Heart disease in pregnancy

In women with cardiac disease physiological changes in the cardiovascular system associated with pregnancy may precipitate decompensation. Heart disease is the commonest cause of maternal death. Close multidisciplinary working is important to ensure the best care possible for pregnant women with heart disease.

During pregnancy, cardiac output increases by approximately 30%, with further increases during labour and in the immediate post-partum period. While women with normal cardiac function tolerate these haemodynamic changes well, women with cardiac disease may decompensate during pregnancy. Those with stenotic lesions, poor ventricular function, ischaemia or an aortopathy are at particular risk.

Cardiac disease remains the commonest cause of indirect maternal death and also the commonest cause of maternal death overall. The 2006–8 triennial Confidential Enquiry into maternal deaths (Saving Mothers' Lives) (Lewis, 2011) reported a total of 53 deaths from heart disease related to pregnancy. This was an increase from the previous triennia when 48 deaths were reported (Lewis, 2007). Some degree of substandard care was considered to be present in 51% of cases (Lewis, 2011).

Cardiac disease can be divided into congenital heart disease and acquired heart disease, with maternal deaths from acquired heart disease greatly exceeding those from congenital heart disease. However, since more women with congenital heart disease are now surviving to their child-bearing years (Moons et al, 2010), the number of women with congenital heart disease seen in antenatal clinics is increasing with a prevalence estimated to be around 0.8% in the antenatal population (Department of Health – Vascular Programme Team, 2006).

This article will discuss some specific cardiac conditions and the particular considerations needed in pregnancy. It will also address wider issues relating to provision of services for women with heart disease in pregnancy.

Acquired heart disease

In contrast to women with congenital heart disease, many women with acquired heart disease present for the first time in pregnancy or the postnatal period. Women with acquired heart disease are therefore more likely to present acutely to the emergency department, to the cardiologists or to the physicians. The main conditions encountered are:

- Myocardial infarction and myocardial ischaemia
- Aortic dissection
- Peripartum cardiomyopathy
- Sudden adult death syndrome
- Valvular disease (rheumatic or endocarditis).

Acute myocardial infarction and ischaemic heart disease

The estimated incidence of non-fatal myocardial infarction has been estimated at 0.7 per 100 000 maternities (Knight et al, 2010), and 0.48 per 100 000 for maternal deaths from acute myocardial infarction or chronic ischaemic heart disease (Lewis, 2011). The majority of women who suffer acute myocardial infarction or ischaemic heart disease have identifiable risk factors relating to lifestyle such as increased maternal age, obesity or smoking. Failure to consider the diagnosis in women presenting with chest pain during pregnancy is a common failing.

Unlike some other cardiac enzymes (e.g. creatinine kinase-MB), troponin I remains within the normal range during labour and delivery. It can therefore be used in the diagnosis (or exclusion) of myocardial infarction during pregnancy and in the peripartum period (Shivvers et al, 1999). There should be a high index of suspicion for myocardial ischaemia or infarction, particularly if the woman is requiring opiate analgesia, and a low threshold for further investigation including coronary angiography (Lewis, 2011) and percutaneous coronary intervention if appropriate. Although coronary artery dissection is rare in the non-pregnant population, it is a recognized complication of pregnancy and the puerperium. It can lead to coronary artery occlusion and myocardial infarction. The post-partum period is a time of particular risk.

Aortic dissection

Of the disorders affecting the aorta during pregnancy Marfan's syndrome and Ehlers–Danlos type IV are the most important. Women with bicuspid aortic valves are also at increased risk of aortic dissection.

Patients with Marfan's syndrome should have regular echocardiograms during pregnancy to detect any increase in the aortic root diameter. The risk of aortic dissection is 1% if the aortic root diameter is less than 4 cm and 10% if the aortic root diameter is more than 4 cm (Rossiter et al, 1995; Lipscomb et al, 1997).

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The time of greatest risk is during labour and immediately post-partum when cardiac output is maximal. Hypertension increases the risk of dissection and the systolic blood pressure should be carefully monitored and controlled. Those with Ehlers–Danlos type IV are at risk of aortic dissection even if the aortic root is of normal size. Consider the diagnosis of aortic dissection in women with:

- Central chest pain, jaw pain or intrascapular pain – not all chest pain is caused by pulmonary embolism
- Family history (Marfan's syndrome and Ehlers–Danlos type IV are autosomal dominant)
- Women with a known bicuspid aortic valve.

Cardiomyopathy

There are three different principal types of cardiomyopathy seen in obstetric practice – peripartum, dilated and hypertrophic.

Peripartum cardiomyopathy typically presents either as a woman approaches term or in the first few weeks after delivery, although it can occur up to 5 months post-partum (Pearson et al, 2000). While it is more common in older women, obese women, black or hypertensive women, it can present in women with no risk factors who have previously been well. Unexplained breathlessness, tachycardia, gross oedema or supraventricular tachycardia should prompt a chest X-ray, electrocardiograph and echocardiography. Before delivery peripartum cardiomyopathy can be treated with diuretics and beta-blocking drugs, with angiotensin-converting enzyme inhibitors being added after delivery. There is a high recurrence risk in future pregnancies and women with cardiomyopathy should receive preconceptual counselling before embarking on further pregnancies (Lewis, 2011). Women whose ventricular function has returned to normal have approximately a 20% recurrence risk in future pregnancies, while those who did not achieve complete recovery of ventricular function have approximately a 50% recurrence risk in future pregnancies (Elkayam et al, 2001).

In those women with a dilated cardiomyopathy, anticoagulation should be considered to prevent intracardiac thrombus formation. There should be a lower threshold for commencing anticoagulation during pregnancy, as pregnancy is a prothrombotic state. During pregnancy low molecular weight heparin should be used as warfarin is both teratogenic and fetotoxic.

Hypertrophic cardiomyopathy is often an autosomal dominant condition. Usually pregnancy outcome is good unless there is severe diastolic dysfunction. Cardiac output may be compromised by:

- Bleeding – therefore prevent or treat post-partum haemorrhage aggressively
- Tachycardia – therefore consider beta-blocking agents to prolong diastole and allow adequate ventricular filling
- Vasodilatation – so avoid nifedipine as a tocolytic
- Arrhythmias – therefore treat arrhythmia and consider anticoagulation.

Women with inherited cardiomyopathy (dilated or hypertrophic) should be referred to a clinical geneticist to discuss the risks to the fetus, testing and follow up.

Sudden adult death syndrome

The case definition for sudden adult death syndrome is a sudden unexpected cardiac death (i.e. presumed fatal arrhythmia) where all other causes of sudden collapse are excluded, including a drug screen for stimulant drugs such as cocaine. There were 10 maternal deaths from sudden adult death syndrome in the 2006–8 triennium, more than in any previous triennium (Lewis, 2011). Six of the women were obese. Obesity appears to be associated with cardiac hypertrophy, and both obesity and cardiac hypertrophy are risk factors for arrhythmia in pregnant women.

Valve disease

Regurgitant valve disease

Although cardiac output increases in pregnancy, the reduction in systemic vascular resistance compensates in part for this, and pregnancy is generally well tolerated (Pearson et al, 2000).

Stenotic valve disease

Increased cardiac output across the stenosed valve will increase the transvalvar gradient and pregnancy may be poorly tolerated (Hameed et al, 2001). The onset of functional worsening occurs most frequently during the second trimester.

Prosthetic valves

Women with prosthetic heart valves require anticoagulation throughout pregnancy. There is debate as to which anticoagulant regimen to use (Hanania, 2001). Low molecular weight heparin does not cross the placenta and is therefore safer for the fetus, but may be associated with a higher risk of valve thrombosis, particularly if patient non-compliance is an issue (McLintock et al, 2009).

Congenital heart disease

More women with congenital heart disease are now surviving until their child-bearing years (Moons et al, 2010) and are the group of women most commonly seen antenatally in a joint obstetric cardiac clinic. The biggest increase in survival has been seen in women with complex congenital heart disease (Department of Health – Vascular Programme Team, 2006). Since this group of women are known to the health-care services beforepregnancy there is an opportunity to offer preconceptual counselling. Prepregnancy counselling should include a frank discussion of the risks involved in pregnancy to enable a woman to make an informed choice about whether to embark on pregnancy or not.

At the time of booking for antenatal care it is important to define the lesion and determine what surgery has been done previously. Women with surgically corrected

congenital heart disease are still at risk, as there may be residual uncorrected defects.

Those with complex congenital heart disease, e.g. pulmonary hypertension or Eisenmenger syndrome, cyanotic heart disease, Fontan circulation and transposition of the great arteries are at highest risk of maternal and fetal complications (Drenthen et al, 2007). There is still a significant risk of maternal mortality (approximately 25%) in women with pulmonary hypertension (Bedard et al, 2009), and termination of pregnancy should be discussed and offered if women become unexpectedly pregnant.

Fetal echocardiography is indicated if either parent had congenital heart disease as there is a 3–6% recurrence risk for the fetus.

Various scoring schemes have been used to try to predict the outcomes of pregnancy in women with congenital heart disease (Siu et al, 2001; Drenthen et al, 2010) Failure to increase heart rate during exercise testing appears to be associated with a poor fetal and maternal outcome (Lui et al, 2011).

Service provision for women with heart disease

Preconceptual care

If women are known to have heart disease before pregnancy, prepregnancy counselling should be offered. This is ideally done jointly by an obstetrician and a cardiologist and includes:

- A frank discussion of the risks involved to enable the woman to make an informed choice as to whether to embark on pregnancy or not
- Optimizing cardiac function (either medically, e.g. control arrhythmias, or surgically, e.g. valvuloplasty)
- Review and adjust medication avoiding teratogens if possible (*Table 1*)
- Contraception advice if the woman decides against embarking on pregnancy
- Contact numbers to facilitate early referral once pregnant.

Women undergoing assisted conception often have additional risk factors such as increased age, the risk of ovarian hyperstimulation and multiple pregnancy.

Early pregnancy

Ideally women with heart disease should be referred to a joint obstetric cardiac clinic. There should be:

- Easy access to facilitate prompt referral
- Accurate information gathered about the type and severity of the cardiac disease, previous and current treatments
- Review and adjustment of medication, for example changing anticoagulation from warfarin to low molecular weight heparin (*Table 1*)
- A frank discussion of the risks involved to enable the woman to make an informed choice as to whether to continue with the pregnancy or not

Table 1. Common cardiac drugs and their effect during pregnancy and breastfeeding

Drug group	Risks to fetus or pregnancy	When to stop treatment	Special considerations in pregnancy	Breastfeeding
Beta blockers	Possible mild growth restriction	No need to stop treatment	Monitor fetal growth	Safe
Digoxin	Small increase in risk of prematurity and low birth weight	Not necessary	Monitor fetal growth	Safe
Diuretics	Decreased placental perfusion	Not necessary	Monitor fetal growth	Safe
Warfarin	Warfarin embryopathy, fetal intracranial bleeding and microcephaly	Before 7 weeks gestation	Change to low molecular weight heparin. Specialist advice if mechanical heart valves as benefit of warfarin may outweigh risks	Safe
Low molecular weight heparin	Fetal – none. Effect on maternal bone density, and very small risk of maternal thrombocytopenia	Not necessary	Check maternal platelets at booking. As the greatest risk of heparin-induced thrombocytopenia is in the first month of use, check platelet count weekly for 4 weeks after starting low molecular weight heparin (full blood count is routinely checked at 28 weeks and this should suffice)	Safe
Statins	Potential effect on fetal neurodevelopment	Preconception if safe to do so, or as soon as pregnancy confirmed	If inadvertently exposed, risk not high enough to warrant offering termination of pregnancy. Consider thromboprophylaxis during pregnancy	Little data, but not advised Restart when no longer breastfeeding
ACE inhibitors and angiotensin receptor antagonists	Congenital malformation, particularly heart defects. Fetal renal dysfunction and oligohydramnios which may be irreversible	Before conception if possible, but if not as soon as pregnancy confirmed	If unable to stop (because of risk of heart failure), monitor with serial ultrasound scans and detailed fetal medicine review and fetal echocardiography by 22 weeks if not already indicated	Limited data, probably safe
Adenosine	None known	Not necessary		No data, probably safe

ACE = angiotensin converting enzyme

- A professional interpreter (if needed) to ensure that all relevant history is disclosed. Interpreters from within the family should not be used as, in the family's desire to help the woman have a successful pregnancy, risks may not be accurately relayed to the patient (Lewis, 2007)
- For women who choose not to continue the pregnancy there should be easy access to termination of pregnancy in a hospital which can care for a woman with heart disease. Infection, bleeding and the need for an anaesthetic are recognized complications of termination but may pose a more significant risk to a woman with cardiac disease (Lewis, 2007).

Awareness of cardiac disease in the antenatal population

Recognition of relevant history, important signs and symptoms which may prompt referral to a cardiologist:

- Unexplained breathlessness
- Isolated systolic hypertension
- Interscapular pain
- Severe chest pain not caused by thromboembolism
- Polycythaemia
- Tachycardia.

Multidisciplinary care plan

This should include a plan for management during pregnancy, intrapartum and post-partum. Consideration should be given to what interventions and support may be needed around the time of delivery as this may affect the choice of hospital for delivery – some large maternity units are on separate sites from the cardiac or intensive care facilities. The care plan should include contingency planning for such conditions as preterm labour and postpartum haemorrhage, and contact numbers for members of the multidisciplinary team (Royal College of Obstetricians and Gynaecologists, 2011). Anaesthetists, haematologists and neonatologists may all need to be involved in planning delivery.

Contingency plans

Preterm labour

Atosiban is a specific oxytocin antagonist with no cardiac side effects and would be the tocolytic of choice in a woman with heart disease.

For post-partum haemorrhage mechanical methods (bimanual compression) and misoprostol are preferred. Although misoprostol has a longer time to onset of action than other uterotonic drugs it has less cardiac side effects. Syntocinon boluses can cause hypotension and tachycardia, ergometrine can cause a hypertensive surge while carboprost (hemabate, prostaglandin F2α) can cause severe bronchoconstriction.

Appropriate response to cardiac arrest is needed, including:

- Knowing how to call the arrest team for an obstetric patient
- Efficient bleep system to ensure that the appropriate staff including an obstetrician and a paediatrician are called
- Awareness that a perimortem caesarean section facilitates resuscitation of the mother, and should be performed as part of the resuscitation after 5 minutes.

Resuscitation training and drills specifically directed at cardiac arrest in a pregnant woman help promote an appropriate response.

Delivery

If possible, aim for a vaginal delivery, unless a woman cannot safely raise her cardiac output sufficiently for labour. Caesarean section for cardiac indications may be appropriate in women with severely stenotic valves, poor ventricular function, ischaemia, cyanosis together with some women with pulmonary hypertension and those with a dilated aortic root.

During labour in women with heart disease avoid hypotension or hypertension, provide good analgesia and ensure careful fluid balance. Syntocinon (5 units in 20 ml) given by an infusion over 10–20 minutes may be preferable to a bolus of syntometrine or bolus of syntocinon for management of third stage, and this should be specified in the individualized care plan.

According to National Institute for Health and Clinical Excellence (2008) guidelines antibiotic prophylaxis to prevent endocarditis is not needed for obstetric procedures and childbirth. However, the evidence on which this is based is scanty (Tower et al, 2008).

Postpartum

The majority of maternal deaths from cardiac causes occur post-partum. This is a time when increased vigilance is required, but when complacency often occurs. Maternal observations must be monitored regularly with an appropriate response if abnormal.

Breastfeeding

Women should be encouraged to breastfeed. Warfarin is not contraindicated. Enalapril and captopril can be used to treat breastfeeding women as they have no known adverse effects on babies receiving their breast milk (National Collaborating Centre for Women's and Children's Health, 2011).

Contraception

Appropriate contraceptive advice must be provided after any pregnancy. This allows time for reassessment of cardiac function and treatment if necessary. One successful pregnancy must not engender complacency. Some conditions, such as peripartum cardiomyopathy, have a high recurrence risk, and assessment and discussion should occur before embarking on a further pregnancy (Lewis, 2011). Other conditions will naturally tend to worsen with age and in each subsequent pregnancy the risks would increase.

Conclusions

Appropriate support by a specialist multidisciplinary team is necessary to optimize the care of women with heart disease in pregnancy. **BJHM**

Conflict of interest: none.

Bedard E, Dimopoulos K, Gatzoulis MA (2009) Has there been any progress made on pregnancy outcomes among women with pulmonary arterial hypertension? *Eur Heart J* **30**(3): 256–65

Department of Health – Vascular Programme Team (2006) *Adult congenital heart disease. A commissioning guide for services for young people and Grown Ups with Congenital Heart Disease (GUCH).* Department of Health, London

Drenthen W, Pieper PG, Roos-Hesselink JW et al on behalf of the ZAHARA Investigators (2007) Outcome of pregnancy in women with congenital heart disease: A literature review. *J Am Coll Cardiol* **49:** 2303–11

Drenthen W, Boersma E, Balci A et al on behalf of the ZAHARA Investigators (2010) Predictors of pregnancy complications in women with congenital heart disease. *Eur Heart J* **31**(17): 2124–32

Elkayam U, Tummala PP, Rao K et al (2001) Maternal and fetal outcomes of subsequent pregnancies in women with peripartum cardiomyopathy. *N Engl J Med* **344**(21): 1567–71

Hameed A, Karaalp IS, Tummala PP et al (2001) The effect of valvular heart disease on maternal and fetal outcome of pregnancy. *J Am Coll Cardiol* **37**(3): 893–9

Hanania G (2001) Management of anticoagulants during pregnancy. *Heart* **86:** 125–6

Knight M, Spark P, Pierce M et al (2010) *United Kingdom Obstetric Surveillance System (UKOSS) Annual report 2010.* National Perinatal Epidemiology Unit, Oxford

Lewis G, ed. (2007) *The Confidential Enquiry into Maternal and Child Health (CEMACH). Saving Mothers' Lives: reviewing maternal deaths to make motherhood safer - 2003-2005.* The Seventh Report on Confidential Enquiries into Maternal Deaths in the United Kingdom. CEMACH, London

Lewis G, ed. (2011) Saving Mothers' Lives: Reviewing maternal deaths to make motherhood safer: 2006–2008. *BJOG* **118**(s1): 1–203

Lipscomb KJ, Smith JC, Clarke B, Donnai P, Harris R (1997) Outcome of pregnancy in women with Marfan syndrome. *BJOG* **104**(2): 201–6

Lui GK, Silversides CK, Khairy P et al for the Alliance for Adult Research in Congenital Cardiology (AARCC) (2011) Heart rate response during exercise and pregnancy outcome in women with congenital heart disease. *Circulation* **123:** 242–8

McLintock C, McCowan L, North R (2009) Maternal complications and pregnancy outcome in women with mechanical prosthetic heart valves treated with enoxaparin. *BJOG* **116:** 1585–92

Moons P, Bovijn L, Budts W, Belmans A, Gewillig M (2010) Temporal trends in survival to adulthood among patients born with congenital heart disease from 1970 to 1992 in Belgium. *Circulation* **122**(22): 2264–72

National Collaborating Centre for Women's and Children's Health (2011) *Hypertension in pregnancy: the management of hypertensive disorders during pregnancy.* NICE clinical guideline CG107. Royal College of Obstetricians and Gynaecologists, London

National Institute of Health and Clinical Excellence (2008) *Prophylaxis against infective endocarditis. Antimicrobial prophylaxis against infective endocarditis in adults and children undergoing interventional procedures.* CG64. National Institute of Health and Clinical Excellence, London

Pearson GD, Veille JC, Rahimtoola S et al (2000) Peripartum Cardiomyopathy National Heart, Lung, and Blood Institute and Office of Rare Diseases (National Institutes of Health) Workshop Recommendations and Review. *JAMA* **283**(9): 1183–8

Rossiter JP, Repke JT, Morales AJ, Murphy EA, Pyeritz RE (1995) A prospective longitudinal evaluation of pregnancy in the Marfan syndrome. *Am J Obstet Gynecol* **173:** 1599–606

Royal College of Obstetricians and Gynaecologists (2011) *Cardiac Disease in Pregnancy.* Good practice No 13. Royal College of Obstetricians and Gynaecologists, London

Shivvers SA, Wians FH, Keffer JH, Ramin SM (1999) Maternal cardiac troponin I levels during normal labor and delivery. *Am J Obstet Gynecol* **180:** 122–7

Siu SC, Sermer M, Colman JM et al (2001) Prospective multicenter study of pregnancy outcomes in women with heart disease. *Circulation* **104:** 515–21

Tower C, Nallapetta S, Vause S (2008) Prophylaxis against infective endocarditis in obstetrics: new NICE guidance: a commentary *BJOG* **115:** 1601–4

KEY POINTS

- Cardiac output increases significantly in pregnancy. Women with cardiac disease may be unable to tolerate this and may decompensate.
- Cardiac disease is the commonest cause of maternal death with the majority of maternal deaths as a result of acquired heart disease.
- The number of women with congenital heart disease surviving to their child-bearing years is increasing.
- Pregnant women with known cardiac disease should be referred for consultant-led obstetric care with involvement of a cardiologist with expertise in the care of women with heart disease in pregnancy.
- There should be a low threshold for referral of women with symptoms which could represent cardiac disease to a cardiologist.
- Resuscitation training should include training on how to modify resuscitation techniques for a pregnant woman.
- Increased vigilance is required in the postnatal period for women who have heart disease in pregnancy, as this is when deterioration can occur and when the majority of deaths occur.