

The role of multidisciplinary care for a pregnant woman with a positive cardiological history in everyday medical practice

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Abstract

Reducing maternal mortality is a global health goal of the World Health Organization. While the number of perinatal deaths from hemorrhage and infection is declining, the number of deaths related to heart disease is on the rise and is now the most important cause in Western countries. The aim of expert societies is to define contemporary, diagnostic-specific outcomes in pregnant women with heart disease.

Knowing about your cardiovascular risk during pregnancy is crucial for pre-contraceptive counseling. In the process of organizing care for a pregnant woman with cardiovascular diseases, a multidimensional approach to the problem is important, involving close cooperation between the cardiological and gynecological teams. Despite numerous publications, more studies are still needed to broaden the knowledge of cardiological care in pregnant women. The data obtained from the registers created on the initiative of the European Society of Cardiology, headed by the ROPAC register, seem promising.

Key words: pregnancy, cardiovascular diseases, perinatal care, cardiological care, ROPAC, ESC guidelines

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Introduction

Maternal conditions complicate the pregnancy in 1–4% of cases. Only limited data on the prevalence and incidence of heart diseases complicating pregnancy are still currently available [1]. Knowledge of cardiovascular risks during pregnancy and how to address them is crucial for preconception counselling [2]. As all available treatment methods affect not only the mother but also the foetus, the aim must be to optimise management from the perspective of both the mother and the child. Treatment that is beneficial to the mother may be associated with potential harm to the developing baby or, in extreme cases, treatment allowing the mother to survive may cause fetal death. On the other hand, management that protects the child may lead to suboptimal treatment outcomes for the mother. As there are no prospective or randomised studies, it seems more difficult to establish uniform rules of management for the

difficult issue of the provision of care for pregnant women with a history of cardiac disease. In order to improve the current state of knowledge, further registries and prospective observational data on epidemiology and drug exposure during pregnancy are needed, provided by the European Society of Cardiology (ESC) guidelines and the Registry of Pregnancy and Cardiac Disease (ROPAC), run by the ESC and the European Surveillance of Congenital Anomalies (EUROCAT) network of registers.

Epidemiology

In Western European countries, the risk of cardiovascular disease during pregnancy has increased due to the older age of women at the time of their first pregnancy. However, this fact alone – pregnancy at a more mature age – does not explain the increased incidence of cardiovascular diseases (CVD) during pregnancy [1]. However, late pregnancies

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falling towards the end of the childbearing age (40–50 years) are statistically more likely to be associated with an increased prevalence of cardiovascular risk factors, especially diabetes, hypertension and obesity. Moreover, an increasing number of women with congenital heart defects are reaching childbearing age [3]. In Western countries, maternal heart disease is the leading cause of maternal death during pregnancy [4].

The most common cardiac condition complicating pregnancy is hypertension which occurs in 5–10% of all pregnancies. Congenital heart defects are next in line. In non-Western countries, rheumatic valvular defects predominate, representing 56–89% of all CVD during pregnancy [5].

Sources of knowledge on the management of patients with cardiovascular diseases during pregnancy

In terms of the publications on the management of cardiovascular diseases in pregnant women, the ESC guidelines occupy a special position. It is possible primarily thanks to the fact that they are among the few recommendations that still somehow escape the rules of evidence-based medicine which still prevails, especially in cardiology. For obvious ethical reasons, pregnant women have always been disqualified from participating in clinical trials, and those who are not pregnant are required to use effective contraception during the trial. Consequently, expert opinions remain the basis for almost all recommendations on this topic. The source of those opinions, apart from indirect indications obtained from animal testing, can only be the clinical experience gained in daily work with patients as well as the registers of pregnant women with a history of cardiac disease, such as ROPAC.

The first guidelines published by the ESC on pregnant women with cardiovascular diseases appeared in 2003 [1]. Those guidelines have been the foundation of knowledge in this difficult topic of pre-, peri- and postnatal care of pregnant women with a history of cardiac disease. The latest update of the ESC Guidelines on the care of pregnant women with heart diseases was published in 2018 [1]. Large amount of knowledge contained therein is based on the authors' own experience. The second component that provides a valuable source of information on the management of the analysed group of patients are the registers maintained, among others, by the ESC. The most important of those are:

ROPAC – Registry of Pregnancy and Cardiac Disease

The register was established at the initiative of the ESC in 2007 [6]. Initially, it included patients with a structural heart defect. Recruitment is currently underway for Part III of the study – female patients with aortic pathology

or a genetic predisposition to its development, as well as pregnant women with at least one valve prosthesis (biological or mechanical). By the end of 2018, 5739 pregnant patients with all types of structural heart disease had been included in ROPAC. That contributed to expanding the current literature and management protocols for this type of patients as well as it allowed identification of further gaps in knowledge about this problem [6]. Aortic abnormalities are among the most common causes of heart disease-related maternal mortality [7]. In the case of valve prostheses, a high rate of complications during pregnancy are observed. The most common ones include: caesarean delivery, increased hospitalisation days during pregnancy, maternal heart failure (HF), pre-term delivery or intrauterine growth retardation [8]. For those reasons, as of February 2019, the ROPAC study is continuing with a particular focus on two types of structural heart disease: pathology within the aorta (as well as genetic predisposition to its development) and the status post replacement of at least one heart valve [9].

The partial results of the ROPAC are now published [10]. In the years 2007–2011, 1321 women were included in the study. Congenital heart defects were found in 66% of patients, valvular defects in 25%, cardiomyopathies in 7% and coronary artery disease in 2% of patients. Maternal mortality was 1% (0.007% in the normal population based on literature data). A total of 338 female patients were hospitalised during pregnancy (26%), including 133 due to HF. Caesarean section was performed in 41% of patients. Maternal and child mortality was higher in developing countries compared to developed countries. Fetal mortality was 1.7% and neonatal mortality was 0.6% [10].

The ROPAC is currently one of the most valuable sources of knowledge used for the purposes of formulating guidelines on the management of pregnant women with a positive cardiac history.

PPCM registry – PeriPartum CardioMyopathy registry

This register was created in 2016. The first results were published in 2017 [11]. This study aims to compare clinical data of patients with PPCM from ESC member countries compared to non-ESC countries. The study began in 2016 and will be continued until the number of 1000 female patients is reached. This publication aims to present preliminary results after the inclusion of the first 500 women in the study. Out of those women, 411 pregnant women from 43 countries with complete records were analysed. Pharmacological treatment initiated after pregnancy was found to be similar in both study groups, including angiotensin-converting enzyme inhibitors, angiotensin-receptor blockers, mineralocorticoid receptor antagonists. In contrast, drugs such as beta-blockers and ivabradine were used less frequently in non-ESC countries while diuretics, digoxin

and bromocriptine were used more frequently (32.6% vs. 7.1%; $p < 0.001$). After 1 month, persistence of HF symptoms was more common in the non-ESC group (92.3% vs. 81.3%; $p < 0.001$). Thromboembolic complications from the venous system, arterial emboli and cerebrovascular incidents occurred in 28 out of 411 patients (6.8%) [11]. The neonatal mortality rate was 3.1%; a detailed analysis was not included in the register. The study is part of the EURObservational Research Programme and is an initiative of the Study Group on PPCM of Herat Failure Association.

Organisation of care for women of childbearing age with cardiovascular disease – general recommendations

Preconception counselling

When providing cardiovascular care to a woman planning a pregnancy or during pregnancy, it is important to remember that it is a long-term and comprehensive process, including follow-up visits, decisions on necessary hospitalisation, tests, the inclusion of pharmacotherapy, suggestions for premature termination of pregnancy or normal termination of pregnancy, the method of termination of pregnancy – spontaneous labour or caesarean labour, breastfeeding or withholding lactation. It is crucial for the patients that the cardiologist and gynaecologist work together to develop a coherent action plan. The provision of care does not end with the childbirth; on the contrary, it must extend up to approximately six months after the birth. It is often prolonged to fulfil the planned treatment, taking advantage of the period between pregnancies.

It is clear that all women diagnosed with heart or aortic disease and planning a pregnancy need preconception counselling [12]. If there is a high risk of complications or possible contraindications to pregnancy, the risks of pregnancy and the need for careful planning should be discussed with the woman at a sufficiently young age. At the same time, it should be noted that in many cases pregnancy does not significantly increase cardiovascular risk. There is only a small group of cardiac conditions in which the pregnancy should be terminated by caesarean section (Figure 1). The minimum diagnostic tests that are necessary to estimate the risk of pregnancy in CVD women include electrocardiogram, echocardiography and cardiac diagnostic test [13]. However, in the event of aortic disorders, full imaging of this vessel by computed tomography or magnetic resonance scanning must be carried out to enable giving appropriate advice before pregnancy. Predictive factors for cardiac events in pregnant women include heart rate limit and peak oxygen uptake (in the spiroergometric test). Exercise capacity in pregnant women $> 80\%$ of maximal value is associated with successful pregnancy termination [1]. Genetic counselling should be considered in women

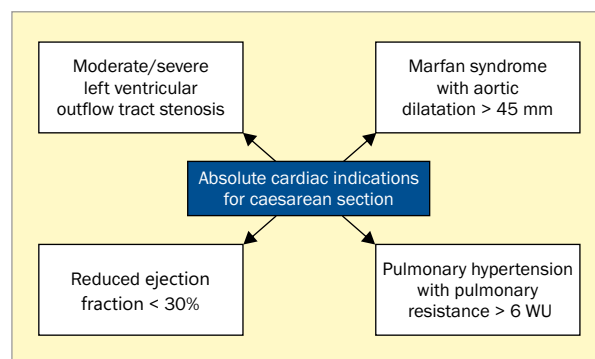


Figure 1. Absolute cardiac indications for caesarean section

with congenital heart disease or congenital arrhythmias, cardiomyopathy, aortic disease or genetic abnormalities associated with CVD [1].

Maternal cardiovascular risk assessment

In a group of patients with a suspected or positive history of CVD, it is recommended that the risk of complications be assessed and counselling be given before pregnancy. The mWHO classification (Table 1), which can be used in both the pre- and post-conceptional periods, will be helpful in this regard [14].

The risk of cardiovascular complications in pregnancy depends on the type of heart disease, ventricular and valvular function, functional class, the presence of cyanosis, pulmonary artery pressure values and other factors, including comorbidities.

The following should be considered in the risk assessment: interview findings (including functional class), arterial blood haemoglobin oxygen saturation (SaO₂), serum natriuretic peptide levels, echocardiographic assessment of ventricular and valvular function, pulmonary artery pressure and aortic dimensions, exercise capacity and the presence of arrhythmias [15].

The risk associated with a specific heart disease should be estimated based on the modified mWHO classification, although this probably performs better in populations in developed countries than in developing countries. According to this classification, heart diseases are classified into five classes (Table 2), which are associated with different risks of complications and need different management [14].

As the risk can vary over time, it should be reassessed at each pre-pregnancy visit.

Risk of obstetric and neonatal complications

Pregnant women with cardiac disease are at increased risk of obstetric complications, including preterm birth, pre-eclampsia and postpartum haemorrhage. Neonatal complications occur with a frequency of 18–30%, including a mortality rate of 1–4% [16]. Predictive factors for adverse maternal and neonatal events are shown in Table 3.

Table 1. Modified WHO (mWHO) classification of maternal cardiovascular complications

Factor	Class				
	mWHO I	mWHO II	mWHO II-III	mWHO III	mWHO IV
Risk	No appreciable increase in the risk of maternal death and at most a slight increase in the risk of other complications	A small increase in the risk of maternal death or a moderate increase in the risk of other complications	A moderate increase in the risk of maternal death or a moderate/major increase in the risk of other complications	A significant increase in the risk of maternal death or a high increase in the risk of other complications	An extremely high risk of maternal death or a high increase in the risk of other complications
Rate of cardiac events in the mother	2.5-5%	5.7-10.5%	10-19%	19-27%	40-100%
Counselling	Yes	Yes	Yes	Yes – expert advice required	Yes – pregnancy contraindicated ^b
Place of care during pregnancy and childbirth	Community hospital	Community hospital	Referral centre	Experienced obstetrics and cardiology centre	Experienced obstetrics and cardiology centre
Minimum number of visits during pregnancy	1-2	In each trimester	1 ×/2 mth	1 ×/1-2 mth	1 ×/mth

^aDiseases that belong to particular classes – previous text; ^bIn the event of a pregnancy, a possible termination should be discussed

Table 2. Classes of diagnosis according to the mWHO classification

	Class I according to mWHO	Class II according to mWHO	Class II-III according to mWHO	Class III according to mWHO	Class IV according to mWHO
Diagnosis (if the patient is otherwise in good health status and the course of the disease is uncomplicated)	Minor cardiac dysfunction(s):	Uncorrected ASD or VSD	Slight LV dysfunction (EF > 45%)	Moderate LV dysfunction (EF 30-45%)	Pulmonary arterial hypertension
	• pulmonary stenosis	Tetralogy of Fallot after corrective surgery	Hypertrophic cardiomyopathy	A history of PPCM without residual LV impairment	Severe systemic ventricular dysfunction (EF < 30% or NYHA class III-IV)
	• PDA	Mostly (supraventricular) arrhythmias	Defective native valve or biological prosthesis not classified as WHO class I or IV (minor MS, moderate AS)	Mechanical valve	A history of PPCM with any residual LV dysfunction
	• mitral valve leaflet prolapse. Simple defect after successful repair (ASD, VSD, PDA, anomalous pulmonary venous drainage)	Turner syndrome without aortic dilatation	Marfan syndrome or other HTAD without aortic dilatation	Systemic RV with good or slightly impaired function	Severe MS
	Atrial or ventricular single ectopic beats		Aorta < 45 mm in patients with bicuspid aortic valve	Fontan circulation if patient is otherwise in good health status and cardiac course is uncomplicated	Severe symptomatic AS
			Corrected aortic coarctation. AVSD	Uncorrected cyanotic heart defect	Systemic RV with moderate to severe dysfunction
				Other complex heart defect	Significant aortic dilatation (> 45 mm in Marfan syndrome or HTAD; > 50 mm in patients with bicuspid aortic valve, ASI > 25 mm/m ² in Turner syndrome, > 50 mm in tetralogy of Fallot)
				Moderate MS	Vascular form of Ehlers-Danlos syndrome
				Severe asymptomatic AS	Severe aortic (re)coarctation
				Moderate aortic dilatation (40-45 mm in Marfan syndrome or HTAD; 45-50 mm in patients with bicuspid aortic valve, ASI 20-25 mm/m ² in Turner syndrome, < 50 mm in tetralogy of Fallot)	Fontan circulation with any complications
			Ventricular tachycardia		

AS – aortic stenosis; ASD – atrial septal defect; ASI – aortic size index; AVSD – atrioventricular septal defect; EF – ejection fraction; HTAD – heritable thoracic aortic disease; LV – left ventricular; MS – mitral stenosis; NYHA – New York Heart Association; PDA – patent ductus arteriosus; PPCM – peripartum cardiomyopathy; RV – right ventricular; VSD – ventricular septal defect; WHO – World Health Organization

Table 3. Predictive factors of adverse maternal and neonatal events

Risk factors for cardiovascular events in the mother	Predictive factors of adverse neonatal events
1. past cardiac event (HF, transient cerebral ischaemia at-tack, stroke, arrhythmia)	1. NYHA class III/IV HF or cyanosis at the first visit during pregnancy
2. NYHA class III/IV HF	2. left heart obstruction in the mother
3. left heart obstruction of blood flow (moderate or severe)	3. smoking during pregnancy
4. impaired systemic ventricular systolic function (EF < 40%)	4. SaO ₂ in the mother < 90%
5. impaired subpulmonary ventricular function (TAPSE amplitude < 16 mm)	5. multiple pregnancy
6. systemic atrioventricular valve regurgitation (moderate or severe)	6. taking anticoagulants during pregnancy
7. subpulmonary atrioventricular valve regurgitation (moderate or severe)	7. taking cardiovascular drugs before pregnancy
8. PAH	8. cyanotic heart defect "at giving birth"
9. pharmacological treatment of heart disease before pregnancy	9. mechanical valve prosthesis
10. cyanosis (SaO ₂ < 90%)	10. maternal cardiac event during pregnancy
11. increased natriuretic peptide levels (NT-proBNP > 128 pg/mL at 20 weeks' gestation is a predictor of adverse events in later pregnancy)	11. worsening of maternal cardiac output during pregnancy
12. history of smoking	12. abnormal uteroplacental flow on Doppler examination
13. mechanical valve prosthesis	
14. corrected or uncorrected cyanotic heart defect	

EF – ejection fraction; HF – heart failure; NT-proBNP – N-terminal pro-B-type natriuretic peptide; NYHA – New York Heart Association; PAH – pulmonary arterial hypertension; TAPSE – tricuspid annular systolic displacement

Diagnosis of cardiovascular diseases in pregnancy

It is possible that some women will only be diagnosed with a cardiac condition during pregnancy. The physiological changes in the cardiovascular system that occur during pregnancy can sometimes cause symptoms that raise the suspicion of CVD (e.g., swelling), making it difficult to diagnose, for example, HF.

Diagnostic evaluation for CVD in pregnant women include:

1. medical interview and physical examination;
2. echocardiography – in case of inadequate or unexplained dyspnoea during pregnancy and/or a new pathological cardiac murmur (e.g. any diastolic murmur);
3. measurement of blood pressure using a validated device;
4. assessment of proteinuria, especially in the case of a personal or family history of hypertension or pre-eclampsia;
5. oximetry in women with congenital heart disease.

If there is an increased risk of fetal abnormalities, fetal echocardiography performed by an experienced specialist is recommended for any pregnant woman with unexplained or new cardiovascular signs and symptoms. If echocardiography is insufficient to establish a definitive diagnosis, a gadolinium-free cardiac magnetic resonance scan should be considered.

In addition, if required, the following can be done:

1. chest radiography;
2. cardiac catheterisation (only for very strict indications);
3. computed tomography (in selected women) and electrophysiological study (only for vital indications) [17].

Treatment and delivery recommendations [18]

- It is recommended that patients at high risk of complications be treated in referral centres where a multidisciplinary team of specialists is available.
- If cardiac surgery is necessary in a pregnant woman, it is advisable to administer a glucocorticosteroid to the pregnant woman between 24 and 37 week of pregnancy.
- In most cases, vaginal delivery is recommended.
- Induction of labour after the 40th completed week of pregnancy should be considered in all women with heart disease .
- In women with severe hypertension, natural labour with epidural anaesthesia should be considered.
- If the gestational age has exceeded 26 weeks, pregnancy termination should be considered before the necessary surgical intervention.
- Consideration may be given to coronary artery bypass grafting or valve surgery during pregnancy if

conservative management (including pharmacotherapy) has failed and if the mother's life is at risk or if percutaneous treatment is not available. Prophylactic antibiotic therapy during labour to prevent infective endocarditis is not recommended [18].

- In patients with severe cardiac dysfunction, full resuscitation and intensive care in the delivery room or operating theatre (intensive obstetric care room) must be provided.

These conditions include:

- anaesthetic care;
- possibility of monitoring: electrocardiogram monitoring, haemodynamic monitoring and pulse oximetry monitoring;
- full resuscitation care: drugs, intubation kit and mechanical ventilation kit, defibrillator, pacemaker and electrodes for transcutaneous and endocavitary stimulation.

Centres that are unable to provide the listed conditions of delivery should not provide obstetric care for pregnant women at risk of cardiac complications. The poor prognosis is usually related to the lack of adequate specialist care, the absence of a clear diagnosis and defined management principles. A well-prepared patient giving birth under intensive care is able to give birth successfully even with very advanced heart disease.

Conclusions

The provision of care for pregnant women with heart disease represents a major challenge in daily medical practice. When organising the management of such patients, a multidimensional approach to the problem – which involves close collaboration between the cardiology team and gynaecology team – is crucial. Despite the numerous publications, more studies are still needed to expand the knowledge of cardiac care for pregnant women. Data obtained from the Registries set up at the initiative of the ESC seem promising. These data are now the main source of knowledge for formulating recommendations on the topic of the provision of care to pregnant women with history of a cardiac disease.

Conflict of interest

None declared.

References

1. Grupa Robocza Europejskiego Towarzystwa Kardiologicznego. Wytyczne ESC dotyczące postępowania w chorobach układu sercowo-naczyniowego. *Kardiolog Pol.* 2019; 78(3): 245–326, doi: [10.5603/KP.2019.0049](https://doi.org/10.5603/KP.2019.0049).
2. Farr A, Lenz-Gebhart A, Einig S, et al. Outcomes and trends of peripartum maternal admission to the intensive care unit. *Wien Klin Wochenschr.* 2017; 129(17–18): 605–611, doi: [10.1007/s00508-016-1161-z](https://doi.org/10.1007/s00508-016-1161-z), indexed in Pubmed: [28101669](https://pubmed.ncbi.nlm.nih.gov/28101669/).
3. Elkayam U, Goland S, Pieper PG, et al. High-risk cardiac disease in pregnancy: part I. *J Am Coll Cardiol.* 2016; 68(4): 396–410, doi: [10.1016/j.jacc.2016.05.048](https://doi.org/10.1016/j.jacc.2016.05.048), indexed in Pubmed: [27443437](https://pubmed.ncbi.nlm.nih.gov/27443437/).
4. Khan KS, Wojdyla D, Say L, et al. WHO analysis of causes of maternal death: a systematic review. *Lancet.* 2006; 367(9516): 1066–1074, doi: [10.1016/S0140-6736\(06\)68397-9](https://doi.org/10.1016/S0140-6736(06)68397-9), indexed in Pubmed: [16581405](https://pubmed.ncbi.nlm.nih.gov/16581405/).
5. Swan L. Congenital heart disease in pregnancy. *Best Pract Res Clin Obstet Gynaecol.* 2014; 28(4): 495–506, doi: [10.1016/j.bpobgyn.2014.03.002](https://doi.org/10.1016/j.bpobgyn.2014.03.002), indexed in Pubmed: [24675221](https://pubmed.ncbi.nlm.nih.gov/24675221/).
6. Roos-Hesselink J, Baris L, Johnson M, et al. Pregnancy outcomes in women with cardiovascular disease: evolving trends over 10 years in the ESC Registry Of Pregnancy And Cardiac disease (ROPAC). *Eur Heart J.* 2019; 40(47): 3848–3855, doi: [10.1093/eurheartj/ehz136](https://doi.org/10.1093/eurheartj/ehz136), indexed in Pubmed: [30907409](https://pubmed.ncbi.nlm.nih.gov/30907409/).
7. Ramlakhan K, Tobler D, Greutmann M, et al. Pregnancy outcomes in women with aortic coarctation. *Heart.* 2020; 107(4): 290–298, doi: [10.1136/heartjnl-2020-317513](https://doi.org/10.1136/heartjnl-2020-317513), indexed in Pubmed: [33122301](https://pubmed.ncbi.nlm.nih.gov/33122301/).
8. Sliwa K, Baris L, Sinning C, et al. Pregnant women with uncorrected congenital heart disease: heart failure and mortality. *JACC Heart Fail.* 2020; 8(2): 100–110, doi: [10.1016/j.jchf.2019.09.001](https://doi.org/10.1016/j.jchf.2019.09.001), indexed in Pubmed: [31511192](https://pubmed.ncbi.nlm.nih.gov/31511192/).
9. Campens L, Baris L, Scott NS, et al. ROPAC investigators group. Pregnancy outcome in thoracic aortic disease data from the Registry Of Pregnancy And Cardiac disease. *Heart.* 2021; 107(21): 1704–1709, doi: [10.1136/heartjnl-2020-318183](https://doi.org/10.1136/heartjnl-2020-318183), indexed in Pubmed: [33468574](https://pubmed.ncbi.nlm.nih.gov/33468574/).
10. Roos-Hesselink J, Baris L, Johnson M, et al. Pregnancy outcomes in women with cardiovascular disease: evolving trends over 10 years in the ESC Registry Of Pregnancy And Cardiac disease (ROPAC). *Eur Heart J.* 2019; 40(47): 3848–3855, doi: [10.1093/eurheartj/ehz136](https://doi.org/10.1093/eurheartj/ehz136), indexed in Pubmed: [30907409](https://pubmed.ncbi.nlm.nih.gov/30907409/).
11. Sliwa K, Mebazaa A, Hilfiker-Kleiner D, et al. Clinical characteristics of patients from the worldwide registry on peripartum cardiomyopathy (PPCM): EURObservational Research Programme in conjunction with the Heart Failure Association of the European Society of Cardiology Study Group on PPCM. *Eur J Heart Fail.* 2017; 19(9): 1131–1141, doi: [10.1002/ehfj.780](https://doi.org/10.1002/ehfj.780), indexed in Pubmed: [28271625](https://pubmed.ncbi.nlm.nih.gov/28271625/).
12. Roos-Hesselink JW, Budts W, Walker F, et al. Organisation of care for pregnancy in patients with congenital heart disease. *Heart.* 2017; 103(23): 1854–1859, doi: [10.1136/heartjnl-2017-311758](https://doi.org/10.1136/heartjnl-2017-311758), indexed in Pubmed: [28739807](https://pubmed.ncbi.nlm.nih.gov/28739807/).
13. Kozyra-Pydyś EE, Pydyś Ł. Bezpieczeństwo diagnostyki kardiologicznej u kobiet w ciąży. *Folia Cardiologica.* 2016; 10(6): 450–456, doi: [10.5603/fc.2015.0085](https://doi.org/10.5603/fc.2015.0085).
14. Pijuan-Domènech A, Galian L, Goya M, et al. Cardiac complications during pregnancy are better predicted with the modified WHO risk score. *Int J Cardiol.* 2015; 195: 149–154, doi: [10.1016/j.ijcard.2015.05.076](https://doi.org/10.1016/j.ijcard.2015.05.076), indexed in Pubmed: [26043149](https://pubmed.ncbi.nlm.nih.gov/26043149/).
15. Drenthen W, Boersma E, Balci A, et al. ZAHARA Investigators. Predictors of pregnancy complications in women with congenital heart disease. *Eur Heart J.* 2010; 31(17): 2124–2132, doi: [10.1093/eurheartj/ehq200](https://doi.org/10.1093/eurheartj/ehq200), indexed in Pubmed: [20584777](https://pubmed.ncbi.nlm.nih.gov/20584777/).
16. Grewal J, Siu SC, d'Souza R, et al. Cardiac Disease in Pregnancy (CARPREG) Investigators. Prospective multicenter study of pre-

- gnancy outcomes in women with heart disease. *Circulation*. 2001; 104(5): 515–521, doi: [10.1161/hc3001.093437](https://doi.org/10.1161/hc3001.093437), indexed in Pubmed: [11479246](https://pubmed.ncbi.nlm.nih.gov/11479246/).
17. American College of Obstetricians and Gynecologists' Committee on Obstetric Practice. Committee opinion no. 656: guidelines for diagnostic imaging during pregnancy and lactation. *Obstet Gynecol*. 2016; 127(2): e75–e80, doi: [10.1097/AOG.0000000000001316](https://doi.org/10.1097/AOG.0000000000001316), indexed in Pubmed: [26942391](https://pubmed.ncbi.nlm.nih.gov/26942391/).
18. Cauldwell M, Steer P, Swan L, et al. The management of the third stage of labour in women with heart disease. *Heart*. 2016; 103(12): 945–951, doi: [10.1136/heartjnl-2016-310607](https://doi.org/10.1136/heartjnl-2016-310607), indexed in Pubmed: [27993911](https://pubmed.ncbi.nlm.nih.gov/27993911/).