Your cardiac patient wants to become a mother. Risk considerations and advice

Part I - Your cardiac patient asks advice on a possible pregnancy

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In this part, the risks and complications of pregnancy in women with active or corrected, congenital or acquired heart disease are reviewed, in order to allow individual counseling on a possible pregnancy or treatment recommendations on contraception.

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Pregnancy causes substantial changes in the cardiovascular system: mainly, a 50% increase in cardiac output, about a 40% increase in circulating plasma volume, whereas systemic peripheral resistance and arterial pressure decrease. The rise in progesterone and estrogen levels accompanying pregnancy stimulates the renin-angiotensin-aldosterone system. Increased prostaglandin production follows renin activation; simultaneously, the arterial vessels show diminished angiotensin sensitivity. The result is pronounced vasodilation. These physiological changes induced by pregnancy put the pregnant woman with heart disease "at risk" of maternal and perinatal mortality and morbidity. Cardiovascular diseases remain the most important non-obstetric cause of maternal death. The cardiological events which can occur in a heart-diseased woman during pregnancy are sudden death, acute pulmonary edema, congestive heart failure, embolism, tachy and bradyarrhythmias, infective endocarditis, myocardial ischemia, and systemic and pulmonary hypertension, these last being in turn potential causes of destabilization of a compensated hemodynamic situation. The risk, obviously, varies in relation to the particular heart disease and its severity; being aware of the maternal risk and behaving appropriately in the light of it are weapons for preventing cardiac events and reducing fetal risks.

The aim of this paper was to review the most updated indications for evidence-based counseling a) of our cardiac patient on a possible pregnancy and on contraception, and if necessary, during pregnancy, labor and the *postpartum* period; b) of physicians on the use of some cardiac drugs during pregnancy and lactation.

This review has been based on English language medical literature accessed through MEDLINE from 1990 to present; additional sources were obtained by cross-referencing. Case reports were excluded. This is a neutral review, without formal appraisal of the data generated from the literature search. For the majority of the items here considered, recommendations could not be based on evidence. Consequently, advice derives from a process of filtering out published papers and clinical experience.

In this first part, advice on a possible pregnancy and on contraception is treated.

Advice on a possible pregnancy

There are no substantial, consolidated statistics on which to base advice. Precise diagnosis and assessment of cardiovascular reserve combined with an understanding of the cardiovascular adaptations of pregnancy allow for individual assessment of risk during pregnancy.

Risk stratification is based on four main factors[1-12]:
• the type of heart disease (surgical repair, residual hemodynamic state, etc.);
• the degree of functional compromise before pregnancy (poor functional class, cyanosis, prior arrhythmia, prior cardiac event, etc.);
• the probability that complications associated with pregnancy will develop;
• the choice of pharmacological treatment.

The fact that severe functional compromise can affect ovarian function, sexuality and, therefore, fertility should also be taken into account.

When formulating an opinion on a possible pregnancy the risks to the fetus must also be considered, normal uterine blood flow and normal placental function being fundamental for fetal viability and growth. Maternal hypertension, for example, is correlated with a higher risk of perinatal mortality, a higher incidence of stillbirths and intrauterine growth retardation. Only about 45-55% of pregnancies in hypoxemic mothers terminate with the birth of a live neonate, who is often underweight and/or premature; there is a high incidence of spontaneous abortions, correlated directly with maternal hematocrit and hemoglobin levels[5-8]. Non-cardiac anomalies (up to 14%) are more common in infants born of cardiopathic mothers (particularly those with aortic stenosis or some type of flow obstruction)[2,13,14].

If the maternal heart disease is a congenital one, the risk of transmitting the cardiac anomaly to the fetus must also be included in the formulation of advice[15-17].

A requested opinion must only be given after having also assessed the function of other organs (especially the kidneys and the liver) and obtained the gynecologist's opinion.

It is obvious that if there are indications for corrective treatment, this should be carried out before giving advice on a possible pregnancy[13,18]. In a woman with recurrent atrioventricular node-dependent tachycardias, radiofrequency ablation as a definite therapy should be offered before she attempts a pregnancy.

Whatever the underlying disease, the patient with pulmonary hypertension (systolic pulmonary artery pressure > 50 mmHg) should be advised against undergoing a pregnancy. The increase in cardiac output and the drop in systemic resistance are poorly tolerated, given the stability of the high pulmonary resistance. Maternal mortality in this group of women is about 50% and perinatal mortality about 40-50%. Pulmonary hypertension can be correctly evaluated by echo-Doppler of the pulmonary and tricuspid valves and by a calculation of the ventriculo-atrial pressure gradient[19,20].

Heart failure develops much more frequently during pregnancy in cyanotic patients (reported in up to 47%[7,8,21,22]) than in non-cyanotic subjects (4.3%); pregnancy should, therefore, be advised against in the former group. Chronic cyanosis lowers the probability of a normal gestation and increases the risk of paradoxical embolism. Moreover, maternal cyanosis causes poor fetal growth with prematurity and dysmaturity and high fetal loss related to hematocrit.

As far as the degree of functional compromise is concerned, women in NYHA functional classes I and II have a low risk of maternal mortality (< 1%), while those in classes III and IV have a risk of cardiovascular morbidity of 30-50% and of maternal death of 25-50%. Therefore, women in functional classes III and IV should be advised most strongly not to go through with a pregnancy[7,8,11,13,21]. Given that pregnancy makes additional demands, an assessment not only of the degree of functional compromise at rest but also of the patient's cardiac reserve seems sensible, however the paucity of clinical experience in this field prevents this logical proposal from being presented as a recommendation. In order to evaluate cardiac reserve, it could be useful, for example, to get the patient to undergo a cardiopulmonary test with measurement of the anaerobic threshold and oxygen consumption which yields information on the patient's physical performance, heart rate and blood pressure response to dynamic stress, and the adequacy of the increase in cardiac output in response to physical effort. The response to dobutamine challenge (by invasive or non-invasive hemodynamic evaluation) can be considered another tool for the evaluation of cardiac reserve[23]. Indications on how to use the data as criteria for making decisional choices are not at present available.

Independently of the type of heart disease, the functional status influences not only the mortality and morbidity of the pregnant woman, but also that of the fetus (interruption of pregnancy, death due to prematurity, prematurity). Fetal mortality passes from 0% in pregnant women in class I to 30% in pregnant women in class IV[11,24,25].

Most common cardiac diseases. A brief list of the most common cardiac diseases occurring in women of childbearing age includes congenital heart diseases, valve diseases, already corrected or not, hypertrophic obstructive heart disease, *peripartum* and dilated primary cardiomyopathy, pulmonary vascular diseases, and finally but rarely myocardial infarction. Moreover, women with a heart transplant, a long QT syndrome and an implantable cardioverter-defibrillator may ask for advice on pregnancy.

Congenital shunt lesions[1-3,5-8,10,12,13,21,22,24-28]. These disorders are normally corrected in the pre-fertile age; in this situation pregnancy is not a problem, carrying a low risk (risk of maternal mortality < 1%). Otherwise, the risk is linked to the size of the shunt, to the functional status of the left ventricle, and to pulmonary hypertension. An accurate evaluation can be carried out by echo-Doppler. The possibility of a pregnancy is a good occasion to evaluate indications for correction.

The risk of fetal transmission is 2.5-5%.

Pulmonary stenosis[1-3,5-8,10,12,13,21,22,24]. Uncorrected in childbearing age, this is usually mild or moderate (right ventricular pressure < 75 mmHg). It does not cause particular problems during pregnancy which carries a low risk (mortality risk < 1%). If the pulmonary stenosis is severe and the right ventricular pressure is high (> 75 mmHg) it is worth carrying out a valvotomy before pregnancy, even in asymptomatic patients. The hemodynamic assessment can be carried out non-invasively by echo-Doppler studies (calculation of the gradient).

The risk of fetal transmission is 2-5%.

Aortic coarctation[1-3,5-8,10,12,13,21,22,24,29]. This is generally corrected in the pre-fertile age and therefore, in association with pregnancy, causes only minor problems related to the often co-existing bicuspid aortic valve disease and to the late recurrence of systemic hypertension. There are still risks for aortic dissection, but very small. Recently, Saidi et al.[30] have reported a retrospective study on 52 women born before 1980 with aortic coarctation who had undergone balloon angioplasty or surgery before pregnancy. It can be concluded from this study, that in women with an arm-to-leg blood pressure gradient of < 20 mmHg after coarctation repair, pregnancy is successful. The occurrence of congenital heart disease in the offspring was 3%. The pre-eclampsia rate was similar to that in the general population.

If aortic coarctation is not corrected during infancy, now a rare occurrence, there is a risk of aortic dissection, cerebral hemorrhages (rupture of aneurysms of the circle of Willis) and development of hypertensive complications associated with organ damage in addition to hypertensive heart failure. If uncorrected, the risk of maternal mortality is 3-6%, and that of morbidity 90%. Patients need prolonged rest, avoiding any physical exertion which can cause an uncontrolled blood pressure rise regardless of therapy. The risks are still higher if there is an associated bicuspid pathology.

The risk of fetal transmission is 2-3%.

Ebstein's anomaly of the tricuspid valve[1-3,5-8,10,12,13,21,22,24,25,31]. Pregnancy carries numerous potential risks. The inadequate right ventricle may not be able to support the increase in cardiac output or the frequent atrial arrhythmias. The most common complications are acute right ventricular failure, shunt inversion and cyanosis. However, there have been reported cases of a successful outcome in pregnancy in acyanotic women with this disorder. In any case, there is a greater probability of fetal death, prematurity, and cardiac abnormalities.

The risk of fetal transmission is 7%.

Tricuspid atresia[1-3,5-8,10,12,13,21,22,24,25]. Pregnancies are at high risk of maternal and fetal complications and should be avoided.

Fallot's tetralogy[1-3,5-8,10,12,13,21,22,24,25,32]. If corrected and the PaO_2 is normal, pregnancy can be expected to proceed normally. If it has not been corrected, the obstruction to the right ventricular outflow was not such as to significantly limit the pulmonary blood flow. During pregnancy, however, there is a risk of an increase in the right-to-left shunt because of systemic vasodilation and decreased venous return to the obstructed right ventricle, caused by the uterus compressing the inferior vena cava. Thus, there is a drop in oxygen saturation, a more marked cyanosis and a rising hematocrit. Fallot's tetralogy creates a high risk of maternal-fetal mortality. The risk is prohibitive in patients with a hematocrit > 65%, syncope, PaO_2 < 70%, and a significant increase in right heart pressures.

Palliative surgical operations can reduce the risk to the mother and fetus. If cyanosis persists even after the operation, the probability of fetal immaturity increases.

The risk of fetal transmission is 4%.

Eisenmenger's syndrome, primary and secondary hypertension[19,33-38]. Pregnancy should be advised against. The irreversibility of high pulmonary resistance and the lack of reserve make the dynamic changes in systemic resistance, cardiac output, and plasma volume occurring during pregnancy particularly dangerous. There is a high risk (50-70%) of maternal death due to hypoxemia, secondary to the decreased pulmonary flow, hypovolemia, thromboembolism, and pre-eclampsia/eclampsia, as well as a poor prognosis for the fetus.

Maternal prognosis depends on the early diagnosis of pulmonary vascular disease, early hospital admission, individually tailored treatment during pregnancy, medical and oxygen therapy, prolonged bed rest and care focused on the *postpartum* period. There is no difference in the percentage risk of maternal death relative to the number of pregnancies: therefore, even a history of a previous pregnancy brought successfully to full term does not authorize a subsequent pregnancy.

Congenital or acquired aortic stenosis[1,5-9,13,39]. If the patient is symptomatic, pregnancy is at very high risk and must be discouraged. If systolic function is preserved, but the stenosis is severe (systolic gradient ≥ 70 mmHg or an area ≤ 0.5 cm^2/m^2), correction should be advised (valvuloplasty or replacement) before undergoing a pregnancy, even if the patient is asymptomatic, because the risk associated with the limited functional reserve still exists[18,39,40]. In fact, pregnancy stresses the already overloaded left ventricle with an increase in circulating volume and cardiac output, whose critical adequacy is the major functional problem of the aortic stenosis.

If the stenosis is mild (gradient < 50 mmHg or the area of the valve is > 0.9 cm^2) or moderate (systolic gradient 50-70 mmHg or valvular area 0.5-0.8 cm^2), the risk of maternal death is less, but still significant (5-15%). The greatest risk is associated with birth and the *postpartum* period, when hypotension, low output, syncope, dyspnea,

angina, and even sudden death can occur. Assessment is carried out by echocardiography.

The risk of fetal transmission is 1-3%.

Bicuspid aortic valve. An unstenosed bicuspid aortic valve does not create problems during pregnancy, apart from the risk of bacterial endocarditis to which patients with congenital heart disease are particularly prone, and the association between the bicuspid aortic valve and cystic medial necrosis, which may predispose to spontaneous aortic dissection, usually in the third trimester[41].

Congenital or acquired aortic regurgitation[1,5-9,13,41]. A pregnancy is usually tolerated quite well in patients in low NYHA functional classes (I and II); even in a higher class the risk is still low if left ventricular end-diastolic pressure is normal. The tachycardia shortens diastole and thus the amount of regurgitation. The increase in cardiac output is balanced by peripheral vasodilation.

In patients in high classes or with abnormal left ventricular end-diastolic pressure or compromised ejection fraction, the risk associated with pregnancy is high. In rheumatic heart disease, associated valve pathology is common and the hemodynamic consequences of a pregnancy must be evaluated bearing this in mind.

The forms of aortic regurgitation caused by pathological changes in the aortic wall can be considered as incomplete Marfan's syndrome, and carry the same risk as Marfan's syndrome itself.

Marfan's syndrome[42-45]. Enlargement of > 5 cm of the aortic root is an indication for elective repair before conception. If an aortic root enlargement of > 4 cm is first detected during pregnancy, termination of pregnancy with prompt aortic repair is recommended, especially if serial echocardiographic controls show progressive dilation. Pregnancy increases the risk of aortic dissection and rupture in Marfan's syndrome and is, therefore, a serious risk to the mother's life. Furthermore, the condition is genetically transmitted as an autosomal dominant trait.

Mitral regurgitation[1,5-9,13,41]. It is usually non-rheumatic and with sinus rhythm. Most of these patients can be treated by valve repair, which should be carried out before pregnancy but pregnancy is usually well tolerated. There are no problems for women in low NYHA functional classes (I and II). The ventricle adapts easily to the increase in volume and to the tachycardia, especially if it is under sinus rhythm. As symptoms are late even in non-pregnant patients, the presence of symptoms is an indication for valve repair. The increased cardiac output and vasodilation reduce the laxity of prolapsed mitral valve leaflets.

Mitral stenosis[1,5-9,13,41]. During pregnancy this creates a 5-15% risk of maternal mortality. If the degree of stenosis is such as to require surgical correction *per se*, this should be carried out before a possible pregnancy.

NYHA functional class is of little relevance in this situation since non-pregnant women in class I or II may pass rapidly into class III or IV during a pregnancy. For this reason, it has been suggested that a mitral valvotomy should be performed in patients with mitral stenosis before they become pregnant even in the absence of indications, *per se*, for surgery, particularly if there is a history of heart failure having occurred during a previous pregnancy. Heart failure can develop at any stage of pregnancy but the most critical periods are from the 20th to the 34th week of gestation, when there is the greatest increase in cardiac output; during labor, when a further 30% increase in cardiac output is required, and in the immediate *postpartum* phase, when autotransfusion of 300-500 ml of blood from the placental circulation can cause acute pulmonary edema. If cardiac failure occurs during pregnancy, surgical treatment, i.e. valvuloplasty or commissurotomy, should be considered. Over a period of 6 years, some studies[46-51] were carried out to evaluate the effectiveness and safety of percutaneous balloon mitral commissurotomy for the treatment of pregnant women with severe mitral stenosis. The incidence of complications was low, thus balloon mitral commissurotomy might be considered the treatment of choice for severe pliable mitral stenosis in pregnant patients who are refractory to medical treatment.

The enlarged atrium and/or its auricle often contain thrombi which create a high risk of embolism, especially cerebral. The frequently concomitant atrial fibrillation makes anticoagulant treatment mandatory. Anticoagulants, however, place the fetus at risk (hemorrhages and malformations) so this must be taken into consideration when making a decision about any advice (see Part II).

Previous peripartum heart disease[52-54]. It is known that a subsequent pregnancy can aggravate clinical conditions and cause recrudescence of the heart disease in about one third of patients who have experienced previous *peripartum* heart disease. That having been said, from the results of recent studies it seems that the future of a pregnancy depends more on the degree of improvement obtained after the previous episode than the severity of the previous episode itself: pregnancy should be discouraged in patients who still have signs and/or symptoms of ventricular dysfunction after 6-12 months. On the other hand, in those who are completely asymptomatic, whose radiological and echocardiographic pictures have normalized, and whose hemodynamics shows a normal response to dobutamine challenge, a further pregnancy can be attempted under close surveillance, with the understanding and acceptance that clinical conditions may compel the termination of pregnancy[23]. Complete clinical remission of *peripartum* heart disease is observed in about 50% of patients. In these cases the cause of cardiac dysfunction is presumed to be an acute myocarditis, possibly associated with a cross-reaction be-

tween myocardial structures and antibodies produced originally in response to immune system stimulation by myometrial and/or feto-placental antigens. An alternative pathogenetic hypothesis is exposure to a virus, which even of low antigenicity, could induce an exaggerated immune response due to the T-helper lymphocyte depression induced by pregnancy. Although limited, experience of subsequent pregnancies in patients in complete remission is encouraging.

Hypertrophic obstructive heart disease[2,3,7,8,10-12,21,24,25]. Pregnancy is normally well tolerated because of the beneficial physiological increase in left ventricular volume. All the hemodynamic effects of pregnancy can become detrimental when there is concomitant mitral regurgitation. In this situation the risk of pulmonary congestion is high and pregnancy should be discouraged.

The disease is caused by an autosomal dominant gene. Up to now, seven genetic loci have been identified by means of linkage mapping or candidate gene analysis in familial hypertrophic cardiomyopathy[55].

Dilated cardiomyopathy. Besides the risk related to the functional compromise (see above), the risk of familial transmission should be taken into account[56-58]. A genetic disease must be considered as the cause of dilated cardiomyopathy in at least one third of patients, and it is believed that these data still underestimate the real frequency, due to the possibility of missing affected individuals, small pedigrees, the absence of early markers of disease, and reduced penetrance, which is the proportion of carriers of the disease gene who manifest a clinical phenotype.

Previous myocardial infarction. This is rare in women of childbearing age (a few have premature coronary disease associated with diabetes, obesity and smoking and a few have familial hypercholesterolemia). Functional evaluation can yield information useful for formulating advice on a possible pregnancy. If this evaluation demonstrates symptomatic or low threshold silent ischemia there is a possibility that the patient will develop myocardial ischemia during pregnancy[59]. Revascularization, if practical, is therefore indicated before pregnancy[60]. If postinfarction left ventricular dysfunction (ejection fraction < 40%) is present, before giving any advice on a possible pregnancy functional compromise should be evaluated both at rest and under stress by cardiopulmonary exercise test and possibly also by hemodynamic stress monitoring in order to assess the extent of the increase in filling pressures in relation to the increase in cardiac output.

Patients with a prosthetic valve[61-63]. A pregnancy can be undertaken, although the problems related to the increased hemodynamic burden, increased incidence of thromboembolism (due to pregnancy hypercoagulability, characterized by increased level of clotting factors and of fibrinogen and platelet adhesiveness), risk of endocarditis and collateral effects of anticoagulation should be carefully evaluated. Moreover, even in asymptomatic or mildly symptomatic patients decreased functional capacity and the need to start or augment drug therapy are not uncommon. An echocardiographic examination of valve function is advisable before making any judgment on the wisdom of a possible pregnancy. However, no advice can be given until there has been an adequate period of ascertained clinical stability.

Patients requiring anticoagulants should be informed on the questionable nature of the evidence supporting the gestational use of the drug and on the medico-legal implications of its use during pregnancy[62,64,65] (see Part II).

Implantable cardioverter-defibrillator. Pregnancy does not seem to increase the risk of major implantable cardioverter-defibrillator (ICD)-related complications or result in a high number of ICD discharges[66]. The mere presence of an ICD should not be considered a contraindication to pregnancy. The underlying structural cardiac disease remains the main point.

Heart transplant recipients[67-71]. The patient must be carefully informed about her life expectancy, the risk of atherosclerosis and the fact that her health will influence the development and care of her child. This having been said, pregnancy after heart and heart-lung transplantation is feasible. The problems associated with pregnancy are those related to the development of arterial hypertension (patients treated with cyclosporin), to right atrial and pulmonary hypertension, to a worsening in any tricuspid regurgitation still present and to the possibility of infection. Furthermore, poor renal function and persistent hypertension could affect fetal growth. In a series of 35 pregnancies in heart transplant recipients with 29 deliveries, hypertension occurred in 12 patients, preeclampsia in 7, premature labor in 9, and allograft rejection requiring treatment in 9 patients[68]. Prematurity and low birth weight of newborns have a relative high incidence, and subsequent pregnancy does not seem to increase the incidence of complications.

Fertility does not seem to be affected by immunosuppressive therapy. Particular attention should be given to monitoring cyclosporin levels, which should never reach toxic levels during pregnancy (cyclosporin crosses the placental barrier and thus creates a risk of fetal immunosuppression and intrauterine growth retardation). Cyclosporin is also secreted in maternal milk: breastfeeding should not be permitted. Tacrolimus has rarely been used in pregnant organ transplant recipients. Its major side effects are glucose intolerance and dose-related nephrotoxicity. In the largest series reported of 9 pregnancies in liver transplant recipients, 6 resulted in premature babies, but none were small for the gestational age. Azathioprine crosses the placenta, but is metabolized in the fetus predominantly into inactive thiouric acid. The fetus should be protected from the effects of

azathioprine in early pregnancy. Prednisone crosses the placenta, but is not teratogenic. It is recommended that prednisone dosage be maintained at or below 15 mg/day, unless rejection is in progress. Echocardiographic-guided endomyocardial biopsy should be used for surveillance of rejection in heart transplanted pregnant women. Subsequent pregnancies do not seem to significantly increase the incidence of complications in either the newborn or mother or increase graft rejection or failure.

Systemic hypertension. If hypertension is labile, pregnancy is generally without risk, but in some cases (about 5%) severe pronounced hypertension can develop in late pregnancy and can continue after the birth. Moreover, women with chronic hypertension who become pregnant have an increased risk of pre-eclampsia and adverse neonatal outcomes. In these women the presence of proteinuria early in pregnancy is associated with adverse neonatal outcomes, independently of pre-eclampsia[72]. If blood pressure is < 160/100 mmHg in the first 20 weeks, there should not be particular risks; what is important is organ function. Pressures above these levels are a risk for both the mother and the fetus and pregnancy should be advised against. Pre-eclampsia is more common in hypertensives (10-20%); maternal mortality is about 5-10% and fetal mortality 20-25%[73]. Acute pulmonary edema and coronary artery spasm may develop during gestosis, and the gestosis, in its turn, can aggravate the pre-existing hypertension.

Long QT syndrome. The results have recently been published of a retrospective study on 422 women (111 probands affected with the long QT syndrome and 311 first-degree relatives) enrolled in the long QT syndrome registry who had one or more pregnancies[74]. The *postpartum* interval was associated with a significant increase in the risk of cardiac events among probands with long QT syndrome but not among first-degree relatives. Prophylactic treatment with beta-adrenergic blockers should be continued during pregnancy and *postpartum* intervals in probands with long QT syndrome.

Advice on contraception

If the carefully considered advice is that a pregnancy should not be undertaken, this advice can be reviewed after indicated actions have been carried out (e.g. optimization of medical treatment and new cardiological assessment, or palliative or corrective surgery). In this case the patient can be advised to use temporary contraception. Otherwise definitive contraception is indicated: that is, bilateral ligation of the Fallopian tubes, planned in consultation with the anesthetist to take place when the patient is in a satisfactory enough condition to be able to sustain such an operation[75]. Temporary contraception can nowadays be achieved without any significant risk by hormonal manipulation: indeed the low doses of estradiol (30 γ) and the third generation progesterones (desogestrel) used in the latest "triphasic pill"[76,77] have reduced the risks associated with steroids to a minimum, although those relating to enhanced thrombogenesis remain (care must be taken in patients with a higher risk of thromboembolism), as do those related to the potential increase in systemic (4-5% in normotensives and 9-16% in hypertensives) and pulmonary blood pressures (seen more frequently when the doses of estradiol were higher: present day third generation progesterones have antialdosterone effects). A valid alternative contraceptive for those women for whom "the pill" carries risks is the intrauterine device, which should always be inserted under prophylactic antibiotic cover. In transplant recipients immunosuppression makes the intrauterine device an easy focus of infection. The side effects of estrogen-progesterones may be relevant in patients already at a high risk of accelerated atherosclerosis. Many centers advise tying the Fallopian tubes.

Male contraception should be considered when counseling a couple[78].

In conclusion, a precise diagnosis and evaluation of cardiovascular reserve, combined with an understanding of the cardiovascular adaptations of pregnancy, allow for an individual assessment of risk and consequent advice on a possible pregnancy.

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