (AHA) created Go Red for Women and the National Heart, Lung and Blood Institute initiated the Heart Truth as targeted campaigns to highlight awareness around the prevalence of CVD in women (Mosca et al., 2013).

Although these campaigns have been successful in increasing public awareness, several health disparities remain, with increasing rates of CVD seen in African American and Hispanic women (Mosca et al., 2013). Overall, awareness of CVD has increased among women and men, but women have not experienced a decline in the disease rates equal to that of their male counterparts (Mosca et al., 2013). Younger women aged 25 to 34 report lower awareness of heart disease as the leading cause of death in women and their lower perception of risk is a barrier to self-care and CVD prevention (Mosca et al., 2013). Inequitable provision of healthcare and lack of knowledge and awareness of sex-specific factors of the disease such as pregnancy, menopause, and female hormones may perpetuate disparity in rates of CVD (Craici, Wagner, & Garovic, 2008). These sex-specific factors may influence onset and diagnosis of CVD and affect the clinical course, efficacy of therapy, and outcomes in women (Craici et al.).

Nursing care of women with a history of preeclampsia and the cardiovascular implications that may follow for both women and their children are presented as follows. Recent changes to both the definition and diagnostic criteria of preeclampsia (American College of Obstetricians and Gynecologists [ACOG], 2013) provide background to the less familiar lifelong risks of CVD to mothers and offspring of pregnancies affected by preeclampsia. Nurses have an important role in advocating for long-term health and wellness for these patients.

Preeclampsia Update

Preeclampsia affects 4% to 8% of all pregnancies, a number equal to those affected by breast cancer each year in the United States (ACOG, 2013; Bushnell et al., 2014; Ilekis, Reddy, & Roberts, 2007). Rates of preeclampsia have risen 25% in the past 2 decades in the United States, contributing to maternal morbidity and mortality and to neonatal prematurity (Wallis, Saftlas, Hsia, & Atrash, 2008). Hypertensive disorders of pregnancy account for 9.4% of maternal deaths in the United States (Creanga et al., 2015). Severe morbidities include consequences of eclampsia, acute renal failure, pulmonary edema, placental abruption, end-organ damage, and neurologic sequelae such as stroke (Lisonkova & Joseph, 2013; Sibai, Dekker, & Kupferminc, 2005). Women with preeclampsia, particularly those with early-onset disease, are at higher risk for induction of labor and cesarean birth (Alanis, Robinson, Hulsey, Ebeling, & Johnson, 2008). Certain risk factors such as heart disease, hypertensive disorders, maternal comorbidities, and advanced maternal age have been implicated in the significant increase in rates of preeclampsia (Leffert, Clancy, Bateman, Bryant, & Kuklina, 2015).

Neonatal complications are associated with preeclampsia. Fifteen percent of pregnancies affected by preeclampsia result in spontaneous or medically indicated preterm birth (Alanis et al., 2008). There is a twofold increased risk of neonatal death in babies of women diagnosed with preeclampsia, and a higher incidence of fetal growth restriction (FGR) and associated neonatal morbidity, including low Apgar scores, seizures, and neonatal encephalopathy (Lisonkova & Joseph, 2013).

Definition and Diagnosis

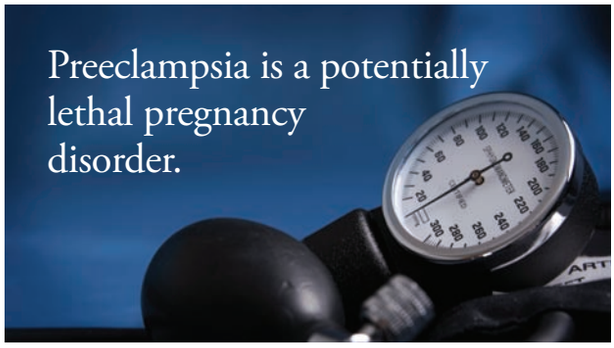
Preeclampsia can occur any time after 20 weeks of gestation and up until 4 weeks postpartum. It is a multisystem disease characterized by new onset of hypertension during pregnancy, defined as systolic blood pressure (BP) ≥ 140 mmHg or diastolic BP ≥ 90 mmHg (ACOG, 2013). To meet

diagnostic criteria, these elevations in BP must be noted on two occasions at least 4 hours apart (ACOG). Although proteinuria ≥300 mg in a 24-hour urine collection remains part of the diagnostic criteria, it is important to note that some women with preeclampsia may not present with proteinuria (ACOG). Women who meet the BP parameters of the disease in the absence of proteinuria can still be diagnosed when any one of the following criteria exist: including platelet count >100,000 per microliter, serum creatinine >1.1 or doubling of serum creatinine in absence of renal disease, elevated concentrations of blood liver transaminases to twice normal levels, pulmonary edema, or new onset of cerebral or visual disturbances (ACOG). Typically as the disease increases in severity, there is an increase in the severity of maternal symptoms and sequelae. Preeclampsia is no longer classified as mild or severe, but rather "preeclampsia without severe features" or "preeclampsia with severe features" (ACOG, p. 18). This modification in nomenclature came after recognition that preeclampsia severity can change rapidly and the classification spectrum should remain fluid, as women with preeclampsia require frequent evaluation by healthcare providers for worsening signs and symptoms (ACOG).

Risk Factors for Preeclampsia Associated With CVD Risks

Although no universal screening protocol in pregnancy has been validated for preeclampsia, there are risk factors that should be noted by healthcare providers who care for childbearing women (ACOG, 2013). A higher level of surveillance is warranted for women with certain risk factors, including previous history of preeclampsia, family history of preeclampsia, obesity, women having their first pregnancy, a new partner, multiple gestation, extremes of maternal age, and use of infertility treatment in order to conceive (Founds et al., 2011; Sibai et al., 2005). Few evidence-based strategies are available for prevention of preeclampsia during pregnancy. Low-dose aspirin is recommended as a therapy for women at high risk for preeclampsia, such as those with chronic hypertension and/or those at risk for recurrent preeclampsia (ACOG; Bushnell et al., 2014). It is recommended that women with these risk factors begin low-dose aspirin therapy by the 12th week of gestation and continue until birth (ACOG; Bushnell et al.).

Risk factors associated with CVD are also associated with preeclampsia (ACOG, 2013). Obesity substantially increases the risk of preeclampsia; women with a body mass index (BMI) of 30 have threefold higher odds of developing preeclampsia (Bodnar, Ness, Markovic, & Roberts, 2005). Preexisting medical conditions such as chronic hypertension, systemic lupus, and diabetes mellitus also increase risk (ACOG; Lisonkova & Joseph, 2013; Sibai et al., 2005). Black women have the highest rates of gestational hypertensive disorders, which may be attributed to higher rates of pregestational hypertension. Paternal race has been shown to be associated with risk of preeclampsia. Racial differences between parents have been shown to confer a small increased risk of preeclampsia (Bryant, Worjoloh, Caughey, & Washington, 2010).



Subsets Link to Future CVD

Preeclampsia has been called the disease of theories because the molecular etiology of the disease remains unknown (Founds et al., 2011). It is heterogeneous in nature and varying subtypes of the disease may exist (Barton & Sibai, 2008; Founds et al.). Pathophysiologic, genetic, metabolic, immunologic, and inflammatory causes have all been postulated (Charlton, Tooher, Rye, & Hennessy, 2014; Founds et al.; Ilekis et al., 2007). Due to its heterogeneity, it is important to consider that the pathophysiology of preeclampsia may also be different among subtypes, based on the associated risk factors noted in affected woman (Barton & Sibai).

The two most common subtypes discussed in the literature are early and late-onset preeclampsia. These two subtypes are defined in relation to the timing of onset of the disease during pregnancy. Early-onset preeclampsia occurs before or at 33 weeks gestation; late onset occurs at 34 weeks or later (Lisonkova & Joseph, 2013). Late onset is further subdivided to include preterm preeclampsia between 34 weeks 1 day until 37 weeks 0 days, and term preeclampsia at or after 37 weeks 1 day gestation (Tranquilli, Brown, Zeeman, Deeker, & Sibai, 2013). Both early and late subsets increase a woman's lifelong risk of CVD; however, the earlier the onset, the higher the later CVD risk. For example, a seven- to eightfold increased risk was found with early-onset disease compared to a twofold increased risk of CVD later in life following late-onset preeclampsia (van Rijn et al., 2013). Women with early-onset disease have higher risk of congestive heart failure as well as ischemic cardiac disease related to left ventricular abnormalities that may persist after the birth (Melchiorre, Sharma, & Thilaganathan, 2014).

Preeclampsia and CVD Care

In 2011, AHA added preeclampsia, pregnancy-induced hypertension, and gestational diabetes as evidence-based risk factors in guidelines to classification of CVD risk in women (Mosca et al., 2011). Many primary and obstetric care providers are unaware of sex-specific CVD risk factors or preventive strategies tailored for women (Ehrenthal et al., 2013). In a recent study, Young, Hacker, and Rana (2012) found that only 9% of internists and 38% of obstetrician-gynecologists provided cardiovascular risk reduction counseling to women with a history of preeclampsia.

Recent AHA guidelines (2014) for prevention of stroke in women reported that 18.2% of women with a history of preeclampsia had a cardiovascular event in the 10 years following the birth of an affected pregnancy compared to 1.7% of women with uncomplicated pregnancies (Bushnell et al., 2014). With identified risk factors and long-term implications of preeclampsia, nurses play a key role in providing evidence-based care and education to women in all phases of childbearing, gynecologic, and primary care.

Prenatal Care

Prenatally, there has been a gap in women's knowledge of signs and symptoms associated with preeclampsia (You, Wolf, Bailey, & Grobman, 2012). Healthcare providers may not be providing women with adequate knowledge on warning signs of preeclampsia. This information may not be provided early in pregnancy out of concern that education about preeclampsia too early in pregnancy may increase a women's anxiety and prove to be counterproductive (ACOG, 2013; Tsigas, 2006). This concern may be unfounded and prove dangerous to the health of women. Early in pregnancy, prenatal care visits may be infrequent. Women should be armed with knowledge early in pregnancy so that they can appropriately report changes in health status to receive timely care and intervention (Tsigas).

As preeclampsia becomes increasingly severe, there may typically be more marked maternal symptoms. It has been suggested that comprehensive patient education could prevent over half of the more serious preeclampsia outcomes (You et al., 2012). The Preeclampsia Foundation found that 51% of college educated women in the United States knew about preeclampsia and understood the signs and symptoms. When women understood the signs and symptoms 75% took appropriate action, whereas when women did not report understanding of the signs and symptoms, only 6% took appropriate action (You et al.).

Infographics such as those created by the Preeclampsia Foundation www.preeclampsia.org/ can be used to educate women early in the prenatal period and can improve understanding of signs and symptoms of preeclampsia. This type of infographic can be especially helpful for those with lower health literacy (You et al., 2012). Healthcare providers must listen carefully when women report vague complaints such as they are "just not feeling right." There may be a tendency to minimize these reports, which can be missed opportunities for early evaluation and improved outcomes (Tsigas, 2006; Walsh, 2013).

Early and frequent prenatal education about preeclampsia can be broadened to include messages about lifelong risk of CVD for mother and her children. An emphasis on asking about preeclampsia in family history and on the concept that pregnancy is a stress test for life (Williams, 2003) can be included in self-care and parenting education.

Postpartum Care

In the immediate postpartum period hemodynamic changes take place that significantly affect BP. In women with preeclampsia, BP typically falls in the first 48 hours postpartum but may show signs of elevation on days 3 to 6 postpartum (ACOG, 2013; Sibai, 2012). Blood pressure should be monitored carefully and if BP remains elevated after 1 day postpartum, nonsteroidal anti-inflammatory agents should be used judiciously as these may contribute to BP elevation (ACOG). It is important for postpartum nurses to be aware of these physiologic changes so that they can monitor for signs and symptoms and provide appropriate patient education. Women who are knowledgeable can more readily identify when they need to seek prompt medical attention for preeclampsia (Druzin, Shields, Peterson, & Cape, 2013).

Nurses should work closely with other interdisciplinary team members to provide women with preeclampsia appointments for early postdischarge follow-up in order to monitor BP. Appointments should be scheduled within 3 to 7 days postpartum if BP medication was used during labor and birth and/or in the postpartum period to help stabilize BP (Druzin et al., 2013; Walsh, 2013). If no antihypertensive medication was used, patients should be seen for follow-up within 7 to 14 days after birth in order to monitor BP stability (Druzin et al.; Walsh). If at the 6- to 8-week checkup, antihypertensive medication is still required, a visit should be scheduled to follow up with a cardiologist (Melchiorre et al., 2014). Through the provision of careful phone assessments, outpatient nurses can appropriately triage the often subtle signs and symptoms associated with postpartum preeclampsia that can be easily misinterpreted. This follow-up is imperative to make sure women with preeclampsia do not remain or become hypertensive once discharged and if so, receive timely and appropriate treatment for hypertension.

Women with a history of preeclampsia are at increased risk for CVD, cerebrovascular events, as well as hypertension (Tranquilli et al., 2013). Nakimuli, Elliott, Kaleebu, Moffett, and Mirembe (2013) found that 34% of women remained hypertensive 3 months after birth. Early gestational age at birth, multiparous women, and women older than 35 all were at higher risk of persistent hypertension in this study (Nakimuli et al.). Melchiorre et al. (2014) report that a prehypertensive state can persist for 1 year postpartum and is most commonly seen in those women who have preterm preeclampsia. Well-designed cardio preventive follow-up programs specific to women with a history of preeclampsia are important. Due to the slowly progressing nature of CVD, preeclampsia provides a unique opportunity to improve prognosis rather than providing treatment once CVD is at a more advanced stage (Melchiorre et al.; Tranquilli et al.). The preeclampsia toolkit from the California Maternal Quality Care Collaborative offers infographics that can be used to educate women about lifetime risk of CVD associated with pregnancy complications (Druzin et al., 2013).

Primary Care

Women at risk for preeclampsia and/or with a history of the disease may be seen in emergency rooms and primary

care office settings. Nurses in these practices should ask about a history of preeclampsia in the woman's medical history, reproductive history, and in family history when applicable (Founds, 2014). Younger women can be encouraged to discuss their mothers' and grandmothers' pregnancy histories to build family histories. Women's BP can remain labile for months postpartum, occasionally not normalizing until the end of the first year postpartum. Although not much is known about this phenomenon, the BP lability may be a predictor of future chronic hypertension (ACOG, 2013). Nurses in contact with women with a history of preeclampsia in all healthcare settings can provide education to them about the importance of conferring with their primary care providers surrounding modification of CVD risk factors and long-term monitoring of BP.

Preconception and interconception health promotion is a key aspect of efforts to improve pregnancy outcomes, as well as long-term health of at-risk women and their children. At each gynecologic visit, preconception counseling on importance of a healthy diet and physical activity to support a healthy weight is essential to optimal maternal and neonatal pregnancy outcomes (Langford, Joshu, Chang, Myles, & Leet, 2011). Elevated BMI is a risk factor for preeclampsia as well as CVD; therefore, preconception and interconception time periods are excellent times to offer targeted education on weight reduction strategies for overweight and obese women. Weight reduction between pregnancies has been associated with decreased risk of recurrent hypertensive disorders (Firoz & Melnik, 2011; van Rijn et al., 2013).

Women with a history of preeclampsia have higher levels of circulating fasting insulin and lipid levels, as well as increased inflammatory and coagulation factors for years after birth. More commonly, they also have increased waist circumference and higher rates of obesity, both factors that also contribute to increased risk for both CVD as well as type 2 diabetes mellitus (Charlton et al., 2014; Tranquilli et al., 2013). Due to the associated increased risk for stroke and CVD, according to recent AHA guidelines, it is reasonable to provide CVD risk factor assessment beginning 6 months to 1 year postpartum including evaluation for hypertension, smoking, dyslipidemia, and elevated BMI (Table 1) (Bushnell et al., 2014; van Rijn et al., 2013).

Currently, there are no evidence-based interventions on CVD risk reduction specific to this population; however, traditional prevention strategies such as smoking cessation, increasing physical activity, eating a healthy diet rich in fruits and vegetables and whole grains, as well as maintaining a healthy body weight all should be encouraged (van Rijn et al., 2013). Spratling et al. (2014) found that telephonic CVD education for women with preeclampsia who recently gave birth was helpful in increasing knowledge of the association between preeclampsia and CVD and subsequently motivating women toward lifestyle modification. It is unclear whether women are able to recall and report their history of preeclampsia when questioned later in life (Stuart et al., 2013); therefore, a smooth transition from obstetric care to primary care may be ensured by the interoperable information systems. Portable medical records could allow for improved tracking of pregnancy data, so that primary care providers can more efficiently review associated CVD risk factors that may otherwise go unreported (Celi et al., 2013).

Cardiovascular Risk Assessment for Women With a History of Preeclampsia

Tools commonly used to assess cardiovascular risk may not be appropriate for use in younger women. The Framingham Cardiovascular Risk Assessment Tool is one of the most common tools and has been used since the mid-seventies to identify those at risk for future CVD (Framingham Heart Study, 2014). The tool was created in 1971, with a single risk equation for men and women, but now there are two separate equations to calculate a male's risk versus a female's risk for CVD. Both equations use the same variables to determine risk, including age, total cholesterol, high-density lipoprotein cholesterol, systolic BP, antihypertensive medication use, current smoking, and diabetes status (D'Agostino et al., 2008).

Risk factors unique to women, such as preeclampsia and gestational diabetes that have been shown to increase a woman's future risk of CVD are not included in the women's equation (Hermes et al., 2013). Sibley, Blumenthal, Merz, and Mosca (2006) found based on the variables currently in the equation, unless a women is older than 70, she will usually not score high enough on the Framingham assessment to qualify for pharmacologic preventive interventions. Sibley et al. suggested that the Framingham model needs to include marginal risk factors and focus on long-term CVD risk. This would be ideal in the case of women who were recently diagnosed with preeclampsia because currently these women and their providers may be falsely reassured of low risk of future CVD. Because many of these CVD models weight age very heavily, subsequently obscuring risk in younger women, short-term risk assessments are not preferable. Smith, Pudwell, Walker, and Wen (2012) recommend use of a lifetime CVD score as they better identify women with preeclampsia at risk of future CVD than do 10- and 30-year risk assessments. If healthcare providers wait to assess preeclampsia as a risk factor for CVD, it has been shown that older women with a history of preeclampsia may be unable to recall history of the disease, leaving a gap in healthcare provider's ability to provide a comprehensive risk assessment later in life (Stuart et al., 2013).

Children of Women Who Have Had Preeclampsia and CVD

It is important for nurses in pediatric settings to be aware of the link between preeclampsia and short- and long-term cardiovascular implications in affected

children. There are conflicting results about the implications of preeclampsia on neonatal BP in the first hours after birth. However, there has been a link between maternal hypertension during pregnancy and increased risk of elevated neonatal BP during the first month of life (Kent & Chaudhari, 2013). According to Barker's fetal origins theory, the intrauterine environment plays a role in predicting future health (Barker, 1995). Babies born of pregnancies of women with preeclampsia demonstrate a higher incidence of hypertension in childhood and adolescence (Geelhoed et al., 2010). This increased risk of CVD may be related to a "direct effect, a familial aggregation of risk, or confounded by its association with intrauterine growth restriction" (Herrera-Garcia & Contag, 2014, p. 3). Fraser, Nelson, Macdonald-Wallis, Sattar, and Lawlor (2013) found no strong evidence of associations between preeclampsia and gestational hypertension and fasting insulin, glucose, and lipids measured in the adolescent children of mothers who had been affected by these conditions during pregnancy; however, mean systolic BP and diastolic BP were elevated during their adolescence. Although some studies suggest that risk of CVD is increased in these children, there are many confounders that may mediate the development of CVD (Herrera-Garcia & Contag). For example, maternal BMI, lipid profile, metabolic syndrome, hypertension, as well as maternal lifestyle all may confound development of CVD in the children (Herrera-Garcia & Contag).

It is difficult to link risk of future CVD to one factor in the children of preeclamptic pregnancies. A complex interaction of factors occurs that may contribute to increased cardiovascular risk. Fetal growth restriction may be one of the most important risk factors that mediates this lifelong risk of CVD in offspring of women with preeclampsia (Herrera-Garcia & Contag, 2014). Fetal growth restriction occurs in up to 25% of preeclampsia pregnancies (Sibai et al., 2005). Growth restriction is proposed to occur due to shallow trophoblast invasion and insufficient remodeling of the uterine vasculature that typically occurs in the weeks following conception. Subsequently, blood flow is restricted to the fetus, resulting in poor growth (Khong, De Wolf, Robertson, & Brosens, 1986; Meekins, Pijnenborg, Hanssens, McFadyen, & van Asshe, 1994). Careful review of a mother's pregnancy and birth history may provide important information about a child's current health status. Currently, there are no evidence-based strategies concerning monitoring protocols or provision of cardiovascular preventive care to the children of mothers who had preeclampsia. More research is needed to assess the two subtypes of preeclampsia and to evaluate associated risks for children of women in each preeclampsia subgroup (Herrera-Garcia & Contag).

Clinical Implications

With an understanding of the connection between CVD and preeclampsia, healthcare providers and women should view pregnancy as a unique opportunity; one that allows an early glimpse into future health risk, as well as an opportunity for women to begin to use preventive strategies proactively with an aim toward health promotion (Bushnell et al., 2014). Mosca et al. (2006) found that women who believed themselves to be at high risk of CVD were more likely to seek healthcare. Women are often distracted caring for others and put their own needs last; however, during the postpartum period they may be motivated to embrace lifestyle changes (Cusimano, Pudwell, Roddy, Cho, & Smith, 2014; Mosca et al., 2006). Preeclampsia is not just a disease of pregnancy, but one that affects a woman throughout her lifespan as well as the children of the affected pregnancy. Preeclampsia has significant long-term cardiovascular risks. Healthcare providers should make sure that women are aware of these risks because their knowledge may motivate them to seek healthcare and adopt cardio preventive lifestyle changes. Preeclampsia should be included in the health histories of women who have had the disease. Women who have had preeclampsia should receive BP and lipid profile monitoring and education on the importance of cardio preventive lifestyle interventions within the first year after they give birth and yearly after that. Maternal reproductive history should be considered when assessing children because preeclampsia and FGR may confer

Table 1. Nursing Interventions to Improve CVD Outcomes in Women With Preeclampsia

1. Ensure early postpartum follow-up to monitor for persistent hypertension.
2. Design creative cardio preventive follow-up programs specific to this population that include: • Smoking cessation • Weight management • Exercise programs • Cholesterol monitoring • Nutrition counseling • Referrals to primary care provider and cardiologist when necessary
3. Refer women who have had preeclampsia to primary care for long-term follow-up and monitoring and CVD risk factor assessment beginning 6 months to 1 year postpartum
4. Educate women about the link between CVD and preeclampsia so that they can advocate for their own cardiovascular health and that of their children.
5. Educate healthcare providers on the link between CVD and preeclampsia.
6. Advocate for the inclusion of preeclampsia in obstetric and family histories in the electronic health record.

increased risk of hypertension during childhood and adolescence. Nurses in a variety of settings must understand the short and long-term implications of preeclampsia to promote the health and wellness of women and children ✣.

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