

STATUS REPORT: THE GROWING ROLE OF FETAL CMR

Transforming prenatal cardiovascular care through innovation and collaboration

The field of fetal CMR is experiencing significant growth, driven by advancements in technology and an increasing number of healthcare institutions adopting specialized devices. As of 2024, the number of institutions equipped with *smart-sync*, the Doppler-Ultrasound fetal CMR gating technology, has risen to 90, highlighting its expanding role in prenatal diagnostics (Figure 1). Recent studies have further solidified fetal CMR as an important tool in the understanding and management of CHDs¹⁻³.

Fetal CMR offers key advantages over traditional ultrasound, such as overcoming poor acoustic windows and reducing operator dependency. This allows for comprehensive assessments of cardiac volumes, flow dynamics, and extracardiac anomalies, significantly improving both prenatal and postnatal management of CHDs¹⁻³. Advancements in tech-

nology, such as 4D-flow MRI and 3D volume reconstructions, have greatly enhanced diagnostic accuracy for these defects⁴⁻⁶. For example, Friesen et al. demonstrated the utility of these methods in diagnosing coarctation of the aorta (CoA)⁴, while Englund et al. emphasized the reliability of 4D-flow MRI for analyzing third-trimester hemodynamics⁵. Additionally, Barough et al. advanced myocardial health assessment using Doppler ultrasound gating and feature tracking⁷.

The clinical integration of fetal CMR continues to grow, as highlighted in reviews by Cundari et al. and Suchá et al., which underline its increasing use as a second-line imaging modality for CHDs^{2,3}. These studies confirm that fetal CMR provides diagnostic insights that ultrasound alone cannot achieve. With its rising adoption and ongoing technological progress, fetal CMR is transitioning from research to clinical practice, firmly establishing its role in prenatal cardiovascular care.

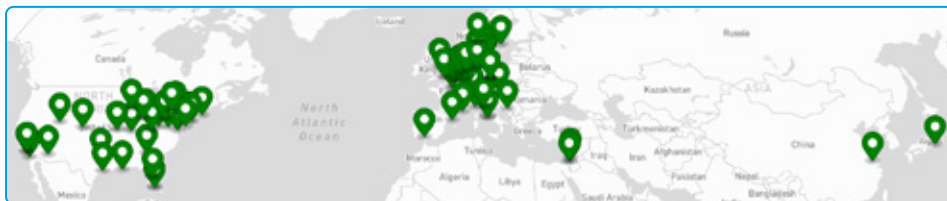


Figure 1: Worldwide distribution of hospitals performing fetal CMR with *smart-sync*.

Customer Feedback: Current Trends and Applications

To gain insights into the status and clinical applications of fetal CMR, we gathered extensive feedback from active users. Key findings include:

- **Clinical Applications:** A majority of centers (60%) now integrate fetal CMR into both research and clinical workflows. Clinical-only use is reported by 20% of centers, while the remaining 20% focus solely on research.
- **Frequency of Use:** Usage varies significantly. High-frequency centers (1–4 scans per week) represent 35%, followed by medium-frequency users (18%, every 2–4 weeks), low-frequency users (26%, every few months), and very low-frequency users (21%, no or minimal scans).
- **Diagnostic Applications:** *smart-sync* technology is recommended for diverse diagnostic purposes, particularly:
 - Malformations of great vessels, such as CoA and aortic arch anomalies.

- Hypoplastic left heart syndrome (HLHS).
- Assessment of extracardiac structures.
- Functional analysis, including heart function, blood flow, and dynamic imaging.

Encouragingly, 47% of users reported a direct impact of fetal CMR on diagnostics or treatment, while another 47% anticipate future impact. Only 6% reported no observed impact, emphasizing strong confidence in the technology's potential.

Addressing Imaging Challenges

Achieving consistently high image quality remains a critical barrier to broader adoption. Customer feedback (Figure 2) indicates that suboptimal imaging often limits the performance and utility of fetal cardiac scans. To address this, we prioritized educational efforts in the past year.

Under the leadership of MRI application specialist Domenico Gullà, these initiatives included on-site visits to optimize imaging protocols and tailor sequences to individual scanner setups. Additionally, we developed a vendor-independent guidance document

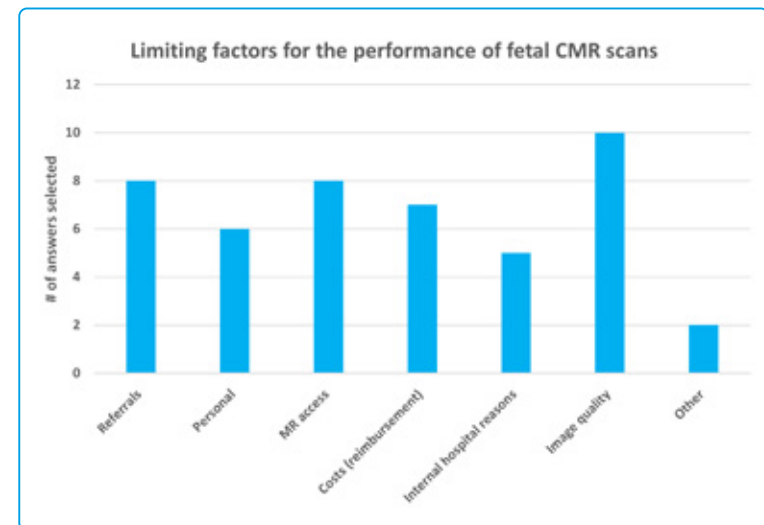


Figure 2: Customer feedback highlights key factors limiting the performance of fetal CMR scans.

(Figure 3) to help standardize protocols and improve image quality. We have made a wealth of training materials available for our customers at www.northh.de.

These efforts have boosted examination frequency and enhanced the clinical utility of fetal CMR. However, challenges remain, particularly in improving motion compensation techniques and identifying optimal imaging strategies for specific CHDs. Continued collaboration and innovation are essential to overcome these obstacles and make technology universally accessible.

Future Prospects

Despite existing challenges, the outlook for fetal CMR is overwhelmingly positive. Based on customer feedback, 80% expressed confidence that fetal CMR will play a significant role in the future, while the remaining 20% showed cautious optimism. Not a single customer doubted its potential impact.

This optimism highlights the transformative potential of fetal CMR in prenatal

care. Through continued innovation, education, and collaboration, we are poised to make this technology an indispensable tool in diagnosing and managing congenital heart conditions.

REFERENCES

- 1 Vollbrecht et al., "Fetal Cardiac MRI Using Doppler US Gating: Emerging Technology and Clinical Implications", Radiology: Cardiothoracic Imaging, 2024
- 2 Cundari et al., "The New Frontiers of Fetal Imaging: MRI Insights into Cardiovascular and Thoracic Structures", Journal of Clinical Medicine, 2024
- 3 Suchá et al., "Fetal Cardiovascular Magnetic Resonance: History, Current Status, and Future Directions", Journal of Magnetic Resonance Imaging, 2024
- 4 Friesen et al., "Predictive Capability of Fetal 4D Flow and Black Blood Slice to Volume Reconstruction for Prenatal Diagnosis of Coarctation of the Aorta", Journal of Cardiovascular Magnetic Resonance, 2024
- 5 Englund et al., "Reliability of 4D Flow MRI for Investigation of Fetal Cardiovascular Hemodynamics in the Third Trimester", Radiology: Cardiothoracic Imaging, 2024
- 6 Hergert et al., "A Comparative Study of Fetal Cardiovascular Assessment", Cardiovascular Imaging, 2024
- 7 Barough et al., "Myocardial Strain Assessment in the Human Fetus by Cardiac MRI Using Doppler Ultrasound Gating and Feature Tracking", European Radiology, 2024

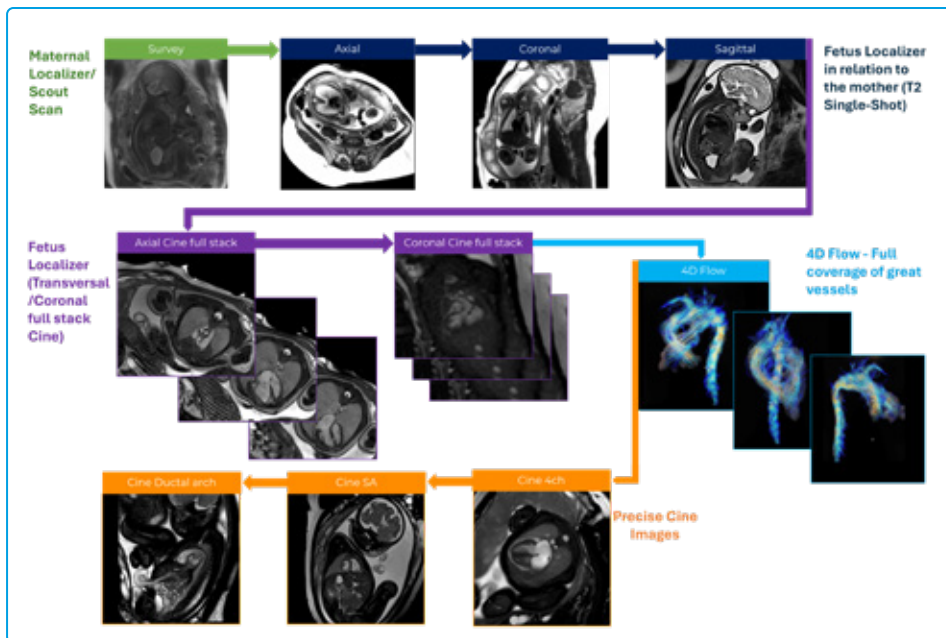


Figure 3: Step-by-step guidance for fetal CMR—How to plan sequences?