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Review paper

Recommendation of the Polish Prenatal Cardiology Society on the Regulation of the Polish Ministry of Health concerning competencies in fetal echocardiography (code 013) and fetal cardiology (code 021)

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Abstract

The Polish Ministry of Health officially introduced a new list of 57 medical competencies in 2023. The list includes two new competencies: prenatal echocardiography (013) and prenatal cardiology (021). Therefore, the Polish Prenatal Cardiology Society presents the following consensus on differentiation between these competencies and screening fetal heart scan.

Kew words: consensus, recommendations, medical proficiency, medical competency fetal echocardiography, fetal cardiology, prenatal cardiology.

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Introduction

In 2023, the Polish Ministry of Health officially introduced a new list of 57 medical competencies [1]. The list includes two new competencies: prenatal echocardiography (013) and prenatal cardiology (021). Therefore, the Polish Prenatal Cardiology Society presents the following consensus on differentiation between these competencies and screening fetal heart scan.

Fetal echocardiography is at least as complex as neonatal, paediatric, or adult echocardiography due to the high number of diagnostic points concerning the morphology and function assessed in still and motion images.

Fetal echocardiography is also more time-consuming in comparison to postnatal scans because of the complexity in spatial and multi-planar analysis using several different ultrasound imaging modalities. Among them, B-mode, M-mode, colour, spectral and power Doppler, and others are applied. Due to technical limitations and fetal positioning, it is not possible to check all the fetal heart structures using all available methods and tools during a single session of echocardiographic analysis. All these competencies should be included in fetal echocardiography proficiency (013), which could lead to detection of congenital heart malformations and diseases. Thus, fetal cardiology requires knowledge and skills that are not covered by any contemporary medical specialty. In order to provide comprehensive information and detailed feedback on optimal perinatal care of the fetal congenital heart disease (CHD) the diagnosis needs to include input from various specialists such as maternal-fetal medicine (MFM) geneticists, neonatologists, paediatric cardiologists, cardiac surgeons, and sometimes palliative care specialists. All these competencies will be supplemented by a fetal cardiologist (021) who should give additional input on perinatal care after diagnosis of congenital heart malformations and diseases. Patient counselling regarding the fetal prognosis is critical to ensuring optimal pregnancy decision-making [2].

Based on the papers that have been published since 2001 by the international and Polish societies [2-29], we hereby present our current recommendations for the following:

1) screening heart scan,
2) fetal echocardiography proficiency to prove normal heart anatomy and function or to detect an abnormality (competency code 013,)
3) fetal cardiology proficiency to perform exam, monitor, and consult regarding the fetus with congenital heart problems (competency code 021).

Screening heart scan is a part of the fetal scan performed by obstetricians according to recommendation by Polish Society of Gynaecologists and Obstetricians (Figure 1) [3].

Fetal echocardiography competency (013)

Step 1: Medical history of the pregnant woman, blood pressure, height, and weight measurements

Before we start an echocardiographic examination of the fetal heart, an interview with the pregnant patient should be performed regarding her health status before the conception and after. For instance, previous pregnancy complications, the occurrence of congenital defects and genetic diseases in the family, fertility problems, medications used before and during pregnancy, the patient's body mass index (BMI) before pregnancy, weight gain during pregnancy, presence of any chronic, metabolic, hormonal, or infectious diseases during the periconceptional period. To make it easier for both sides we may use a standardised questionnaire which the pregnant woman answers in the waiting area in printed form. Before

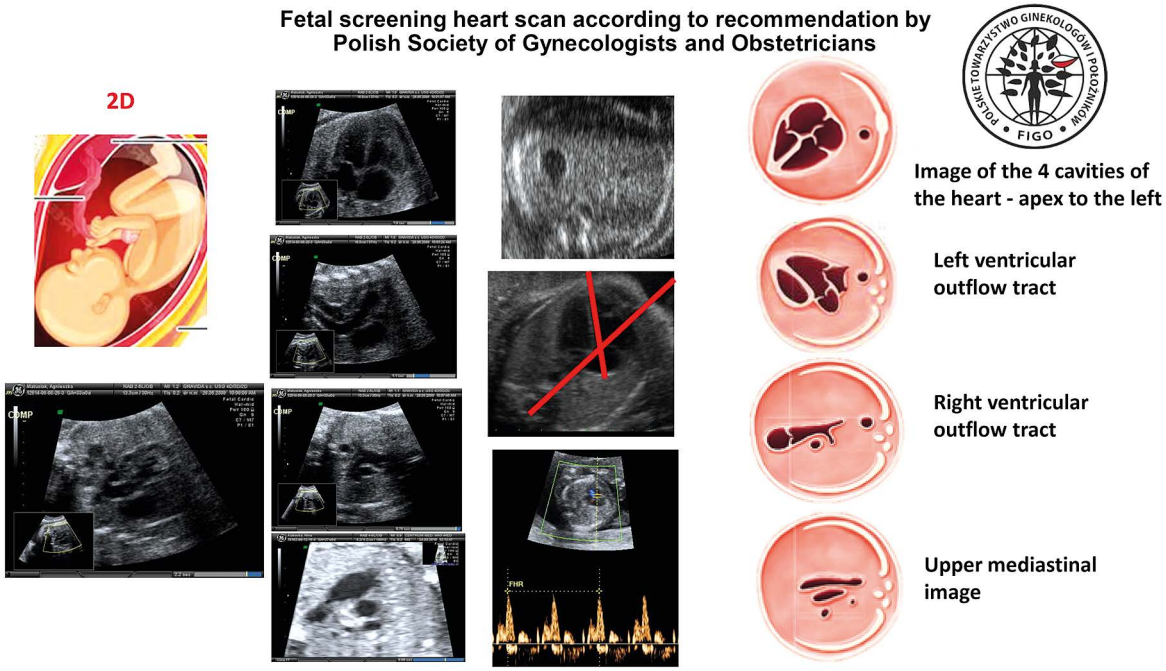

Figure 1. Fetal screening heart scan according to recommendation by Polish Society of Gynecologists and Obstetricians

we start the scan the nurse prepares the ultrasound machine: warming gel, entering the patient's data, including date of last menstrual period, height and weight, and blood pressure data as well as the name of the sonographer.

We start with a basic physical examination: checking the patients' pulse, uterine tension, and the legs to rule out oedema. Patient may follow our exam on a large screen on the Echo LAB wall or on the celling. Cellular phones in the echo lab should be used in silent mode because regular ringtones may interfere with fetus behaviour and may disturb difficult examination proceedings.

Step 2: The obstetrical part of the examination is documented in a digital database in the form of images [3, 17]

The fetal ultrasound exam starts with the prenatal obstetric part of the examination, which includes the following:

1) assessment of the position of the placenta and maternal body are marked on the screen, measurement of the placenta thickness (in cm), assessment of echogenicity of the placenta and placental vascularisation with colour Doppler, localisation of the placental umbilical cord attachment;
2) assessment of the amniotic fluid index (AFI) in singleton pregnancy (sum of 4 pocket measurements), or maximal vertical pocket (MVP) in twins;
3) assessment of fetal position with its body mark on the screen;
4) fetal routine biometry to assess fetal weight (biparietal diameter – BPD, head circumference – HC, abdominal circumference – AC, femur length – FL);
4) peripheral blood flow assessment with Doppler in the umbilical vein and artery, middle cerebral artery, and ductus venosus;
5) assessment of fetal basic anatomy including gender.

Step 3: Fetal echocardiography examination should cover all parts documented in digital form by pictures or cine loops (Figure 2)

1. Localisation of the stomach, aorta, and inferior vena cava in the abdomen. Are they in the usual position? (Picture)
2. Localisation of the heart and position of the heart apex in relation to the stomach. Is the correlation normal? (Picture cine loop)
3. The segmental transition from the stomach level up to the chest level and mediastinum in 2D mode (Cine loop).
4. Assessment of the fetal heart size. Transverse and longitudinal dimensions, heart area/chest area ratio (HA/CA), or heart circumference/chest circumference ratio (HC/CC). (Picture)
5. Fetal heart axis measurement. (Picture)
6. Four-chamber view analysis: atria, foramen ovale size, atrioventricular valves, level of their attachments, cross of the heart, size of the ventricles, wall structure, position of the trabecular bands, vetriculo-arterial connections (Picture cine loop).
7. Three-vessel analysis: their size, alignment, thymus transversal measurements. (Picture)
8. Colour and spectral Doppler analysis of the blood flow across valves. We should prove no aliasing is noticed in the heart area. Cine loops of colour Doppler should be saved. Each valve should be analysed – we suggest this order: tricuspid, mitral, aortic, and pulmonary valve (Picture cine loop).
9. Longitudinal views of the inferior vena cava and superior vena cava (they should be the same size), as well as ductus arteriosus arch and aortic arch: in 2D, in colour Doppler, and in spectral Doppler. (Picture)

Fetal echocardiography can be performed as early as week 13, but an optimal time to perform a comprehensive transabdominal echocardiographic examination of the fetus is 18-22

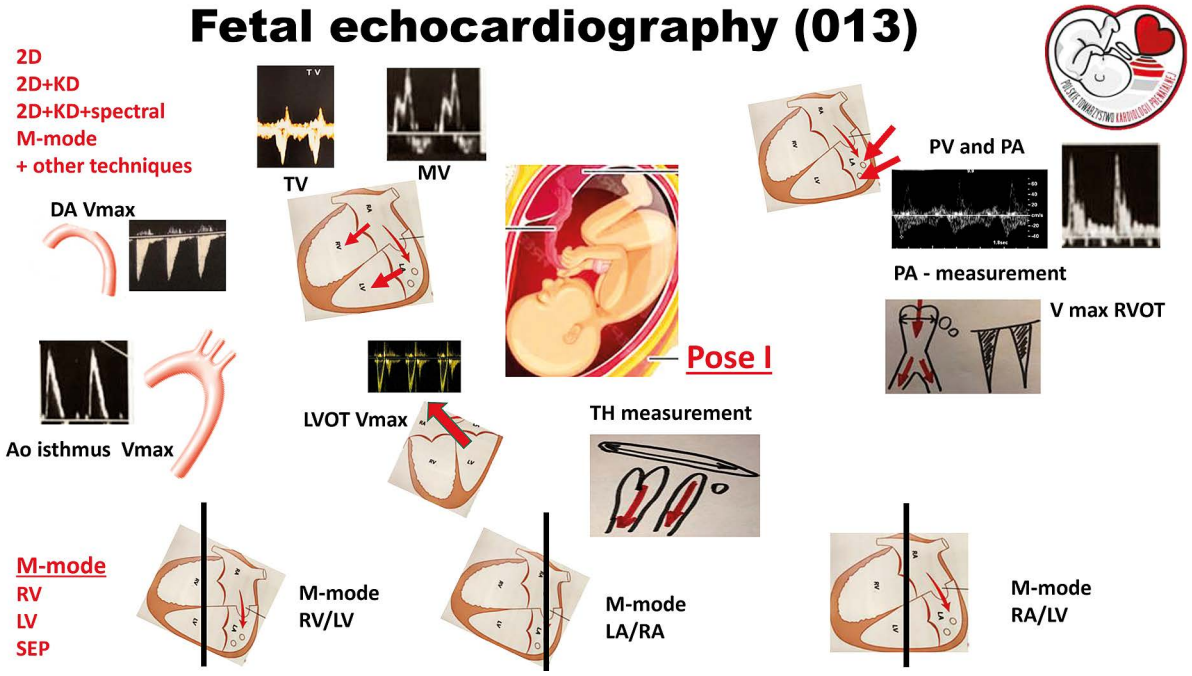

Figure 2. Fetal echocardiography (code 013)

weeks. The recommended examination time for a single fetus to confirm normal heart anatomy and normal heart study is about 20-30 min, and another 15-20 min should be reserved to prepare a written report and discuss the results with the patient. It is our responsibility to perform a complete examination, make digital documentation, and create a statement in a written report about the limitations (due to maternal condition, fetal position, ultrasound machine limitations, etc.). During the study it is important to reduce any noise in the echo lab and pay special attention to fetal heart sound.

In the case of normal heart size, normal intracardiac blood flows, and normal fetus biometry and anatomy at this stage, no additional measurements are necessary. As the Polish Prenatal Cardiology Society, we also recommend third-trimester fetal echocardiography to confirm normal heart anatomy and normal function of the fetal heart [22-24].

Fetal cardiology competency (021)

In case of confirmation of any abnormality during basic fetal heart echocardiography (code 013) such as: congenital heart disease, cardiomegaly, hypertrophy, fetal heart arrhythmia, turbulence of blood flow within the fetal heart, disproportion at the atria or level of ventricles, big vessel abnormality, asymmetry of valves, or another indication to perform an extended fetal echocardiography, the patient should be referred to a fetal cardiology certified (code 021) specialist. This type of fetal heart examination is the most difficult because it usually concerns difficult and complex problems (Figure 3).

The modalities of different heart malformations are extremely wide, and different correlations between heart structures seem to have no limit. The fetal cardiologist has to understand the complexities of diagnosis and management of CHD throughout the continuum from fetal to postnatal life. In the 2D part of exam all possible measurements are taken and expressed in millimetres and in Z-scores.

In a colour Doppler blood flow exam different colour maps are used with different filters. For instance, we use different colour maps to study intracardiac and pulmonary vein blood flow.

In spectral Doppler blood flow assessment not only pulse Doppler is used, but also continuous Doppler for assessment of turbulent blood flow.

In spectral Doppler it is obligatory to obtain a good tracing of mitral, aortic, tricuspid, and pulmonary blood flows for myocardial performance index (MPI) for right ventricle (RV) and MPI for left ventricle (LV) assessment. It is recommended that the PR interval be obtained for instance from pulmonary vein and pulmonary artery tracing (it is recommended that zoom and high speed are used to avoid mistakes during calculations).

M-mode technique is necessary for evaluation of the RV and LV shortening fraction, septum thickness, and type of tracing (flat, contractions with RV or contractions with LV)

M-mode technique for RA and LA for evaluation contractility of RA and LA walls, for evaluation of foramen ovale valve movement, including its amplitude M-mode technique for RA and LV in case of fetal arrhythmia. M-mode technique for TAPSE/MAPSE (tricuspid/mitral annular plane systolic excursion) and calculation of MPI [30].

In case of suspicion of any segmental wall contractions abnormality it is recommended to use tissue elasticity (TDI) and segment interaction (SI, FS-right and left 24-segmental evaluation). In cases of imminent cardiac insufficiency, it is recommended that CO (cardiac output)/CCO (combined cardiac output) be analysed [31].

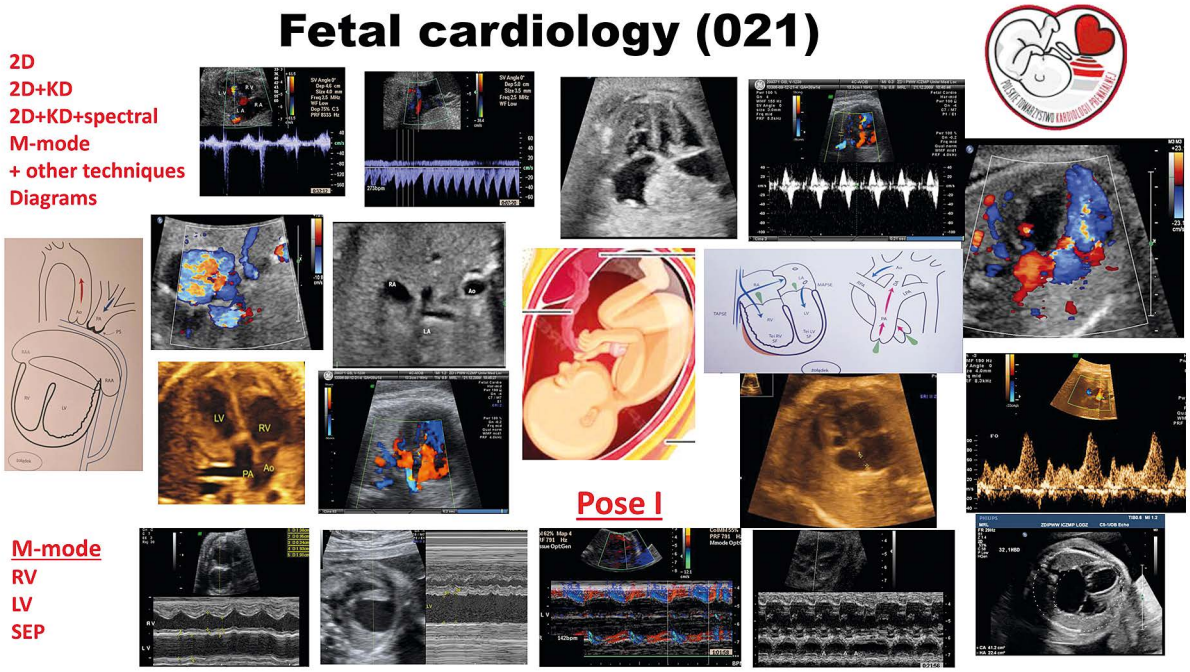

Figure 3. Fetal cardiology (code 021)

Table 1. Recommendations of the Polish Prenatal Cardiology Society for obstetrical part of the fetal echocardiography (013) and fetal cardiology (021) competency

Obstetrical part		
	Fetal echocardiography (013)	**Fetal cardiology (021)**
Placenta + maternal pictogram	• Localisation of the placenta • Width • Placental vascularity • Abnormal mass in the placenta?	• Localisation of the placenta • Width, length • Placental vascularity power angio3D cine • Umbilical cord attachment to the placenta
AFI	+	+
Position of the fetus + fetal pictogram	+	+
EFW/ percentiles	• BPD, HC, AC, FL • SGA? • AGA? • LGA?	• BPD, HC, AC, FL, HL • Cerebellum, stomach, bladder, kidneys, feet, pancreas, spleen, ear, etc.
Umbilical cord	• 3 vessels or 2 vessels • Around the neck? • Fetus attachment • Doppler blood flow	• 3 vessels or 2 vessels • Around the neck? • Fetus attachment • Doppler blood flow • Knot?
MCA Doppler	• V_{max}, PI	
DV	• Present? • Normal flow?	• V_{max}, PI, absent?
Fetal anatomy		
Head	• Cranium • Head shape • CSP • Choroid plexus • Midline falx	• Cranium • Head shape • CSP • Choroid plexus • Midline falx • Thalami • Lateral cerebral ventricles • Cerebellum, cisterna magna
Face	• Profile	• 2D + 3D + 4D • Orbits and bulbi • Midsagittal facial profile • Nasal bone • Upper lip + amniotic fluid flow: nose and mouth?
Neck	• Nuchal fold	• Nuchal fold • Any masses (eg. cystic hygroma) • Nuchal cord: single/double/triple
Chest	• Chest and lungs echogenicity • Diaphragm	• Chest and lungs shape/size • Diaphragm • Pulmonary vasculature
Abdomen	• Stomach position	• Stomach – position on which side and its length • Bowel • Gallbladder on right side? • Both kidneys (length measurements) • Urinary bladder length • Cord insertion site – fetal abdomen
Skeletal	• Spine (transverse and sagittal views) • Arms and hands • Legs and feet	• Spine (transverse and sagittal views) • Arms and hands • Legs and feet • Muscles tensions, legs and feet movements
Genitalia	• Male or female	• Male or female genitalia or "x"? in 2D and in 3D

AFI – amniotic fluid index, EFW – estimated fetal weight, BPD – biparietal diameter, HC – head circumference, AC – abdominal circumference, FL – femur length, SGA – small for gestational age, AGA – adequate for gestational age, LGA – large for gestational age, HL – humerus length, V_{max} – maximum velocity, PI – pulsatility index, MCA – middle cerebral artery, DV – ductus venosus, CSP – cavum septi pellucidi.

Table 2. Recommendations of the Polish Prenatal Cardiology Society for echocardiographic part of fetal echocardiography (013) and fetal cardiology (021) competency

Echocardiography part of fetal US exam			Freezed frame or cine
	Fetal echocardiography (013) (High risk pregnancy, suspected of fetal heart pathology)	Fetal cardiology (021) (Confirmed CHD or pathology)	
Stomach/apex localisation	• 2 freeze frames	• Localisation of the apex of the heart/stomach/performance of sweep technique	+ +
4- chamber view RVOT/LVOT	• 2D • 2D + colour Doppler	• 2D + colour Doppler • 2D + colour Doppler + spectral Doppler • Tricuspid valve, mitral valve • Pulmonary valve, aortic valve	+ + + +
Mediastinum	• 3V	• 3V • 3VTV • Thymus evaluation and measurements	+ + +
Long axis Aortic arch Ductal arch	• 2D • 2D + colour Doppler	• 2D • 2D + colour Doppler • 2D + color Doppler + spectral Doppler	+ + + +
Pulmonary veins	• 2D + colour Doppler	• 2D • 2D + colour Doppler • 2D + colour Doppler + spectral Doppler	+ + +
M-mode	• RV/LV • RA/LV • RA/LA	• RV/LV • RA/LV • RA/LA	+ + +
Other		• TAPSE • MAPSE	+ +
Additional non obligatory techniques*		• Tissue Doppler • STICK	+
		Speckle tracking: • SV • Endo-GLS • EF • FAC • SI, FS – right and left 24-segment	 + + + + +
		CO/CCO: cross-sectional area of the semilunar valve-pulsed-wave Doppler of the aortic and pulmonary valves (3.14 × valve radius2) × VTI × FHR/normal values (225–626 ml/min/kg)	+
Number of transducers	Usually 1-2 (convex, volume)	Three (convex, volume, cardiac)	
Dedicated time for US + Echo	30 min	60 min	
Dedicated time for written report	15 min	30 min	
Dedicated time for counselling	15 min	30 min	

CHD – congenital heart disease, RVOT – right ventricular outflow tract, LVOT – left ventricular outflow tract, RV – right ventricle, LV – left ventricle, RA – right atrium, LA – left atrium, TAPSE – tricuspid annular plane systolic excursion, MAPSE – mitral annular plane systolic excursion, STICK – spatio-temporal image, SV – stroke volume, endo-GLS – endocardium global strain, EF – ejection fraction, FAC – fractional area change, CO – cardiac output, CCO – combined cardiac output, VTI – velocity time integral, FHR – fetal heart rate.

Table 3. Medical counselling after fetal echocardiography (013) and after fetal cardiology study (021)

Counselling after fetal echocardiography (013)	Counselling after prenatal cardiology (021)
• Normal heart anatomy and normal heart function confirmed – no need to change the perinatal care and management • Normal heart anatomy and function heart anomalies – suggested additional echo exam or prenatal cardiology counselling • Detection of anomaly – prenatal cardiology counselling	• Confirmation of functional anomaly, fetal echo monitoring • Confirmation of structural anomaly, fetal echo monitoring • Confirmation of fetal heart arrhythmia: – Fetal echo monitoring or – Transplacental treatment or – Suggestion for delivery • Counselling for pregnant woman on short-term prognosis and long-term prognosis • Counselling for obstetrician regarding the optimal way of delivery • Any indications for transplacental fetal treatment? • Any indications for direct fetal treatment? for instance valvuloplasty or shunt? • Any indications for emergency cardiac procedures on the 1st of postnatal life? • Any indications for prostaglandin or emergency cardiac surgery? or delayed surgery or non-urgent postnatal care?

It is recommended, but not obligatory, to use STICK technique in cases of congenital heart defect.

It is recommended not to focus just on the single transducer but to use at least 2 or 3 ultrasound transducers (convex, volume, but also cardiology transducers) and different sets of software during the extended fetal echocardiography.

Discussion

In cases of confirmed fetal heart defect or arrhythmia, echocardiography performed by a fetal cardiologist should be repeated according to the possibility of defect evolution, based on the gestational age at the time of diagnosis, fetal and maternal condition, and planned time and mode of delivery. Extended fetal echocardiography in the third trimester should be performed to predict postnatal management in cases in which it is possible. The patient and her family in most cases can get ready for early cardiac surgery (up to 7-10 days after birth), planned neonatal surgery (in the first month of life), or non-urgent surgery in the first year of life according to the echocardiography result [32].

The recommended examination time for a single fetus with CHD, fetal heart arrhythmia, or congestive heart failure is about 60 min. The next 30 min should be spent on preparing a written report along with heart sketches (Figure 3). The additional time of 30 min is spent in a consulting room (with no computer, no desk, no ultrasound machine, but with comfortable furniture and nice surroundings to explain the examination's results to the patient and discuss the results with the pregnant woman and her family member).

Additional leaflets explaining specific fetal heart problem and presenting any possibilities to solve the problem, together with prenatal and postnatal management, are usually also very helpful. We recommend the use of graphic drawings of the fetal heart to explain not only fetal heart anatomy, but also fetal intracardiac blood flows and any abnormalities in the anatomy of the fetal heart. Some examples are presented in Figure 3.

Nowadays, in the case of, for instance, suspected foramen ovale restriction or ductus arteriosus contraction, we may have 5-8 subsequent echocardiographic scans before delivery. We recommend making a copy of the conclusions from each exam or making a short summary of the findings from the prenatal period and make a copy of the statement from maternal hospital record to the neonatal history record with the most important images or cine-loops. It is crucial not to overload our colleagues from the perinatology team with too many data and calculations that are difficult to read and understand for those who do not perform fetal echocardiographic scans.

In the case of a planned early cardiac intervention (for instance, balloon valvuloplasty) or early cardiac surgery (for instance, in single heart tumour), medical care should be planned in cooperation with a perinatologist, neonatologist, paediatric cardiologist, and cardiac surgeon.

Summary

Our recommendation for screening heart scan, fetal echocardiography, and fetal cardiology are summarised in Tables 1-3 and Figures 1-3.

Fetal echocardiography, fetal cardiology, optimal perinatal care, and the progress in paediatric cardiology and cardiac surgery allow a change in the natural history of many cardiac defects [33-40]. Prenatal cardiology is important for monitoring fetal well-being in the number of conditions, including fetal growth restriction and other pathologies [41-43]. As a new part of perinatal medicine, fetal cardiology is developing very rapidly. This is due to new ultrasound technology and dedicated scientific centres all over the world, and also their new organising possibilities. Therefore, prenatal cardiology has allowed a change in the definition of critical heart disease in the newborn and has become one of the most important tools in fetal diagnosis and assessment of fetal well-being [44, 45]. We believe that the new Regulation of the Polish Ministry of Health on medical competencies, especially code 021, is the answer to the following question raised in the international letter published in 2022: Is it time to establish a separate independent medical subspeciality? [46].

Conflict of interest

The authors declare no conflict of interest.

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