Assessment and Evaluation of the Woman With Cardiac Disease During Pregnancy

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Maternal heart disease complicates 0.2 to 3% of pregnancies and is responsible for 10% to 25% of maternal deaths. Many healthy women manifest subtle signs of cardiac failure during uncomplicated pregnancy and birth. Classic symptoms of heart disease mimic common symptoms of late pregnancy, such as palpitations, shortness of breath with exertion, and occasional chest pain. A complete cardiovascular examination assists the healthcare team to fully assess and evaluate the pregnant woman with known heart disease. Detailed assessment of the woman throughout pregnancy may lead to initial discovery of heart disease. Compilation of these objective data with subjective functional capacities allows for risk stratification and assignment to a New York Heart Association functional classification. Key words: cardiovascular, disease management, heart disease, nursing assessment, pregnancy, pregnancy complications

THE WOMAN WITH CARDIAC DISEASE IN PREGNANCY

Uncomplicated pregnancy is characterized by enhanced myocardial performance, yet many women exhibit signs similar to those of cardiac failure during uncomplicated late pregnancy and birth. Women may present with dyspnea, fatigue, a reduction in exercise capacity, peripheral edema, distension of the central veins, audible flow murmurs, and a third heart sound indicative of volume overload.

Normal adaptations to pregnancy

During pregnancy, the uterus increases in weight from 70 to 1100 g to accommodate an enlarging vascular bed. The cardiac muscle also shows a mild hypertrophy related to an increase in cardiac valve diameters and increased blood flow to the heart. Uterine blood flow also increases by at least 1 L of blood flow each minute, requiring the body to produce more blood during pregnancy. This process results in a 25% increase in red blood cells, a 50% expansion of plasma volume during pregnancy, and an overall hemodilution. However, the increase in total red blood cellular volume includes an increase in clotting factors and platelets, defining the hypercoagulable state of pregnancy. The changes in maternal hemodynamics are accompanied by a
nitric oxide–mediated decrease in systemic and peripheral vascular resistance, which maintains smooth blood flow and accommodates the expanding vascular system and blood volume. \(^7,8\)

These changes start as early as 6 weeks of gestation. \(^9\) By approximately 6 to 8 weeks after conception, cardiac output already shows an increase from prepregnant values. This increase, along with the accompanying decrease in systemic vascular resistance and an unchanging metabolic rate, results in a “hyperdynamic” maternal circulation. \(^5\) Cardiac output increases from 30% to 50% throughout pregnancy with stroke volume increasing 20% to 30% from prepregnancy baseline, and maternal heart rate increasing by 10 to 20 beats per minute.

Additional changes occurring in labor and after birth include an increase of 20% to 30% in cardiac output during second stage labor and up to 75% above prebirth values immediately after birth. Circulating hormones and significant changes occurring in the hemodynamic state during pregnancy can also precipitate direct effects on the electrophysiology of the heart, making arrhythmias more likely to occur. \(^10\) While these physiologic changes are important for successful adaptation to pregnancy, labor, and birth, they create distinct physiologic challenges for the woman with cardiac dysfunction.

Effects of adaptations on preexisting cardiac conditions

A woman with cardiac dysfunction may have difficulty accommodating to the physiologic changes of pregnancy. Blood volume increases may result in congestive heart failure, and vascular bed changes can cause aneurysm formation or dissection. \(^8\)

Symptoms and signs of cardiac failure may occur during pregnancy or at the onset of labor in the woman with stenotic heart valves. \(^3\) The hypercoagulable state of pregnancy also predisposes women to increased risk of arterial thrombosis and postpartum hemorrhage. \(^11\) Women who have had valve replacement surgery or any valvular damage prior to pregnancy also run a higher risk for congestive heart failure and require close monitoring during pregnancy.

Vascular resistance can also be a problem for pregnant women with cardiac dysfunction. An adequate vascular resistance allows blood to flow safely and effectively. In women with valvular lesions (eg, pulmonic valve disease) and shunt lesions (eg, atrial septal defect, ventral septal defect, or patent ductus arteriosus), blood flow may be impeded. These women depend on a tight control of systemic vascular resistance. Hypertension increases the risk of left-to-right shunting in women with shunt lesions. Hypotension can increase right-to-left shunting, bypassing pulmonary circulation and leading to hypoxemia and hypoxia. Immediately after birth, the cardiac filling pressure increases dramatically because of the decompression of the vena cava and the return of uterine blood into the systemic circulation. \(^7\) The sudden loss of the low resistance placental bed may cause such compromise in women who are dependent on consistent volume to the right side of the heart (eg, Tetralogy of Fallot).

The work of the right ventricle and intraventricular pressure are increased by pulmonary artery stenosis. Severe pulmonary stenosis causes reduced forward blood flow through the heart, thereby decreasing left ventricular output. It is important to maintain preload to optimize myocardial contractility; however, excessive preload can precipitate right heart failure and atrial arrhythmias. \(^6,12\) During pregnancy, preload may be reduced by aortacaval compression and at birth by the vasodilation associated with neuraxial sympathetic block. \(^6\) Regurgitation of blood flow through an incompetent aortic valve decreases cardiac output and coronary artery blood flow. Reducing the afterload improves forward flow, and maintaining a high normal heart rate reduces the time for regurgitant flow. The reduction in afterload and the increase in heart rate associated with pregnancy may improve symptoms in woman with aortic regurgitation.

Adverse maternal cardiac events (pulmonary edema, sustained bradyarrhythmias, or tachyarrhythmias requiring therapy, stroke, cardiac arrest, or death) occurred in 13% of completed pregnancies in a major Canadian study. These events were significantly more likely among women with reduced left ventricular systolic function (an ejection fraction below 40%), left heart obstruction (significant aortic or mitral stenosis), previous cardiovascular events, or abnormal functional capacity of the heart. \(^15\) Outcome of cardiac disease in pregnancy is dependent on the ejection fraction and left ventricular end-diastolic volume at diagnosis, response to medical therapy, and normalization of left ventricular function within 6 months of pregnancy.

**PHYSICAL ASSESSMENT**

Ideally, the management of women with known heart disease should begin before conception. A complete cardiovascular examination combined with the woman’s history, including assessment of lifestyle risk factors, assists the healthcare team to fully assess and interpret the findings. This evaluation should include
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a careful history and physical examination, a 12-lead electrocardiogram, an echocardiogram, and a Doppler study. Techniques used for physical examination are inspection, palpation, percussion, and auscultation. Inspection involves direct purposeful observation of neck veins, nail beds for clubbing, and digits for capillary refill. Inspection also includes direct examination of vital signs (pulse, blood pressure). Palpation is the use of hands to feel skin texture and temperature. Presence of peripheral pulses and edema can also be detected by palpation. An irregular peripheral pulse can be noted during palpation and then compared to an apical pulse during auscultation. Auscultation involves the use of the stethoscope to hear sounds originating in the heart. Cardiac auscultation reviews the presence of S1 and S2 at the point of maximal impulse: extra heart sounds, murmurs, and rubs.

CLINICAL TESTING

Echocardiography can be done to assess ventricular function, valve structure, chamber size, heart wall motion, and aberrant blood flow and may provide an alternative to invasive monitoring of maternal hemodynamics. Echocardiography is the best diagnostic tool for evaluating suspected cardiac disease in a previously undiagnosed pregnant woman. Clinicians should have a low threshold for performance of echocardiography in all symptomatic pregnant and postpartum women in whom the diagnosis of cardiac disease is being considered. In healthy women, serial echocardiograms show minor increases in the left and right ventricular diastolic dimensions, which remain in the normal range, with a slight decrease in the left ventricular end-systolic dimension and a minimal increase in the size of the left atrium. Echocardiography confirms ventricular failure with increased left ventricular end-diastolic dimensions and decreased ejection fraction.

Murmurs

The occurrence of murmurs and arrhythmias for the first time in pregnancy in women with normal hearts has no clinical significance in such cases. However, these findings may also occur as a result of previously undiagnosed heart disease. Auscultation of heart sounds with a stethoscope is one of the important initial steps in cardiac diagnosis. Aortic phenomena include sounds, or short vibrations, and murmurs, which are caused by the turbulent sound of blood flowing through the cardiac valves. Murmurs have been described as blowing, rumbling, soft, and harsh.

Heart murmurs in pregnant women are often considered “innocent” because the normal course of pregnancy requires both an increase in cardiac output and in blood volume to accommodate the growing fetus and the uterus. The extra blood volume pumping through the heart during pregnancy may produce a slight systolic murmur. Eighty percent of pregnant women have a third heart sound, or systolic flow murmur and more than 90% of healthy pregnant...
women have a soft ejection systolic murmur auscultated on the left sternal edge. The intensity of these murmurs may increase during pregnancy as cardiac output increases. The nurse auscultating a pregnant woman’s heart sounds must be alert to normal and abnormal sounds (Table 1).

There are 2 sounds heard during cardiac auscultation of a healthy heart. The first sound (S1 or “lub,” in lub-dub) is caused when the ventricles contract, the mitral and tricuspid valves close, and blood is propelled into the aorta and the pulmonary artery. Ventricular systole begins with this sound. Once the ventricles complete the ejection of blood, start to relax, and the aortic and pulmonic valves close, the second heart sound (S2 or “dub,” in lub-dub) is heard and indicates the beginning of ventricular diastole. This “dub” sound is typically heard as a sharp snap because the aortic and pulmonic valves tend to close much more rapidly than the mitral and tricuspid valves. Since systole is shorter than diastole, a heart beating at a normal rate exhibits a brief pause after the second heart sound. Therefore, the pattern is one of “lub-dub” pause, “lub-dub” pause, and so on. If these valve closures are altered in any way, such as in women with narrowed or leaky heart valves, the sounds made by the heart will be different. A murmur between the first and second sounds or during the systolic part of a heartbeat could be related to either a narrowing of one of the aortic or pulmonary valves or to a leak through the mitral or tricuspid valves. Close attention should be paid to any pregnant woman with an unexplained fever and cardiac murmur. Rapid detection of endocarditis and appropriate treatment is important in reducing the risk of both maternal and fetal mortality. See Table 1 for descriptions of common murmurs.

**Arrhythmias**

As mentioned earlier, pregnancy can precipitate arrhythmias not previously present in seemingly well individuals. Arrhythmias are often noticed for the first time during a manual pulse check. The PR, QRS, and QT intervals are slightly decreased in pregnancy, most likely related to a slight increase in the woman’s resting heart rate or to a gradual left rotation of the heart (15°) due to the increasing size of the gravid uterus. Visually, there is no change in the amplitude of the P wave, QRS complex, and T wave. Fortunately, malignant arrhythmias during the course of normal gestation are rare, and the common complaint of palpitations is usually due to benign arrhythmias. Other nonspecific findings include low voltage, left ventricular hypertrophy, and nonspecific ST-segment and T-wave abnormalities.

Arrhythmias are often generated by the increased blood volume during pregnancy and may be the first manifestation of a woman’s congenital heart disease. Arrhythmias in women with limited cardiac reserves may have significant hemodynamic consequences and can compromise fetal well-being. Any woman with an arrhythmia should have a diagnostic evaluation to rule out an underlying disease, including cardiac, pulmonary, endocrine, or metabolic disease. In addition, removal of precipitating factors, such as excessive ingestion of caffeine and/or alcohol, cigarette smoking,
Table 2. New York Heart Association functional classification

<table>
<thead>
<tr>
<th>Class capacity</th>
<th>Objective assessment</th>
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<tbody>
<tr>
<td>Class I. Patients with cardiac disease but without resulting limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea, or anginal pain.</td>
<td>A. No objective evidence of cardiovascular disease</td>
</tr>
<tr>
<td>Class II. Patients with cardiac disease resulting in slight limitation of physical activity. They are comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea, or anginal pain.</td>
<td>B. Objective evidence of minimal cardiovascular disease</td>
</tr>
<tr>
<td>Class III. Patients with cardiac disease resulting in marked limitation of physical activity. They are comfortable at rest. Less than ordinary activity causes fatigue, palpitation, dyspnea, or anginal pain.</td>
<td>C. Objective evidence of moderately severe cardiovascular disease</td>
</tr>
<tr>
<td>Class IV. Patients with cardiac disease resulting in inability to carry on any physical activity without discomfort. Symptoms of heart failure or the anginal syndrome may be present even at rest. If any physical activity is undertaken, discomfort is increased.</td>
<td>D. Objective evidence of severe cardiovascular disease</td>
</tr>
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Drug abuse or antiarrhythmic drug therapy, is indicated as these measures are desirable in any pregnant woman. Antiarrhythmic drug therapy is indicated in women with persistent, symptomatic, or hemodynamically significant arrhythmias.

In cases where congenital heart disease or any other cause for arrhythmia is identified, the underlying disease should be treated first. In theory, antiarrhythmic drug therapy in pregnant women follows the same approach as in nonpregnant women. However, special consideration should be given to selection of medication in order to avoid adverse effects on the fetus. The smallest effective dose should be used, and the indication for antiarrhythmic therapy should be periodically reassessed during the course of pregnancy.

The goal of antiarrhythmic therapy is to protect the woman and the fetus through birth, after which definitive therapy can be administered.

**RISK CATEGORIES**

The reported incidence of maternal cardiac and obstetric complications in women with heart disease is 13% to 32%. Maternal morbidity in women with heart disease is related to the physiologic circulatory changes that occur during pregnancy. Most women with congenital cardiac disease and a good functional class before pregnancy tolerate pregnancy without major problems. The specific risks associated with cardiac disease in pregnancy require an individualized interdisciplinary management plan.

Cardiac disease in pregnancy increases the risk of adverse maternal, fetal, and neonatal outcomes. The absolute risk conferred on a given woman by pregnancy also depends on additional clinical factors. The classifications summarized below describe the status of individual women. Functional capacity is an estimate of what the woman’s heart will allow her to do and should not be influenced by the character of the structural lesions or an individual opinion as to treatment or prognosis (Table 2). The classification of women according to cardiac functional capacity is only part of the information needed to plan the management of cardiac disease in pregnancy. Recommendations are based not only on the amount of effort possible without discomfort but also on the nature and severity of the disease.

A woman’s functional capacity, exercise tolerance, New York Heart Association (NYHA) classification, degree of cyanosis, medication needs, and history of arrhythmias should all be taken into account when assessing risk levels in the parturient with cardiac disease. Assessment of risk is based on care given by a coordinated team with the experience and resources necessary to care for pregnant women with cardiac disease. The ideal team would include a perinatologist, a neonatologist, a cardiologist, an anesthesiologist, a clinical nurse specialist, and staff nurses from labor and delivery as well as the intensive care unit. A case manager and/or spiritual support person can be of assistance with discharge planning as well. Part of the team’s responsibility is the initial interview and assessment of functional capacity.

Functional capacity is assessed by determining the number of flights of stairs a woman can walk up with ease, ability to walk a level block, ability to sleep flat in bed, number of pillows needed to sleep at night, perception of heart racing, experience of chest pain during exertion, and presence of chest pain during periods...
Table 3. Risk factors for cardiac complications in pregnancy.\(^\star\),\(^\dagger\)

<table>
<thead>
<tr>
<th>Low/minimal risk factors</th>
<th>Intermediate/moderate risk factors</th>
<th>High/major risk factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Small left to right shunts (ASD, VSD, PDA)</td>
<td>• Unrepaired or palliated cyanotic congenital heart disease, uncorrected tetralogy of Fallot</td>
<td>• Marfan syndrome with aortic root involvement</td>
</tr>
<tr>
<td>• Mild to moderate pulmonic or tricuspid disease</td>
<td>• Large left to right shunt</td>
<td>• Complicated coarctation of the aorta</td>
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<tr>
<td>• Repaired lesions without residual cardiac dysfunction (e.g., corrected tetralogy of Fallot)</td>
<td>• Valvular regurgitation with normal ventricular systolic function</td>
<td>• Pulmonary hypertension</td>
</tr>
<tr>
<td>• Bioprosthetic valve</td>
<td>• Uncomplicated coarctation of the aorta</td>
<td>• Severe aortic or mitral stenosis</td>
</tr>
<tr>
<td>• Mitral stenosis NYHA class I and II</td>
<td>• Aortic stenosis or mitral stenosis NYHA class III and IV</td>
<td>• Ejection fraction less than 35%</td>
</tr>
<tr>
<td>• Marfan syndrome with normal aortic root</td>
<td>• Mechanical or artificial valves, mitral stenosis with atrial fibrillation</td>
<td>• NYHA class III or IV symptoms</td>
</tr>
<tr>
<td>• Bicuspid aortic valve without stenosis</td>
<td>• Severe pulmonic stenosis</td>
<td>• History of peripartum cardiomyopathy with residual ventricular dysfunction</td>
</tr>
<tr>
<td>• Isolated mitral valve prolapse without significant regurgitation</td>
<td>• Moderate to severe systemic ventricular dysfunction, previous myocardial infarction</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• History of peripartum cardiomyopathy with no residual ventricular dysfunction</td>
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\(^\star\) Data from Head and Thorne,\(^8\) Bhatla et al,\(^28\) and Siu et al.\(^12;\)\(^13\)

\(^\dagger\) ASD indicates atrial septal defect; VSD, ventral septal defect; PDA, patent ductus arteriosus; and NYHA, New York Heart Association.

of time when her heart races. Answers to these questions assist the clinician in assigning a NYHA classification as well as formulating an interdisciplinary plan of care for the remainder of the pregnancy. Prepregnant functional capacity of NYHA classes I and II generally predicts a woman’s ability to tolerate the pregnancy and have a good outcome.\(^9\)

In 1997, a published study of 252 completed pregnancies in women with cardiac disease identified 5 risk factors as being predictive of poor maternal and/or neonatal outcome.\(^12\) A subsequent study with 562 pregnant women with congenital or acquired cardiac disease in 2001 identified 4 factors as being predictive of poor maternal and fetal outcome: prior cardiac event, poor NYHA functional class or cyanosis, left heart obstruction, and systemic ventricular dysfunction.\(^13\)

The degrees of risk for cardiac complications in pregnancy are outlined in Table 3. The woman with minimal cardiac symptoms, good ventricular function, normal oxygen saturation, and no left heart obstruction should tolerate pregnancy well.\(^8\) Marfan syndrome is a connective tissue disorder that alters vascular structure. The compounding vascular changes in a pregnant woman with Marfan syndrome increase her chance of aortic dissection.\(^29\)

An NYHA functional class of III or IV prior to pregnancy is considered moderate risk, and carries more than 7% risk of mortality and a 30% risk of morbidity. Women in NYHA functional class III/IV are generally counseled against childbearing, yet their unexpected arrival in active labor can happen at any time. Women in this group tend to have babies of lower birth weight and have more maternal complications than do women with NYHA class I/II.\(^28\)

The outcomes for women who run the highest risk of cardiac complications in pregnancy include the potential for maternal, fetal, and/or neonatal death. Many women in this class are advised against conception or continuing their pregnancies if conception occurs. Women with Eisenmenger syndrome have a 50% maternal mortality risk, with most deaths occurring in the postpartum period. Vaginal birth is preferred over cesarean birth because of decreased myocardial oxygen demands and cardiac work. Other benefits of vaginal birth include minimal blood loss, greater hemodynamic stability, and less chance of postoperative infection and pulmonary complications. Obstetric indications such as fetal intolerance of labor or failure to progress dictate choice for cesarean birth. Pregnancy has been demonstrated to be statistically shorter in duration in women in NYHA class III/IV than in women in NYHA class I/II, most likely due to early discontinuation for maternal indications.\(^30\)

**NURSING IMPLICATIONS**

The role of staff and advanced practice nurses in the care of these women prior to and during labor and birth contributes to successful outcomes. Staff nurses
can focus their attention on physical assessment of the woman and her fetus, communicate findings to team members, and implement the plan of care to best economize the woman’s strength and energy, as well as provide education and psychosocial support (assessment of social support, family/childcare needs). Advanced practice nursing implications include coordination of care between involved disciplines, ensuring an inter-disciplinary plan in place in advance for management of labor and birth, including location, equipment and personnel needed to optimize care, and explicit planning regarding indications for cesarean birth. This collaborative nursing practice should prepare the woman and other ancillary care providers (neonatology, critical care) with specific planning and education to manage complications during any invasive testing when women are more than 24 weeks’ gestation.

**SUMMARY**

The normal cardiac changes of pregnancy may reveal or complicate longstanding cardiac problems, or mask subtle ones. Improved neonatal care now allows women with significant heart disease to become pregnant, although there is an increased incidence of congenital heart disease among infants of women (and men) with cardiac disease. Although the morbidity and mortality risks of pregnancy in women with cardiac disease have decreased over time, they still include congestive heart failure, cardiac arrhythmia, thromboembolism, angina, hypoxemia, and infective endocarditis. Researchers have shown improved perinatal care and maternal/neonatal prognosis through intensive scrutiny and evaluation of the woman with cardiac disease.

**REFERENCES**


