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Learning Objectives

- Explain the relationship between folic acid, zinc and obesity and how it affects a woman’s risk for having a baby with a congenital anomaly.
- Identify nursing opportunities to educate, prevent, and assess for congenital heart malformations and their risk factors.

CHDs are the leading birth defects and the leading cause of death from congenital malformations. Pediatric, neonatal, NICU and obstetric nurses must be able to identify some of the non-genetic risk factors for CHD as well as the reasons these risks exist. Since cardiac development occurs in the first three to nine weeks of gestation, it is...
also important to help parents and future parents make informed and educated decisions about their health, their diet, future child’s health and risk reduction techniques even before pregnancy.

The goal of this article is to increase nurses’ awareness on the role of maternal nutrition, its impact on CHD and neonatal health.

**Prenatal Multivitamins and Folic Acid**

Increasingly, research shows that folic acid is protective against the development of birth defects, although the complete mechanism of this protection is not fully understood. Several genes related to heart and neural tube development are dependent upon the folate pathway. Daily pre-conceptual and first-trimester supplementation with multivitamins fortified with 400 mcg of folic acid has been shown to provide consistent protection against neural tube defects as well as CHD, cleft lip/palate, hydrocephalus, and urinary tract defects. (See Box 1 for the daily recommended folic acid intake for women.) Two studies have found a 50% lower risk of cardiac outflow tract defects when the mother took multivitamin supplements pre-conceptually. Jenkins, et al also noted a decrease in the risk for CHD with folic acid supplementation at a rate similar to the reduction in neural tube defects with folic acid supplementation.

At Children’s Hospital of Philadelphia, Goldmuntz and other genetic researchers conducted research on left-sided CHD (such as hypoplastic left heart syndrome, coarctation of the aorta and aortic valve stenosis) and conotruncal CHD (such as TOF, TGA, double outlet right ventricle, truncus arteriosus, interrupted/isolated aortic arch, and perimembranous or posterior malalignment VSD). These researchers studied 386 and 700 parent-child triads (mother, father, child) to determine the effect that variants of folate metabolism had on left-sided and conotruncal cardiac defects. They found that genetic variants in the folate pathway contributed to conotruncal defects but there was not as strong a relationship to the occurrence of left-sided lesions. There is also an increased familial risk for CHD. If a family member had a conotruncal defect, another family member was more likely to have a conotruncal defect than a left-sided lesion. By the same token, a family member with a left-sided lesion is more likely to have a relative with a left-sided lesion than a conotruncal defect. Their research provides “persuasive evidence that the risk of CHD is influenced by genetic variation within the folate pathway.”

Homocysteine is important for the folate pathway. Mothers with hyperhomocysteinemia (very high measured quantities of homocysteine) have a 2.9 times greater risk of having a baby with CHD. Mothers with hyperhomocysteinemia show a consistently lower serum folate and vitamin B12 concentration, as compared to mothers without this condition.

Some studies have also found that folic acid may protect the fetus when the mother has a febrile illness or is taking a folic-acid-antagonist medication. Since the late 1990’s, folic acid fortification has been mandated in the U.S. food supply (grains and cereals) to reduce neural tube defects. The Centers for Disease Control (CDC) states that folate is a form of the B vitamin folic acid and is found in foods such as beans, citrus fruits/juices and leafy, dark green vegetables. However, the CDC also states that the “body does not use folate as easily as folic acid” and “we cannot be sure that eating folate would have the same benefits as getting 400 micrograms of man-made (synthetic) folic acid.” Therefore, the CDC recommends that “women who can get pregnant should consume 400 micrograms of synthetic folic acid [from a vitamin supplement] in addition to the natural food folate from a varied diet.” The March of Dimes recommends that “women of childbearing age take a multivitamin with 400 micrograms of man-made (synthetic) folic acid.” Poorly

**Box 1: Daily Recommended Intake (for women) Folic Acid**

- Non-pregnant woman - 400mcg/day
- Pregnant woman - 600mcg/day
- Nursing woman - 500mcg/day
nourished women, and women with unplanned pregnancies, who may not start prenatal vitamins before embryogenesis is complete, are particularly at risk of not receiving the recommended daily amount of folate.

**Zinc and Alcohol**

Zinc has been widely researched (1) for its role in fetal development, (2) for its possible ability to reduce the rates of low birth weight babies, (3) as a crucial element required for central nervous system development through zinc-dependent enzymes, zinc finger proteins and zinc-dependent neurotransmitters, and (4) for the relationship of zinc deficiency in the presence of maternal alcoholism.

Maternal alcohol consumption during pregnancy places the fetus at risk for Fetal Alcohol Syndrome Disorders (FASD), a higher risk for CHD and teratogenicity. Combining zinc deficiency, alcohol and stress in a pregnant woman results in zinc sequestration in the liver, decreased zinc uptake, and multifaceted developmental aberration. The fetus is thus impacted by chromosomal damage, excessive oxidative damage, impaired intracellular signaling, low activity of zinc enzymes and impaired cell progression/death.

To date, studies of zinc supplementation have not been large enough to result in recommendations for zinc supplementation during pregnancy. In addition, zinc supplementation alone can distort the maternal metabolism of several essential nutrients including iron, copper, selenium, folate, and vitamin A. Reduction in zinc uptake may also be caused by physiological stress and/or poor diet. This may be one reason why some women who have a poor diet have complicated pregnancies.

Nursing assessment of the pregnant woman should include weight gain, diet, stressors, and drug intake, including prescription, over-the-counter, recreational and illicit drugs, as well as nutritional supplements. Because vegetarians have a reportedly lower serum concentration of zinc, a vegetarian diet should be noted. Alcohol, a legal drug, can result in FASD, which includes a higher risk for heart, kidney, optic, central nervous system, bone and facial defects. Diet, stress and alcohol intake affect the availability of zinc for fetal development and can cause birth defects, including CHD.

**Table 1: Folic Acid Antagonist Medications**

<table>
<thead>
<tr>
<th>Medication: Generic (Trade)</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trimethoprim</td>
<td>Antibiotic used for urinary tract infections, pneumonia, traveler’s diarrhea</td>
</tr>
<tr>
<td>Trimethoprim/sulfamethoxazole</td>
<td>Antibacterial combination sulfonamide drug for urinary tract infections, otitis media, traveler’s diarrhea</td>
</tr>
<tr>
<td>Methotrexate</td>
<td>Antineoplastic drug used for severe psoriasis, rheumatoid arthritis, and carcinomas</td>
</tr>
<tr>
<td>Sulfasalazine</td>
<td>Drug used for bowel inflammation, diarrhea, rectal bleeding</td>
</tr>
<tr>
<td>Triamterene</td>
<td>Diuretic used to treat edema</td>
</tr>
<tr>
<td>Carbamazepine</td>
<td>Anticonvulsant medication used to prevent/control seizures, and for trigeminal neuralgia</td>
</tr>
<tr>
<td>Phenytoin</td>
<td>Anticonvulsant medication used to prevent/control seizures</td>
</tr>
<tr>
<td>Phenobarbital</td>
<td>Barbiturate used for sedation and anticonvulsant to prevent/control seizures</td>
</tr>
<tr>
<td>Primidone</td>
<td>Anticonvulsant used to prevent/control seizure</td>
</tr>
<tr>
<td>Valproic Acid</td>
<td>Anticonvulsant used to prevent/control seizures, and as a mood stabilizer</td>
</tr>
<tr>
<td>Lamotrigine</td>
<td>Anticonvulsant used to prevent/control seizures</td>
</tr>
<tr>
<td>Cholestyramine</td>
<td>Antilipemic used to lower serum cholesterol</td>
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</table>
which are both more prevalent in the studied populations.²

Perinatal outcomes are influenced by perinatal nutrition.¹⁹ Maternal nutrition affects outcomes by altering physiologic functioning at the cellular and organ level and altering fetal environment and gene expression (epigenetics).¹⁹ For example, maternal deficiency of folic acid contributes to abnormalities of the heart and neural tube that are prevented by folic acid supplementation.⁵,⁶,⁷,⁹,¹⁰

Moreover, undiagnosed congenital anomalies are more likely in obese women because it is more difficult to obtain optimal imaging with obstetric ultrasounds.¹⁸ An understanding of the limitations of ultrasound, and knowledge of a mother’s pre-pregnant and delivery BMI should prepare nurses to be on the alert for a possible undiagnosed anomaly. Postnatal pulse oximetry screening of all newborns may find CHD that had not been detected prenatally for whatever reason.

**Nursing Implications**

Nursery nurses may not see parents for several hours after the birth and during that period must depend on the nursery’s often cursory prenatal record for assessment and risk information. As soon as possible, the family should be asked, in detail, about the prenatal history. Did the mother have infections or stressors during the pregnancy? Is she a vegetarian or did she have a nutrient-poor diet? Did she take prenatal vitamins prior to and during the pregnancy? Does the family have adequate resources for vitamins and a nutrient rich diet? What amount, if any, of alcohol did she imbibe? Is there a family history of CHD or FASD in other children? Answers to these questions serve not only to assist with more accurate newborn assessments, but will become part of the prenatal record for this and future pregnancies and may provide data for future studies.

When assessing a mother and infant, consider the maternal BMI and the resolution of the ultrasound. Is it possible that an anomaly was undetected on ultrasound? Remember, under-nutrition and over-nutrition does not mean that the right amount of micro-nutrients are available for the developing fetus.¹⁹ A quality nursing assessment for identifying congenital malformations is especially important when the mother is obese.

Nurses who have an opportunity to educate future parents may be instrumental in encouraging preconception health and vitamin supplementation. The protective effects of a daily multivitamin with 400 mcg of folic acid during the preconception period (at least 3 months prior to conception and ideally a year in advance of a pregnancy) cannot be overstated. Because 50% of pregnancies are unplanned, educating sexually active women to take a daily vitamin/mineral supplement may significantly improve maternal/fetal and neonatal outcomes. Promoting these low-cost vitamins as a public health initiative is a cost-effective way to reduce congenital anomalies. One tactic that would encourage use is renaming these supplements, as many women do not see themselves as “prenatal.” Recently, a birth control pill containing folic acid was approved by the FDA because not every woman takes the pill correctly and an unplanned pregnancy may occur.

In addition, it is important to stress that prenatal vitamins are also important throughout the course of the pregnancy. As Figure 1 illustrates, crucial fetal development occurs up until birth. Mothers should take their vitamins throughout pregnancy and during lactation as well.

Nurses play an influential role in the lives of many women and have several opportunities to help promote healthy and successful pregnancies. Proper pre-pregnancy nutrition, folic acid supplementation, alcohol

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**Figure 1: Periods of Fetal Development**³

![Figure 1: Periods of Fetal Development](http://www.fasdcenter.samhsa.gov/documents/WYNK_Effects_Fetus.pdf)

Recently, a birth control pill containing folic acid was approved by the FDA because not every woman takes the pill correctly and an unplanned pregnancy may occur.

avoidance, attaining a normal BMI and stress reduction are important goals for a healthier pregnancy. Postnatal nursing assessment including a complete prenatal history, physical examination and pulse oximetry screening after 24 hours of age, will improve neonatal health by earlier detection of CHD.

About the Author
Stefanie Modri RN, BSN, C-MNN, PBC is an obstetrics and newborn nurse who graduated from The College of New Jersey and had been verified in Maternal-Newborn Nursing since 2000. has practiced in Massachusetts, New Jersey and Hawaii. Stefanie is presently enrolled in the Innovations and Intra/Entrepreneurship in Advanced Practice Nursing MSN program at Drexel University, where she has earned her post-baccalaureate certificate in the same. She currently works in the Special Delivery Unit at the Children’s Hospital of Philadelphia, where she cares exclusively for mothers delivering babies with birth defects. Ms. Modri is also the founder of PrecisionRN, LLC. The company shares evidence-based nursing research via text messages to nurses to improve bedside nursing practice and the quality of patient care. She can be reached at info@PrecisionRN.com.

REFERENCES: