Preconception care is an important aspect of pregnancy-related care. Unfortunately, it is often ignored or minimized by both the patient and the provider. This article provides a framework for preconception care by offering the mnemonic “VITAL MOM.” It is hoped that this offering will assist the clinician in optimizing pregnancy outcome.

(Key words: preconception care, preconception counseling, prepregnancy advice)

More than 50% of pregnancies in the United States are unplanned. Among those women who have had a planned pregnancy, a minority seeks any type of preconception counseling or care. Of the 4 million live births in the United States, nearly one quarter have institution of prenatal care after the 12th week of pregnancy.

Poor pregnancy outcome includes congenital anomalies, miscarriage, preterm birth, fetal growth restriction, and stillbirth. Clearly, only a small percentage of poor outcomes may be amenable or modifiable either by early preconception or preconception care. It is acknowledged that with a few exceptions, limited evidence-based studies exist to recommend universal preconception care. Nevertheless, the suggestions set forth in this article promote a healthy and informative approach to the woman contemplating a pregnancy. Ideally, it should serve as routine patient education to all women of childbearing age.

Serious congenital anomalies occur in approximately 2% of all pregnancies. Of all anomalies, at most approximately 5% to 8% may be due to preventable causes such as medications, chemicals, infections, or maternal metabolic disorders such as diabetes. The teratogenic period lasts from days 31 through 71 after the last menstrual period (or 17 to 56 days after conception). In practical terms, weeks 4 through 10 are the most significant for development of congenital anomalies. Because most women will have their first prenatal visit either during or after this important time, information is best disseminated before pregnancy.

The mnemonic “VITAL MOM” may serve as a reminder as to the questions to be asked and recommended interventions to promote a healthy, successful pregnancy (Figure).

Vitamins and minerals
Folic acid
Several prospective studies have shown that supplementation with folic acid before conception reduces the incidence of neural tube defects. The Centers for Disease Control and Prevention (CDC) has recommended that daily intake of 0.4 mg of folic acid be added to the diet of all women of childbearing age. Additionally, women who have had a previous child with a neural tube defect are encouraged to take 4.0 mg of folic acid starting at least 1 month before conception and continuing through the first 3 months of pregnancy.

Although rare, patients with vitamin B12-deficiency anemia should not receive high doses of folic acid because of the adverse neurologic effects. This deficiency should be recognized and treated before any folic acid supplementation to prevent a recurrent neural tube defect.

Iron
The requirements for iron increase to 30 mg/d during pregnancy. Most women do not consume adequate amounts for pregnancy. Young maternal age and short interconception periods may increase the need for supplementation in the first trimester or before pregnancy. For most women, supplementation may be delayed until the second trimester.

Prenatal vitamins
Prenatal vitamin-mineral supplements are routinely prescribed during pregnancy and for preconception care. Except for certain groups such as teenagers and those with a poor diet, little evidence exists to suggest that this practice is of any benefit. Nevertheless, because prenatal vitamins contain folic acid and iron, such preparations are a convenient way for women to obtain these supplements. Many non-prescription multivitamin-mineral supplements contain the recommended daily requirements for iron and folic acid and are an acceptable alternative to prescription prenatal vitamins or individual folic acid and iron tablets. Patients must be cautioned not to exceed the daily recommended doses for vitamins, primarily vitamin A. Vitamin A in excess doses has been found to be teratogenic.

Immunize
Most women of childbearing age have received immunizations for measles, mumps, and rubella (MMR), tetanus, and diphtheria, though such immunization is by no means universal. A small percentage (about 8%) may remain seronegative after immunization for rubella. It is likely that most of these individuals are still protected; however, considering the ramifications of congenitally acquired rubella, revaccination seems appropriate. Documentation of prior immunization may not be adequate to determine rubella immunity. Because serologic testing is performed for routine prenatal care, it seems reasonable to check a titer on all women of childbearing age. Those women with a negative titer should be immunized.

A booster of tetanus and diphtheria should be offered every 10 years.

Approximately 95% of adults have natural immunity to varicella. Susceptible adults who acquire the disease may have a more severe course. Therefore, it is recommended that susceptible adults be vaccinated.

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Hepatitis B vaccination is now recommended for children. Adults in a high-risk situation, such as healthcare workers, should be encouraged to be immunized.\(^{11}\)

The MMR and varicella vaccination should not be administered to pregnant women. Additionally, pregnancy should be deferred for 3 months after immunization, though inadvertent pregnancy is not an indication for abortion.\(^{12}\)

Tetanus, influenza, and pneumococcal vaccinations can be given in pregnancy if indicated. The CDC actually recommends immunizing women for influenza if they will be in the second or third trimester during the influenza season.\(^{13}\)

The incidence of carrier frequency is approximately 4% in the North American Caucasian population. Although screening is often offered to all women undergoing formal genetic counseling, universal screening is not currently recommended. Those women with a family history should be offered testing.\(^{14}\)

Tuberculin skin test—Healthcare workers and those individuals with increased risk of exposure to tuberculosis should be tested on a yearly basis.\(^{15}\)

**Diabetes screen**—Those women who are obese, have a family history of diabetes, previously large baby (>9 pounds), previous gestational diabetes, or age greater than 35 years should be screened for diabetes. A fasting or postprandial plasma glucose determination is adequate, and a formal glucose tolerance test is not routinely advocated. New criteria for the diagnosis of diabetes include a fasting glucose level greater than or equal to 126 mg/dL, or a random plasma glucose level greater than or equal to 200 mg/dL.\(^{16}\) These values are too high for a normal pregnancy. A fasting and postprandial glucose level less than 105 mg/dL and 120 mg/dL, respectively, should be considered normal for a preconception screen. Elevations above these values require further evaluation.

Other testing should be based on the patient’s medical, occupational, and genetic history, and initial screening tests. These tests include:

- **Sickle cell screen**—The frequency of carrier status is approximately 8% for those of African American heritage. The sickle cell screen is still recommended by some; however, it may be an inadequate screen for those women at risk for a hemoglobinopathy. This inadequacy is due to the other abnormal hemoglobin genes such as HgbC, which cannot be detected by the sickle cell screen. Hemoglobin electrophoresis is the current recommended test for individuals at risk for a hemoglobinopathy.\(^{17}\)

- **Hemoglobin electrophoresis**—Those women of African American, Mediterranean, Middle Eastern, and Southeast Asian heritage are at an increased risk for hemoglobinopathies.

- **Tay-Sachs screen**—Those of Ashkenazi Jewish, French Canadian, or Cajun heritage are at an increased risk for this disorder, with carrier frequency of about 3% to 4%.

- **Canavan disease screen**—Those women of Ashkenazi Jewish heritage are at an increased risk for this disorder, with carrier frequency of about 2% to 3%.

- **Cystic fibrosis screen**—The incidence of carrier frequency is approximately 4% in the North American Caucasian population. Although screening is offered to all women undergoing formal genetic counseling, universal screening is not currently recommended. Those women with a family history should be offered testing.\(^{18}\)

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- **Other testing**, which remains controversial and is not mandated for routine prenatal testing, include serologic testing for toxoplasmosis, cytomegalovirus (CMV), and parvovirus. All can cause congenital infection if acquired during pregnancy.

- **Toxoplasmosis**—Toxoplasmosis is acquired by eating undercooked meat or by inhaling or ingesting oocysts excreted in the feces of domestic cats. Some have recommended routine testing for all women before pregnancy, whereas others suggest that testing be reserved for those at risk.\(^{16(p255)}\) It is not unreasonable to offer testing to women at risk and to educate all to proper preventive measures. These measures include adequate cooking of meats, washing of all fruits and vegetables, and avoiding contact with materials that may be contaminated with cat feces. Wearing protective gloves during gardening may also be preventive.

- **Cytomegalovirus**—Cytomegalovirus infection is the most common congenital viral infection in the United States. Approximately 2% of women acquire a primary infection during pregnancy and another 1% have reactivation of latent disease. One third of these women transmit the infection to the fetus, resulting in approximately 1% of all infants being infected at birth. Most of these infants are asymptomatic. Serious congenital disease, when present, is invariably from a primary infection. Significant damage to the infant is rarely due to latent infection in the mother.\(^{16(p308)}\)

Transmission of CMV occurs primarily through respiratory secretions, urine, and sexual contact. There appears to be an increased risk of transmission in day care settings and certain healthcare facilities such as pediatric, neonatal, and dialysis units. Because CMV may be excreted asymptomatically for a prolonged time, all providers should practice universal precautions. Women who have occupational exposure as described previously should be given the option of being tested for immunity to CMV.\(^{18}\) If the woman is nonimmune, particular attention should be directed at precautions to prevent exposure.

**Parvovirus**—Parvovirus B19 was identified as the etiologic agent of fifth disease (erythema infectiosum) in 1983. Since that time, transmission of the virus to the fetus with stillbirth due to hydrops fetalis has been reported.\(^{16(p255)}\) Between 50% and 75% of women are immune to parvovirus. To those who lack immunity, the transmission rate is quite high when exposed to close contacts (60% to 80%). Previous reports of high transmission rate and damage to the fetus were erroneous. At most, one third of all fetuses are infected, and only 5% are affected with serious consequences. Therefore, it appears that although the possibility of severe fetal disease exists in women who acquire parvovirus during pregnancy, the risk is relatively low.\(^{5}\) Routine testing for immunity does not appear to be warranted under most circumstances. Fifth disease is primarily an infection of children, occurring most frequently in the winter and spring seasons. Women who may have close contact with children, such as teachers, daycare providers, and medical workers, are at increased risk. Women with young children at home are also at risk as the child may be exposed at school or day care and transmit the virus to the parents. Testing for immunity of individuals who may have
an increased risk due to occupational exposure will allay concern if immunity is present. Conversely, such testing may create undue anxiety if susceptibility is demonstrated. Because no prospective studies are available for guidance, education for all with the offer to test those in a definite at-risk situation seems plausible.

**Ask**

**Genetic history**

Genetic questions should focus on ethnicity, family history, and maternal age at time of delivery. Ideally, the patient should be aware of her own and her partner's ethnic background and family history. If not, she should be encouraged to obtain this information if possible. As described previously, certain ethnic groups are at an increased risk of certain genetic disorders, most notably sickle cell anemia in African Americans and Tay-Sachs disease in Ashkenazi Jews and French Canadians. Specific questions about relatives with congenital anomalies, stillbirths, mental retardation, and medical disorders with an inherited basis should be pursued. Finally, each couple should be asked about the possibility of consanguinity. Any positive responses or maternal age at delivery of 35 years or beyond should prompt the offer for formal genetic counseling and testing if desired.

**Obstetric history**

By far the best predictor of pregnancy outcome is previous pregnancy performance. Patients with past miscarriage, preterm delivery, fetal growth restriction, or preeclampsia are at an increased risk of similar complications with any future pregnancy. Most of these complications are not preventable, but certain factors may be modifiable to improve future pregnancy outcome. Specific complications should be explored in detail, and previous medical records reviewed. For example, patients who had severe preeclampsia remote from term should have renal function evaluated before any future pregnancy to assess for preexisting renal disease. Those who have had an infant weighing more than 9 pounds or gestational diabetes in a previous pregnancy should have an assessment of glycemic control in the nonpregnant state. Referral to an obstetrician with training in complicated pregnancies is advisable before conception in instances of previous poor pregnancy outcome.

**Spousal abuse**

Approximately 25% of women may be abused by a partner during their lifetime. Unfortunately, abuse does not stop with pregnancy. It is estimated that partner abuse occurs in 4% to 17% of all pregnancies. Routine screening for domestic violence should be part of every health maintenance visit, including preconception counseling.

**Lose**

**Tobacco**

Approximately 30% of women of reproductive age smoke cigarettes. Although
founded by multisubstance abuse often
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3.9%, opiates.5 Studies on the effects of
ed that 2.6% to 28% have used cocaine;
reproductive years. A 1990 survey report-
not uncommon among women in their
adverse effects of illicit drugs is beyond
A detailed description of the potential
Illicit drugs
The effect of alcohol on the developing
fetus is well known and has been described
tensively in the medical and lay literature.
Alcohol is the leading preventable cause of
mental retardation. The fetal alcohol syn-
drome is a triad of abnormalities including
growth deficiency, central nervous system
damage, and craniofacial abnormalities.
The exact incidence is not known, but
quoted to be from 1 in 500 to 1 in 2500
live births. There is no known safe level of
alcohol consumption during pregnancy.5
Despite the well-reported adverse effects of
drinking during pregnancy, the practice
continues. Alcohol consumption of some
kind was reported in approximately 16%
of pregnant women in a 1995 study.24
Heavy drinking, described as one drink
per day, or binge drinking was reported as
occurring in 3.5% and 3.1% of pregnant
women, respectively. Clearly, alcohol con-
sumption during pregnancy is a major
public health issue. It should not be
assumed that most women will quit drink-
ing during pregnancy. The recommenda-
tion for abstinence should be emphasized
to any woman contemplating pregnancy.

Medical complications
■ Diabetes—It is estimated that approxi-
amately 1 in 20 Americans has diabetes.
Type 2 diabetes mellitus accounts for
approximately 90% to 95% of all dia-
betes in the United States, and the remain-
ing 5% to 10% are type 1.28 Gestational
diabetes, by definition, is that which is
first diagnosed or recognized during preg-
nancy. It complicates approximately 3% to
5% of all pregnancies and accounts for
nearly 90% of all diabetes during preg-
nancy. Most affected women will return
to normoglycemia after delivery. Some,
however, may have had occult or incipi-
ent diabetes that was only fortuitously
diagnosed during pregnancy. Gestational
diabetes is associated with a future risk of
development of type 2 diabetes that may
approach 50%.29

Several major issues are associated with
diabetes and pregnancy that should be
addressed as part of a preconception visit.
■ Congenital malformations—It is well
known that poor glycemic control in the
first trimester of pregnancy is associated
with an increased risk of fetal malforma-
tions. The incidence of major malforma-
tions in infants of diabetic mothers ranges
from 5% to 10% compared with 2% to
3% in a control population.29,30 Metici-
ulous glycemic control during the period of
embryogenesis has been shown to reduce
the incidence of anomalies to essentially
that of a control population.30 Women
with preexisting diabetes should be
advised to maintain near-normal glycemic
control for several months before con-
ception and continue that practice
throughout the pregnancy. Ideally, fasting
plasma glucose levels should be less than
105 mg/dL, and the postprandial values
no greater than 140 mg/dL and 120
mg/dL at 1 and 2 hours, respectively. Mul-
tiple glucose determinations and insulin
administration are necessary to achieve
these levels. A hemoglobin A1c level should
ideally be in a normal range. These values
may be difficult or impossible for some
preexisting diabetics and may result in
adverse hypoglycemia. Because the risk of
fetal malformations is not linear but
rises rapidly with very poor control, an
acceptable goal would be to achieve a
hemoglobin A1c level less than 1% to 2%
above the upper limit of normal.28
Women with poor glucose control have an
80% chance of having a child without a
malformation.31 Therefore, consultation
with a maternal-fetal medicine specialist or
an obstetrician experienced with compli-

some (20%) will discontinue smoking
once pregnancy is recognized, many,
unfortunately, will continue this practice.
Smoking has been associated with sponta-
naneous abortion, premature rupture of
membranes, preterm birth, low birth
weight, fetal growth restriction, placent-
al abortion, and sudden infant death
syndrome (SIDS).5,21-23 Complications
clearly appear related to the number of
cigarettes per day. Passive smoke has been
less conclusively linked to these poor preg-
nancy outcomes, though it has been relat-
ed to neonatal respiratory complications.

Smoking cessation programs that
include counseling and nicotine medica-
tions offer the best promise to quit.

Alcohol
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fetus is well known and has been described
tensively in the medical and lay literature.
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Medical conditions and
medications
This section first briefly reviews several
common medical conditions and the
impact that they may have on pregnancy.
The second part of this section reviews
certain common medications that may be
used by women of childbearing age and
the guidelines for preconception and preg-
nancy use. This discussion is not meant to
be all-inclusive.
cated pregnancies is encouraged before any contemplated termination of pregnancy. Use of oral hypoglycemics should be discontinued and substituted with use of insulin because of the potential teratogenic effects as well as the difficulty in achieving optimal pregnancy control with these agents.

- **Associated medical complications**—Retinopathy, nephropathy, and cardiovascular complications are commonly associated with duration of disease greater than 10 years (class C or greater per White Classification). Nevertheless, an evaluation of all preexisting diabetic patients is indicated before pregnancy. Assessment of renal function with a 24-hour study for creatinine clearance and total protein, retinal ophthalmologic examination, and thyroid function study are recommended. Additionally, studies may include an electrocardiogram and further cardiac evaluation for women with suspected or existing vascular disease.

- **Screening for diabetes**—Screening for diabetes as part of preconception tests has already been addressed. Patients with previous gestational diabetes should have regular assessment of glycemic control because of the increased risk of type 2 diabetes associated with this diagnosis. From a preconception standpoint, screening levels for glucose should be lower than those used to diagnose frank diabetes. Such levels should be in a normal range (that is, fasting level <105 mg/dL). If glucose levels are elevated, further evaluation is indicated.

- **Hypertension**—Hypertension affects approximately 20% of the population, with women affected equally as men. Hypertension complicates approximately 5% to 10% of all pregnancies. Chronic hypertension in pregnancy is defined as a blood pressure greater or equal to 140/90 mm Hg before 20 weeks’ gestation. Both diastolic and systolic blood pressures normally decrease an average of 7 mm Hg in diastolic and systolic blood pressures normally decrease an average of 7 mm Hg in the first trimester of pregnancy, usually before the first obstetric visit. This decrease may be more marked in women with chronic hypertension. Therefore, at time of the first obstetric visit, the blood pressure may be “normal.”

Women with pregnancy complicated by chronic essential hypertension are at an increased risk for superimposed preeclampsia, placental abruption, and poor perinatal outcome. The outcome is dependent on the severity of the hypertension. Severe hypertension is generally defined as blood pressure greater than 160/110 mm Hg. Treatment of hypertension in pregnancy is primarily aimed at preventing complications in the mother, as the use of antihypertensive medications do not reduce the incidence of most of the obstetric complications. Women with mild essential hypertension generally have a good pregnancy outcome. Use of most antihypertensives can be continued during pregnancy with the exception of angiotensin-converting enzyme (ACE) inhibitors. These drugs have been associated with fetal and neonatal complications, including renal failure, and should be avoided during pregnancy. Use of diuretics may be continued during pregnancy if necessary, but under most conditions, can be discontinued without the need of additional medication during the pregnancy. Use of diuretics generally should not be started after 20 weeks of pregnancy owing to the theoretical risk of interference with normal volume plasma expansion and its effect on uteroaplacental perfusion. Women with severe essential hypertension or hypertension complicating diabetes, renal disease, or connective tissue disease have an increased risk of adverse pregnancy outcome and should have a preconception consultation with a maternal-fetal medicine specialist or an obstetrician with experience in caring for complicated pregnancies. Input from other disciplines such as nephrology, cardiology, and rheumatology may be indicated.

- **Seizure disorders**—Seizure disorders occur in 1% of the population and are the most common neurologic disorder seen in pregnancy. Discussion here is limited to the effects of anticonvulsants on contraception, congenital malformations, and preconception advice.

- **Contraception**—Certain common anticonvulsants such as carbamazepine, and phenytoin affect hepatic metabolism and may make oral contraceptives less effective. Sexually active women should be advised of this potential complication. Other anticonvulsants such as valproic acid do not have this effect.

- **Congenital malformations**—An increased risk of congenital malformations exists in women who use anticonvulsant therapy during pregnancy. This risk appears to be approximately 6% to 8%, which is two to three times the background risk. All the commonly prescribed anticonvulsants have teratogenic potential, including phenytoin, carbamazepine, and valproic acid. Cleft lip and palate and cardiac abnormalities are the most common abnormalities. Additionally, carbamazepine and valproic acid have a risk of neural tube defects of 1% and 2%, respectively. Recent study suggests that fetuses with low levels of epoxide hydrase may be at the highest risk for these anomalies. Drugs metabolized through this pathway include phenytoin and carbamazepine.

Many anticonvulsants interfere with folic acid metabolism. A dose of 4 mg/d is recommended as a preconception and pregnancy supplement.

- **Preconception advice**—Most women with seizure disorders will have an uncomplicated pregnancy. The increased risk and type of fetal malformations have been reviewed and should be discussed fully. There appears to be an increased risk of growth restriction; therefore, these pregnancies require close prenatal surveillance. Polypharmacy and level of seizure control are two variables that may affect outcome. There does not appear to be a “safest” anticonvulsant; therefore, it is advisable to use the medication that best controls the seizures. Newer anticonvulsant medications such as felbamate, gabapentin, and lamotrigine are classified as category C by the US Food and Drug Administration (FDA). Sufficient information concerning use and safety in pregnancy is lacking, however, and it seems prudent to use other drugs if possible at this time. If a patient has been seizure free for several years, withdrawal of anticonvulsant drugs may be considered after consultation with a neurologist. Up to half of patients will have a recurrence of epilepsy and may need to resume use of medication.

It is difficult to predict which women may show an exacerbation of seizure activity. Close monitoring of drug levels is essential because of absorption and vascular volume changes in pregnancy. Patients should be encouraged to avoid fatigue and sleep deprivation, which are known to increase the frequency of seizures.

Children of women with seizures have an increased risk of epilepsy that may be four times greater than the background risk of 1%. In women planning pregnancy, supplementation of 4 mg/d of folic acid is recommended.

- **Medications**

- **Anticonvulsants**—As previously discussed, all anticonvulsants have terato-
genic potential. There currently does not appear to be any antiepileptic that is without risk in pregnancy. The reader is referred to the discussion on seizure disorders for further information.

**Antihypertensives**—Methyldopa is one of the drugs most commonly used for hypertension in pregnancy. It is rarely used as a first agent in the nonpregnant population. Methyldopa has been studied more extensively than other antihypertensive drugs in pregnancy and remains a favorite of many physicians because of its strong safety record. Clonidine is a similar type drug and can be substituted for methyldopa if desired. Recently, β-blockers such as labetolol and atenolol have been used more frequently during pregnancy. Despite the conflicting evidence on their possible association with growth restriction, β-blockers generally appear relatively safe for the pregnant patient. Calcium channel blockers have been used in pregnancy in preterm labor without any reported adverse effects to date. Limited experience is available regarding teratogenicity; however, these drugs appear relatively safe.

As already discussed, ACE inhibitors are contraindicated during pregnancy. Fortunately, discontinuation of their use in the first trimester obviates the fetal complications with these medications. There seems to be no increased risk of teratogenesis. Diuretics, also previously discussed, do not appear to pose any increased risks of malformations. Diuretics are rarely indicated in pregnancy, especially as monotherapy. Generally, their use can be discontinued without adverse effect to the mother.

**Oral hypoglycemic agents**—No good evidence that most of the currently available oral diabetic agents are teratogenic exists. Many patients are taking these medications at time of conception, and it appears that when controlled for glucose levels, an increased teratogenic risk does not exist. Nevertheless, these compounds, unlike insulin, can traverse the placenta and affect fetal metabolism. For this reason, as well as the difficulty in achieving satisfactory glucose control during pregnancy, use of these drugs should be discontinued and insulin therapy initiated.

**Coumarin derivatives**—Coumarin is a definite teratogen, especially for exposure during the 6th to 9th weeks of pregnancy. The risk may be as high as 25% for development of the fetal warfarin syndrome if used during the first trimester. This syndrome primarily involves abnormal development of the nasal septum and epiphyseal damage. Use later in pregnancy may be associated with myriad complications, including central nervous system abnormalities, placental abruption, stillbirth, and fetal and neonatal hemorrhage. Patients should be educated to this risk and switched to heparin before conception if continued anticoagulation is needed.

**Isotretinoin**—Isotretinoin (Accutane) is a vitamin A isomer used for the treatment of severe acne. It is a potent teratogen and is classified as category X by the FDA. This is the most common prescription medication used by women of reproductive age, with such great potential for fetal damage. It is estimated that more than a third of users of isotretinoin are women between 15 and 19 years old. Abnormalities from this drug include craniofacial, cardiovascular, and central nervous system defects.

The manufacturer advises two forms of contraception (or abstinence) be used for 1 month before, during, and 1 month after use of isotretinoin. Fortunately, the half-life of isotretinoin is approximately 10 to 12 hours and the terminal elimination half-life is 96 hours. Therefore, shorter intervals between the last dose and conception are probably safe. Nevertheless, it seems prudent to advise patients to discontinue use of this medication at least 1 month before attempts at conception.

**Common antibiotics**—Most antibiotics are considered safe during pregnancy, with the exception of tetracycline and quinolones. Periconceptional and first trimester exposure to nearly all antibiotics are considered relatively safe for the developing fetus. Tetracycline binds to developing teeth and affects deciduous teeth from the 26th week of pregnancy until 6 months of infancy. This results in discoloration of the teeth. There appears to be no documented risk if tetracycline is taken in the first trimester.

Quinolones do not appear to be teratogenic when used in the first trimester. Nevertheless, because of the potential for causing damage to the developing cartilage and producing a fetal arthropathy, quinolones are contraindicated in pregnancy. Metronidazole is prescribed for trichomoniasis and bacterial vaginosis. Data collected on first-trimester exposure do not support a teratogenic effect. Certain animal studies have suggested a carcinogetic effect; therefore, it seems prudent to withhold this medication in the first trimester.

**Occupational exposures**

The study of reproductive hazards in the workplace is an area of increasing research owing to the large number of pregnant women in the workforce and the employment of women in previously male-dominated or exclusive jobs. It has been estimated that approximately two thirds of all women are employed during their first pregnancy.

Following is a brief overview of the problem of studying occupational exposures, the questions included in a preconception history, and a few examples of common encounters.

**Problems with assessment of risk**

Environmental and occupational legislation has set limits of exposure to essentially every chemical agent to protect the worker. Unfortunately, in most instances, such levels of exposure were not designed to protect the fetus. Safe levels for most occupational and environmental exposures have not been determined for pregnant women. Unlike pharmaceuticals, the use of chemicals does not require testing for reproductive hazards. Basic principles of teratogenesis take into account the particular agent, timing of exposure, dose, route, and species variation. Many occupational exposures involve combinations of chemicals rather than a single agent.

Data controlling for dose and time of exposure in the workplace are generally lacking. All these factors have made it difficult to assign a risk with precision. Fortunately, most exposures in the workplace below standard levels for the nonpregnant woman have not been associated with a measurable increased risk of congenital malformations or poor pregnancy outcome. The foregoing caveats, however, should be noted.

**Suggested questions and assessment**

The occupational history should be more than a perfunctory question as to whether or not the patient is employed outside the home. The patient’s current job title, employer, and description of duties should be noted. Length of employment and previous work history should be obtained. Potential chemical exposures as well as interaction with biological or physical agents should be determined. Questions concerning the presence of physical or psychological stress should be pursued. Finally, as some hobbies are associated with occupational exposure, these should also be noted.
with a risk of toxicity, this information must be obtained.

If a positive response is offered, further occupational information and evaluation is necessary. Material safety data sheets (MSDSs) are required by law for many of the chemical agents encountered in the workplace. These MSDSs must be made available to any employee on request. The employer should be contacted for further information concerning methods of workplace monitoring and safety measures. Additionally, it should be determined whether periodic examinations by an occupational health provider and biological monitoring are done. It would be wise to inquire about the pregnancy outcomes of other workers, if available. Once this initial information is obtained, specifics concerning the particular exposure may be available through computer databases such as the Toxicology Information Program at the National Library of Medicine or REPROTOX. Formal consultation with a genetic counselor, maternal-fetal medicine specialist, and occupational health physician may be prudent if any concerns remain after the initial investigation and analysis.

Three common occupational exposures

- Video display terminals—Video display terminals (VDTs) are potential sources of radiation. The accumulated data to date suggest that no significant association exists between the use of VDTs and adverse pregnancy outcome, including miscarriage and congenital abnormalities. It is not believed that women need to limit usual occupational exposure before or during pregnancy.

- Organic solvents—Organic solvents are commonly encountered not only in industry but also in many household products. Evaluation of risk is difficult due to the mixture of these agents and possible by-products. Toxicity of many solvents has been documented, but the effect on the fetus is unclear, especially at nontoxic maternal levels. It has been determined that many of these agents are teratogenic in laboratory animals. Nevertheless, the threshold for inducing these abnormalities has not been established for most solvents.

- Lead—Lead represents a common occupational exposure consultation in pregnancy. Exposure continues to occur in certain occupations, including glass staining, paint manufacturing for automobiles and aircraft, printing, smelting, and battery industries. Lead has been known to be associated with decreased fertility, miscarriage, and fetal death. The most worrisome consequence of elevated lead levels has been the effect on neurologic development and function. Acceptable lead levels have been reduced to 10 μg/dL for children and 40 μg/dL for adults. The exact maternal level that may cause fetal damage is not known. Lead does cross the placenta readily, and there is concern that mobilization of lead from maternal bone may occur during pregnancy. From a preconception standpoint, current recommendations are to investigate for possible sources of contamination if levels are greater than 10 μg/dL, and consider chelation therapy if levels are greater than 25 μg/dL. Because of issues of toxicity from treatment, no specific recommendations for therapy can be made for patients who are already pregnant. Each case must be individualized after appropriate consultation. Further research is needed to determine more precisely the effects of chronic low-level exposures and the need, benefit, and safety of treatment during pregnancy.

Modify

Risk factors for adverse pregnancy outcome are frequently classified into modifiable and nonmodifiable categories. Effects of diet, exercise, employment, stress, and caffeine intake on pregnancy are commonly posed questions by pregnant and soon-to-be pregnant women.

Diet

It is estimated that approximately 35% of women between the ages of 20 and 74 years are classified as obese. At least one in five women between the ages of 20 and 29 years is obese, and this prevalence may be higher in certain ethnic and socioeconomic classes. In addition, the incidence of dieting is reported as high as 40% in women, including those who are at a normal weight. Eating disorders such as bulimia and anorexia nervosa are not uncommon in our society. It is clear from these data that nutrition in the United States is far from ideal. Underweight or overweight women have an increased risk of complications in pregnancy. A detailed discussion of nutrition is beyond the scope of this article. Nevertheless, it seems prudent to emphasize attainment of normal body weight and ingestion of a well-balanced diet to all women, especially those who are planning a pregnancy.

Exercise

Until recently, in modern times, exercise during pregnancy was either prescribed or discouraged because of perceived risks that were anecdotal and unsupported by scientific inquiry. Increased interest and research during the past decade have provided new insight into this issue. Studies have demonstrated benefits to both the mother and fetus, with little or no data to support any increased risk of complications. The exact benefits of exercise during pregnancy are hampered by methodologic flaws and study bias. It is not clear, for example, that exercise definitely affects the outcome or duration of labor. Nevertheless, exercise does appear to improve cardiac function, limit excessive weight gain, and contribute to better self-image and mental state. The effects of exercise in pregnancy appear to parallel those in nonpregnant women. In the past, it was thought that exercise during pregnancy might be detrimental to the developing fetus. Recent study suggests the opposite. It has been suggested that offspring are leaner and have improved tolerance to stress with advanced neurobehavioral maturation. Additionally, one study has suggested that there is a reduced risk of spontaneous miscarriage in women who exercise.

Unless contraindicated by specific maternal or fetal complications, it seems that beginning or continuing an exercise program during pregnancy is of benefit to both the mother and fetus. Such activity should be encouraged, especially in a society where automation and technology have limited routine daily physical expenditures of energy such as walking to the store, school, or work. Guidelines have been developed that are appropriate for most women. Discontinuing certain exercise that may pose an increased risk of maternal injury, such as downhill skiing, seems prudent. Additionally, scuba diving to levels deeper than 30 feet or exercise at altitudes higher than 8000 feet should be avoided because of lack of data or evidence suggesting potential adverse outcome.

Caffeine intake

It is estimated that more than 75% of pregnant women consume caffeine during
pregnancy (primarily in the form of coffee or soft drinks), despite information that questions the safety of this practice.56 A recent meta-analysis concluded that there was a small but significant increased risk of spontaneous abortion and low birth weight in women who consumed more than 150 mg of caffeine per day.55 Inasmuch as a 6-ounce cup of coffee contains approximately 120 mg of caffeine and a cola drink, 45 mg of caffeine, it is clear that this level is of no small concern.52 A recent study that examined paroxetine intake (a metabolite of caffeine) found no association with miscarriage at levels consistent with moderate caffeine intake.60 Nevertheless, an editorial accompanying that article61 discusses potential biases in that study and recommends that caffeine intake should be limited in pregnancy. It seems prudent to recommend a limit of 150 mg per day until further evidence suggests otherwise.

Stress

Study of the impact of psychological stress on reproductive outcome has produced results that suggest an association with certain types of poor outcome. Incorporation of social support into prenatal care unfortunately has not shown a great impact in reducing adverse outcome in certain populations.62 Recent study, however, has suggested a biologic explanation to explain the role of stress in poor outcome. It has been demonstrated that elevated levels of maternal corticotropin-releasing hormone are associated with stress and preterm delivery as well as reproductive failure.63,64 Based on this information, further study is needed to determine what interventions, if any, may be beneficial. Clearly, estimation of and tolerance to stress are highly individualized and difficult to quantify. It seems reasonable, however, to explore this issue with prospective mothers and their partners to acknowledge the possibility of an association. Promotion of adequate physical and mental rest, identification of stress-promoting factors, and attempts to ameliorate the same constitute a wise recommendation for the pregnant woman.

Employment

The impact of employment on pregnancy outcome has been debated worldwide for decades. In the United States, it is estimated that of women employed, more than three quarters continue to work into the third trimester. Studies have been conflicting in demonstrating an association between employment and adverse pregnancy outcome.65,66 It appears that it is the type of work and not work per se that may be detrimental to an otherwise healthy pregnancy. In a recent meta-analysis, it was concluded that physically demanding work, prolonged standing, shift work, and fatigue were associated with preterm birth, small-for-gestation-age infants, and preeclampsia.67 Many of these jobs are filled by the socially and economically deprived who can least afford to discontinue employment. Nevertheless, another recent study found an association between similar occupational stressors and an increased risk of preterm birth among nurses.68 Clearly, most women who work do so without any adverse pregnancy outcome. It seems advisable, however, to take more than a cursory occupational history with special attention to the foregoing factors. Education of not only patients but employers as well should be part of the responsibility of any physician or provider caring for pregnant women.

Comment

This article identifies for the primary care provider certain common questions and issues that might be operational for a soon-to-be pregnant woman. Few of the recommendations have been tested prospectively and are based on a reasonable approach to known physiology and potential risks. It is hoped that the guidelines presented will assist those providers in that endeavor.

References
