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Review

Implications for anesthetic care in antenatal and postpartum care for pregnant women with cardiovascular conditions

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Abstract

Cardiovascular disease (CVD) has become an increasingly prevalent cause of maternal morbidity and mortality during pregnancy over the past decade. This trend emerges due to rising survival rates in patients with congenital heart disease, but also due to an increased prevalence of acquired conditions such as arterial hypertension. The physiological changes of pregnancy, such as the 40–50% increase in cardiac output and a reduction in systemic vascular resistance in particular, pose significant risks to women with impaired cardiac function. Effective management requires an interdisciplinary Pregnancy Heart Team (PHT), of which anaesthetists are an integral part. Preconception and antenatal anaesthetic assessments are crucial for planning labour analgesia or surgical deliveries, particularly in high-risk cases. The use of regional anaesthetic techniques is generally preferred, although general anaesthesia may be required in emergency situations or when neuraxial blocks are contraindicated. Specialist anaesthetists should be involved in caring for women at risk of acute decompensation or requiring advanced support. It is vital to carefully select anaesthetic agents, as drugs such as methylergometrine, oxytocine and carboprost can exacerbate cardiac stress. Postpartum monitoring is also crucial due to ongoing haemodynamic shifts. Incorporating anaesthesia expertise into coordinated, risk-stratified antenatal and postpartum care improves safety and outcomes for both mother and newborn.

Key words: **Cardiovascular diseases, Pregnancy, Pregnancy Heart team, Person-Centered Care, Cardio-obstetrics, Anesthetics.**

Introduction

The increasing prevalence of cardiovascular disease (CVD) in women poses a significant and growing challenge for healthcare systems worldwide. Cardiac related mortality is now recognised as one of the three leading causes of maternal death[1,2]. The increasing prevalence of CVD in pregnant women can be attributed to several factors. Advances in medical and surgical care have improved the survival rates of women with congenital heart disease (CHD), resulting in a growing population of these women reaching childbearing age[3,4]. Furthermore, the prevalence of acquired heart disease (AHD) is simultaneously increasing due to widespread risk factors such as obesity, diabetes mellitus, hypertension, and a sedentary lifestyle[4]. In addition, maternal health characteristics like increasing maternal age, multiparity and pre-existing hypertensive disorders contribute to an increased risk of cardiovascular complications during pregnancy[5]. Despite advances in understanding and management, 68% of cardiac related mortality cases have been estimated to be

preventable with the use of appropriate medical monitoring[6], highlighting an urgent need for a more pro-active management of CVD during pregnancy. Historically, women have been underrepresented in cardiovascular research and clinical trials, further leading to treatment disparities and a lack of awareness on sex-specific disease presentations and risk factors[7]. Although the term "women" will further be used in this narrative review to highlight research gaps and physiological differences, this high-risk population also includes individuals assigned female at birth but who do not identify as such[7].

CVD in women during covers a wide range of cardiovascular conditions, ranging from congenital, hereditary to acquired forms of heart disease[8,9]. Congenital heart disease (CHD) includes structural and/or functional abnormalities of the heart and/or great vessels present at birth, while hereditary heart disease (HHD) includes genetically transmitted conditions such as cardiomyopathies and arrhythmogenic disorders 8. Acquired heart disease (AHD) develops during life due to factors such as hypertension, ischaemic heart disease or cardiomyopathies[9]. Risk stratification is commonly performed using the modified World Health Organization (m-WHO) classification 2.0, which categorizes pregnant women with CVD according to the severity of their underlying cardiac condition and associated maternal risk(s)[10]. In addition, hypertensive disorders, including preeclampsia, are major contributors to pregnancy-related cardiovascular complications. According to the 2021 International Society for the Study of Hypertension in Pregnancy (ISSHP) definition, preeclampsia is no longer characterised by proteinuria alone but is defined as new-onset hypertension after 20 weeks' gestation accompanied by evidence of maternal organ dysfunction and/or foetal complications[11]. This expanded definition emphasises the importance of raising awareness of pre-eclampsia as a potential (additional) diagnosis and adds to its relevance in cardiovascular risk assessment during pregnancy and postpartum.

Haemodynamic changes during pregnancy induce significant cardiovascular adaptations supporting the metabolic demands of the developing fetus and maintaining maternal haemodynamic stability. Poor adjustments can therefore lead to adverse maternal and perinatal health outcomes such as foetal growth restriction, preeclampsia and foetal demise[12]. Cardiac output (CO) increases by 40-50%, starting from the first trimester of pregnancy, mainly due to a 20-30% increase in stroke volume (SV) and a 15-30% increase in heart rate (HR)[10]. A 10-15% reduction in serum colloid osmotic pressure during pregnancy additionally increases the risk of pulmonary oedema, particularly in those with impaired cardiac function13. At the same time, systemic vascular resistance (SVR) decreases by about 30%, facilitating optimal uteroplacental perfusion and nutrient delivery to the fetus13. Furthermore, failure to adequately adapt to these changes can lead to adverse maternal and perinatal outcomes, including heart failure, arrhythmias, aortic dissection, foetal growth restriction, preeclampsia and foetal demise[2,10,14]. An increased CO, combined with an absence of an SVR drop, is associated with left ventricular hypertrophy. This increases the risk of developing arterial hypertension and enhances myocardial contractility to meet circulatory demands[14]. As the CO can further increase by 25% during labour, these changes impose an additional intra- and postpartum risk of complications in women with pre-existing CVD[15]. These postpartum changes increase women's risk of developing cardiomyopathy, hypertension, arrhythmia, pulmonary oedema and hypertensive disorders[15].

Given these physiological demands, pregnant women with CVD thus require specialised, interdisciplinary care, involving cardiologists, obstetricians, anaesthetists, midwives, nurses, psychologists and other healthcare professionals, such as pharmacists, neonatologists, surgeons, pediatricians and social workers, to optimise outcomes. The Pregnancy Heart Team (PHT) model has emerged as best practice to ensure comprehensive, coordinated and personalised care. The rationale behind this approach is first and foremost the optimisation of risk stratification and management, allowing for the development of personalised care plans, timely implementation of medical interventions, monitoring strategies and birth planning[10]. Second, a collaborative care model can improve maternal and perinatal outcomes by facilitating real-time decision making, ensuring maternal stabilisation and reducing foetal complications such as intrauterine growth restriction and preterm birth[10]. Finally, women with CVD often experience increased psychological stress and anxiety throughout their pregnancy[16,17]. Integrating mental health professionals in the PHT ensures holistic care that addresses the emotional and psychosocial burden associated with high-risk pregnancies[16,17]. In line with these guidelines, the MBRRACE-UK 2024 report highlighted the need for improved interdisciplinary collaboration and emphasises that a significant proportion of maternal CVD-related deaths could be prevented through improved medical surveillance, integrated

psychosocial support and standardised care pathways[18].

Due to the complexity of managing CVD during pregnancy, this narrative review aims to provide an overview of the most effective current practices. The important role of anaesthetists as part of the PHT in risk assessment, monitoring, and therapeutic interventions will be emphasised. Additionally, emerging strategies to optimise maternal and foetal outcomes will be highlighted, including novel diagnostic tools and personalised treatment approaches. By addressing these issues, this narrative review aims to contribute to the evolving landscape of maternal cardiovascular health by advocating the adoption of the PHT model to improve care for this high-risk population.

Key interventions

The European Society of Cardiology (ESC)[10] and the American Heart Association (AHA)[19] guidelines have been instrumental in improving cardio-obstetric care. A cornerstone of these guidelines is the establishment of an interdisciplinary team approach, consisting of a dedicated cardio-obstetric PHT. This team should include cardiologists, obstetricians, anaesthetists, midwives, nurses, psychologists amongst other healthcare professionals to optimise both maternal and foetal outcomes[10]. The implementation of standardised clinical guidelines has played a pivotal role in improving risk stratification, therapeutic management, and long-term follow-up of women with CVD during the antenatal and postpartum period[12].

Anaesthetic management is a critical aspect of this care of pregnant women with CVD. Anaesthetists play a central role in preoperative assessment, intrapartum monitoring, analgesia planning, haemodynamic stabilisation and postpartum care. Their expertise in haemodynamic, pharmacological and airway management is essential to ensure a favourable maternal and foetal outcomes. Both the ESC and the AHA strongly advocate for early involvement of anaesthetists in antenatal planning as illustrated by their formal inclusion in a PHT[10, 20, 21].

Risk stratification

Preconceptional or antenatal care should include a risk assessment in these women as part of interdisciplinary meetings to assess the overall maternal and foetal risk during pregnancy and enable the team to anticipate this particular risk[10]. The ESC guidelines propose the use of the modified World Health Organisation (m-WHO) 2.0 classification for the management of CVD in pregnancy[22], as briefly represented in Table I. This classification stratifies women with CVD into five risk classes, from category 1 (low risk) to category 4 (very high risk)[22]. Category 1 patients include those with well-controlled CVD, such as atrioventricular nodal re-entry tachycardia (AVNRT) or small atrial septal defects (ASD) that have been surgically treated[10]. C Categories 2 and 3 represent patients at small to intermediate risk, while category 4 includes women at significantly increased risk[22]. Category 5 comprises women at extremely high risk of maternal and foetal morbidity and mortality[22]. This classification also provides information on the recommended frequency and setting of follow-up and delivery[22]. For example, women classified at high risk (categories 3 and 4) are recommended to be followed up in a tertiary referral centre with a specialised PHT[10].

Preconceptional evaluations

In order to address persisting gaps in care and reduce maternal and foetal morbidity and mortality, it is recommended that women with CVD receive patient education and preconceptional counselling[14]. The ESC[10] and AHA[19] guidelines emphasise the need to perform additional cardiovascular assessments to predict potential risks and outcomes during pregnancy. Preconceptional assessments should include an electrocardiography (ECG), blood tests, a transthoracic echocardiography and cardiopulmonary exercise testing (CPET)[10,19], with CPET having a predictive value of >80% for complications during pregnancy in women with CVD. Additionally, depending on the CVD type, coronary angiography, right heart catheterisation, endomyocardial biopsy, Cardiovascular Magnetic Resonance (CMR) or Computed Tomography (CT), arterial oxygen saturation, holter monitoring and detailed genetic screening could be considered[10,19].

Furthermore, risk stratification models, as described above, should be applied to every woman at the preconceptional stage to estimate the risk related to morbidity and mortality. Shared decision making finally remains an integral part of preconceptional care, empowering women to make their own informed, reproductive choices[19].

Early referral for anaesthetic assessment is strongly recommended. In cases of actual or anticipated cardiovascular decompensation, the involvement of cardiac anaesthetists may be warranted, particularly in patients who may require peripartum cardiothoracic surgery or mechanical circulatory support such as extracorporeal membrane oxygenation (ECMO)[20] or in women with conditions like Marfan syndrome or dural

Table I. — Modified World Health Organisation (mWHO)classification of maternal cardiovascular risk.

Class	Diagnosis	Maternal cardiac event rate	Recommended location of care during pregnancy	Recommended location of delivery
mWHO I	CHD/structural diseases: - Small or mild lesions - Successfully repaired simple lesions Arrythmias: - Atrial or ventricular ectopic beats, isolated Aortopathies: - Non-HTAD mild aortic dilatation (<40 mm) Genetic diseases: - HCM: genotype positive + phenotype negative	3.1–9.9%	Local Hospital	Local Hospital
mWHO II	CHD/structural diseases: - Unoperated atrial or ventricular septal defect - Repaired ToF - TGA (arterial switch, no significant residuals) Arrhythmias: - Bradycardia with pacemaker - Most supraventricular arrhythmias Genetic diseases: - Turner syndrome without cardiovascular involvement (e.g., no BAV, coarctation, hypertension, or aortic dilatation)	7.7–21.7%	Local hospital	Local hospital
mWHO II–III	CHD/structural diseases: - HCM without complications - Repaired AV septal defect (no significant residuals) - Uncomplicated Ebstein anomaly (mild–moderate TR, no stenosis/accessory pathway) - Repaired coarctation Valvular disease: - Mild mitral or moderate AS (not high risk) - Moderate valvular regurgitation Aortopathies: - Marfan/HTAD without aortic dilatation - BAV with aortic diameter <45 mm Cardiac dysfunction: - Mild LV impairment (EF >45%) - Significantly impaired subpulmonary RV function - DCM/NDLVC with EF >45% Arrhythmias: - LQTS (no events, on beta-blockers) - Well-controlled CPVT - Brugada syndrome (no events) - Low-risk ARVC (genotype-positive, mild/no phenotype)	12.8–17.7%	Shared care with local hospital + Pregnancy Heart Team	Shared care with local hospital + Pregnancy Heart Team. Location depends on CV status and evolution of pregnancy

Legend: m-WHO = modified World Health Organisation classification; CHD = Congenital Heart Disease; HCM: Hypertrophic Cardiomyopathy; HTAD = heritable thoracic aortic disease; ToF = Tetralogy of Fallot; TGA = Transposition of the Great Arteries; BAV = Bicuspid Aortic Valve; AV = Atrioventricular; TR = Tricuspid Regurgitation; AS = Aortic stenosis; LV = Left Ventricle; EF = ejection fraction; RV = Right Ventricle; DCM = Dilated cardiomyopathy; NDLVC = Non-dilated left ventricular cardiomyopathy; LQTS = Long QT-syndrome; CPVT = Catecholaminergic polymorphic ventricular tachycardia; ARVC = Arrhythmogenic right ventricular cardiomyopathy; PPCM = Postpartum cardiomyopathy; SCAD = Spontaneous Coronary Artery Dissection; STEMI = ST-segment Elevation Myocardial Infarction; NSTE-ACS = Non-ST-Segment Elevation Acute Coronary Syndrome; PAH = Pulmonary Arterial Hypertension; NYHA = New York Heart Association. Table developed based on the ESC Guidelines, 2025 10.

Table I. — Modified World Health Organisation (mWHO)classification of maternal cardiovascular risk - continued.

mWHO III	• CHD/structural diseases: - Unrepaired cyanotic heart disease (not Eisenmenger) - Ebstein anomaly with complications • Valvular disease: - Mechanical valve - Moderate mitral stenosis - Severe asymptomatic AS - Severe left-sided regurgitation • Aortopathies: - Marfan with previous aortic root replacement - Prior aortic dissection with stable diameter - Moderate aortic dilatation (based on syndrome-specific thresholds) • Cardiac dysfunction: - LV impairment (EF 30–45%) - DCM/NDLVC with EF 30–45% - Previous PPCM with mild residual dysfunction - Systemic RV with good/mild dysfunction - Uncomplicated Fontan with good function and no major issues • Arrhythmias: - Sustained ventricular tachycardia - LQT2 (postpartum) - Symptomatic or poorly controlled LQTS/CPVT - Brugada syndrome with previous events - Moderate/severe ARVC - HCM with arrhythmias or moderate haemodynamic compromise • Other conditions: - History of SCAD - Previous ischaemic events (STEMI/NSTE-ACS) - Prior adverse pregnancy outcomes requiring hospitalisation - Prior cardiovascular toxicity from cancer therapy	21.1-28.9%	Care led by Pregnancy Heart Team	Expert centre, care led by Pregnancy Heart Team
mWHO IV	• CHD/structural diseases: - Fontan circulation with any complication - Eisenmenger syndrome • PAH • Valvular disease: - Severe mitral stenosis - Severe symptomatic AS • Aortopathy: - Severe aortic dilatation (thresholds vary by condition) - Prior aortic dissection with increasing aortic diameter - Vascular Ehlers-Danlos syndrome • Severe cardiac dysfunction: - LV EF <30% or NYHA class III–IV (including DCM/NDLVC and PPCM) - HCM with severe LV dysfunction (EF <50%) or symptomatic obstruction (≥50 mmHg) - Systemic RV with moderate/severe dysfunction • Other conditions: - Severe (re)coarctation of the aorta	35.6–50.3%	Care led by Pregnancy Heart Team	Expert centre, care led by Pregnancy Heart Team

ectasia[10]. Meng et al. (2023) outlined specific indications for the involvement of a specialist cardiac anaesthetist, which are summarised in Table II[20]. A comprehensive pre-anaesthetic assessment should include a detailed cardiovascular history, review of relevant investigations (e.g., ECG, echocardiography, cardiopulmonary exercise testing), assessment of functional capacity, airway assessment and identification of any contraindications to neuraxial anaesthesia (e.g., anticoagulation, coagulopathy, spinal abnormalities)[20,21]. Optimisation of comorbidities such as pulmonary oedema or arrhythmias is essential, particularly given its impact on coronary perfusion[20]. The anaesthetic plan and perioperative risk reduction strategies should be discussed in advance with the Pregnancy Heart Team[20,21].

Antenatal care

During pregnancy, continuous specialist care for women with CVD is paramount[10,19]. A dedicated PHT, consisting of cardiologists, obstetricians, anaesthetists, midwives, nurses, psychologists and other healthcare professionals, should meet regularly to provide individualised care[10,19]. These interdisciplinary meetings are essential to monitor the women's condition and ensure timely interventions. The frequency of these meetings needs to be tailored to the women's risk category, as defined by the m-WHO classification 2.0 (cfr. Table I)[10,19].

In the third trimester, a birth plan should be developed, bearing in mind the couple's birth preferences[20]. The birth plan outlines the place of delivery, the preferred time of delivery, the need for induction, the preferred mode of delivery, the need for epidural, spinal or combined epidural-spinal anaesthesia and the requirement for prior consultation with the anaesthesia outpatient clinic[20]. It also addresses the potential need for a prolonged stay and cardiological assessment at the maternity ward[10]. A list of medications to avoid during labour and after delivery should be determined (see section 2.6 on delivery and postpartum monitoring).

In addition, foetal echocardiography is increasingly recognised as an essential component of antenatal care, especially for women with CVD[23,24] as it allows cardiologists to monitor the foetal health throughout pregnancy and screen for potential complications[24]. It is important to note that foetal echocardiography is not only used in cases of genetically inherited CVD, as previous research shows that each infant from women with any pre-existing CVD has a 2.09-fold higher risk of developing CVD[23]. Furthermore, if the biological father has CVD, the child's risk is also elevated, albeit to a lesser extent (by a factor of 1.49)[23]. Early identification through foetal echocardiography enables healthcare providers and parents to prepare for the possibility of the newborn requiring specialised cardiac or neonatal care at birth[24].

Remote monitoring

The advent of remote monitoring technologies provides an opportunity for better management of CVD during pregnancy. In particular, remote telemonitoring of blood pressure has emerged as a valuable tool for the detection and management

Table II. — Factors requiring the consultation of a cardiac anesthetist.

Disease related factors
Patients in mWHO class IV
And/or: PASP >50 mm Hg, pulmonary hypertension with right heart failure, pulmonary hypertension with significant cyanosis with or without RV failure
And/or: Any unstable cardio-obstetrics patient (e.g., dissecting major vessel)
And/or: Presence of major cardiovascular support device (e.g., LVAD, RVAD, ECMO)
Anticipated challenges for neuraxial analgesia
Women at risk of dural ectasia (i.e. Marfan syndrome)
Factors related to obstetric management
Heart failure + preeclampsia
Factors associated with anticipated monitoring or procedures
Titration of inotropes
Need for echocardiography/pulmonary pressure monitoring
Maternal decompensation requiring general anaesthesia
Cardiothoracic surgeon or ECMO on standby
Need for combined delivery and cardiac procedure

Legend: m-WHO = modified World Health Organisation classification; PASP = pulmonary arterial systolic pressure; RV= right ventricular; LVAD = left ventricular assist device; RVAD = right ventricular assist device; ECMO = extracorporeal membrane oxygenation. Table developed based on the work of Meng et al. (2023)[20].

of arterial hypertension during pregnancy[25,26]. Women with pre-existing CVD are at increased risk of developing hypertensive disorders, including preeclampsia. Early diagnosis of preeclampsia and optimal management of arterial hypertension in pregnancy are essential to reduce the risk of preterm birth, long-term maternal health complications and foetal mortality[6]. Research shows that telemonitoring programs, which allow pregnant women to self-monitor their blood pressure and heart rate at home and send the data to healthcare providers, improve early detection of hypertensive complications and help reduce hospital admissions[27]. Mobile applications and remote patient monitoring systems integrated with electronic health records allow for real-time risk stratification and timely intervention, leading to improved maternal and foetal outcomes[28]. In addition, telemonitoring has been associated with reduced healthcare costs as the need for face-to-face consultations and hospital admissions decreased[29].

In terms of anaesthetic follow-up, telemonitoring could be useful for tracking blood pressure trends and planning monitoring during childbirth and the immediate postpartum period. Furthermore, this monitoring method enables patients to be discharged safely from hospital, as it facilitates close monitoring during the high-risk transition period, when cardiac complications, including high blood pressure, may arise[15].

In addition to clinical benefits, telemonitoring increases patient satisfaction by promoting self-efficacy, reducing stress associated with frequent hospital visits, and improves access to specialist care, as demonstrated in a sample of women with gestational diabetes mellitus[30]. Monitoring blood pressure at home can provide continuity of care and encourage adherence to treatment plans, since healthcare providers are available to check in with patients regularly. Furthermore, it enables patients to easily contact their healthcare provider with any concerns or questions they may have.

Psychosocial wellbeing

Pregnancy in women with CVD can have a significant psychosocial impact[16,31], however this interaction goes in both directions as psychosocial vulnerabilities could also play a role in the development of psychosocial complications[16,31]. Prior qualitative studies have highlighted experiences of anxiety (including existential fear of death) and uncertainty about for example genetic inheritance of congenital heart disease, medication safety and the upcoming birth process[16,31]. While these qualitative findings are valuable, there currently remains a lack of quantitative assessments of the psychosocial impact of pregnancy in women with CVD. In addition, research suggests that financial constraints, residency status and systemic health inequalities can limit access to appropriate cardiovascular and obstetric care[18]. However, additional research on how these inequalities affect cardio-obstetric outcomes and care is required. Furthermore, substance use - including tobacco, alcohol and illicit drugs - has a well-documented negative impact on cardiovascular health and pregnancy outcomes[32]. Women with CVD who use substances are at increased risk of arrhythmias, exacerbation of heart failure and adverse foetal outcomes[32]. Despite this, substance use remains an under-recognised issue in the management of pregnant women with CVD.

Given the growing body of evidence linking stress and mental health to adverse cardiovascular outcomes, the Lancet Commission on Inequalities and Disparities in Cardiovascular Health highlights the role of psychological distress in worsening disease progression and limiting access to optimal care[33]. Women who experience significant stress or mental health problems are at increased risk of developing cardiovascular complications and may receive suboptimal care[33]. Understanding the psychological burden of pregnancy in this high-risk group is crucial to encourage health professionals to implement early screening strategies and integrate psychological support into pregnancy and postpartum care[16,31]. Every healthcare provider who is part of the PHT should address this issue by assessing women's psychosocial well-being across the perinatal and postpartum period. This could be achieved by asking women how they are feeling and whether they are receiving adequate social support. Furthermore, future research should focus on identifying the most relevant patient-reported outcomes (PROs) for this patient group. This will help address the issue and improve person-centered care.

Delivery and postpartum monitoring

Delivery

Regarding the timing of delivery, it is known that induction of labour at 39–40 weeks can reduce the likelihood of an emergency caesarean section by 12% and of stillbirth by 50% in women without CVD[34]. The benefits could be even greater for women with CVD[34]. Any maternal benefit of early term delivery (from 37 weeks 0 days through to 38 weeks 6 days of gestation) should be weighed against the increased likelihood of adverse foetal outcomes and thus early delivery should only be performed for obstetric reasons in women with CVD[10,35].

Induction of labour combined with postpartum monitoring must be considered when medically required, particularly in hypertensive patients or those on anticoagulation (e.g., low-molecular-weight heparin or warfarin), where timing is critical to minimise the risk of bleeding[10,21]. Several methods are considered safe for labour induction, including mechanical methods, misoprostol (PGE1), dinoprostone (PGE2), oxytocin, and artificial rupture of membranes[36], however, high-dose misoprostol (600 mg) has a theoretical risk of coronary vasospasm and arrhythmias[37]. An extra 2 IU of oxytocin during the third stage of labour is safe in women with CVD and reduces blood loss[38]. For high-risk women (m-WHO 2.0 classes III–IV), oxytocin is the first-line uterotonic, with misoprostol and carboprost as second-line options[39]. Uterotonic agents such as bolus oxytocin, methylergonovine and carboprost tromethamine, presented in Table III, should be avoided in patients with pulmonary hypertension or left ventricular dysfunction because of their vasoconstrictive effects[20]. If membranes are ruptured, labour should be immediately augmented to minimise infection risk and reduce the need for repeated vaginal exams.

Furthermore, effective analgesia is crucial for women with CVD during labour, as it alleviates physical stress[10,21]. Neuraxial techniques, such as the epidural, spinal and combined spinal-epidural approaches, are highly effective. Epidural analgesia takes around 15 minutes to take effect, which allows for gradual titration. This is particularly important for women taking therapeutic low-molecular-weight heparin (LMWH) or who are at risk of haemodynamic instability[21]. Spinal and combined techniques act faster, taking around five minutes, but carry a higher risk of hypotension and foetal heart rate abnormalities[40]. Single-shot spinal analgesia is commonly used for caesarean sections due to its simplicity and reliability effectiveness[41]. Low-concentration, high-volume local anaesthetic–opioid mixtures can be administered via an epidural catheter, enabling conversion to caesarean anaesthesia without the need for general anaesthesia and avoiding these risks[10,21]. General anaesthesia should be avoided where possible due to the risk of myocardial depression, arrhythmia, and haemodynamic instability[21,40]. However, it may be required in emergencies or when neuraxial techniques are contraindicated[21,40]. In such cases, IV opioids like remifentanil can also be used, despite the risks of hypoventilation and apnoea[40].

The choice of mode of delivery is critical in the management of pregnant women with CVD[10]. The ESC guidelines generally recommend (planned) vaginal delivery, except in specific high-risk scenarios such as severe aortic pathology (e.g. aortic dilatation >45 mm), severe aortic stenosis, severe left ventricle outflow tract obstruction, hypertrophic cardiomyopathy or anticoagulant use (which should be stopped 24h prior to delivery)[10]. Vaginal delivery is associated with less blood loss and lower risk of infections and venous thromboembolism[10], and planned cesarean section (CS) does not improve maternal outcomes and

Table III. — Obstetric medications and considerations for women with CVD classified as high risk for complications during peripartum and/or postpartum period.

Medication	Indication	Practical considerations	Reason
Methylergonovine	Postpartum hemorrhage	Avoid, if possible, with: - Chronic hypertension - Preeclampsia - Aortopathies - Ischemic heart disease	Causes vasoconstriction leading to hypertension and myocardial ischemia
Terbutaline	Premature labor, prolonged or frequent uterine contractions	Extreme caution, contraindicated	Causes hypertension and tachycardia (1% to 10%)
Carboprost tromethamine	Postpartum uterine bleeding or pregnancy termination	Avoid in women with: - Vascular disease or aortic aneurysms - Pulmonary hypertension - Significant shunt lesions	Causes hypertension
Oxytocin	Labor augmentation Prevention of postpartum hemorrhage	Preferable used as diluted solution in a continuous IV infusion Avoid bolus in complex CVD when possible	Causes a decrease in peripheral vascular resistance -> hypotension Large bolus can cause sudden decrease afterload and reflex tachycardia Rare reports of ischemia

Legend: CVD = cardiovascular disease; IV = intravenous.Table developed based on the work of Davis et al. (2021) (40).

may be even related to adverse foetal outcomes[10]. Vaginal delivery with neuraxial analgesia is preferred in haemodynamically stable patients as it attenuates the sympathetic response to pain and allows rapid conversion to surgical anaesthesia if urgent intervention is required[10,20].

The birth plan should also include a review of medications that may pose risks during labour[20]. Next to the uterotonic medications discussed earlier, specific cardiovascular medications, such as beta-blockers and vasodilators, may alter the physiological response to anaesthesia and must be discussed in peripartum planning[20].

Furthermore, during labour, tachycardia, hypotension, and hypoxia should be avoided as these can reduce coronary perfusion and exacerbate myocardial ischemia[21]. Close haemodynamic monitoring (continuous ECG) is essential in this phase, and high-risk patients may require invasive monitoring (e.g., arterial line and minimally invasive Cardiac Output [CO] monitoring) during labour and delivery[10,21]. In the event of cardiac arrest, anaesthetists play a key role in airway management and contribute to the decision-making about perimortem caesarean section, which should be performed within 4-5 minutes of maternal arrest if indicated[42].

Delivery

The early postpartum period presents an increased risk of decompensation due to rapid fluid shifts, autotransfusion from uterine contractions, and increased susceptibility to arrhythmias, hypertension, heart failure (HF), or stroke[20,21]. Management should be individualised based on underlying CVD, arrhythmia risk, and pregnancy course. Anaesthetists should remain actively involved for the first 24-72 hours postpartum to guide fluid management, haemodynamic monitoring and analgesia[20,21]. Women at high risk of HF may require intensive monitoring for 24–48 hours. Analgesic strategies should avoid the use of agents with adverse haemodynamic effects, such as NSAIDs in women with preeclampsia or left ventricular dysfunction[20,21]. Emergency preparedness should be discussed in high-risk cases, including planning for reoperation or cardiopulmonary resuscitation[20]. Early ambulation is recommended to reduce thromboembolism risk.

Conclusion

CVD is one of the main leading causes of maternal mortality, highlighting the importance of up-to-date and effective management of CVD during pregnancy. To prevent complications, a comprehensive, interdisciplinary approach is essential to optimise maternal and foetal health outcomes. As emphasised in both European and American guidelines, a dedicated cardio-obstetric PHT, including the involvement of cardiologists, obstetricians, anaesthetists, midwives, nurses, psychologists and other healthcare professionals, is essential to provide personalised care for women with CVD during pregnancy and the postpartum. Early risk stratification using the m-WHO classification 2.0, combined with preconceptional assessment and ongoing monitoring throughout pregnancy and the postpartum, will ensure that women with CVD receive optimal management, thereby reducing adverse maternal and foetal health outcomes. In addition, the development of a personalised birth plan and postpartum monitoring are critical in reducing long-term cardiovascular risks.

Despite the progress made in the field of cardio-obstetrics, there is still a need for additional research. Emerging practices such as the use of remote telemonitoring of blood pressure and integration of psychosocial support further enhance the ability to work towards both personalised care and a more effective management of CVD during pregnancies. Given the increasing burden of CVD in pregnancy, integrating telemonitoring into routine obstetric and cardiovascular care is a promising strategy to optimise maternal perinatal health outcomes. However, further research is needed to refine implementation strategies, evaluate long-term effectiveness, and address these accessibility challenges. Moreover, the psychosocial impact of pregnancy in women with CVD is in particular a under-researched area. By prioritising personalised care, expanding educational and research initiatives, and strengthening collaborative care teams, we can continue to improve outcomes for both mothers and their offspring and ultimately reduce maternal morbidity and mortality in this vulnerable population.

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