SPECIAL REPORT

Improving the Accuracy and Efficiency of Women's Health Ultrasound and the Role of Artificial Intelligence Technology

Published by Global Business Media

Published by Global Business Media

Global Business Media Limited
62 The Street Ashtead Surrey KT21 1AT
United Kingdom

Switchboard: +44 (0)1737 850 939
Fax: +44 (0)1737 851 952
Email: info@globalbusinessmedia.org
Website: www.globalbusinessmedia.org

Publisher
Kevin Bell

Business Development Director
Marie-Anne Brooks

Editor
Dr. Jonathan D. Agnew, PhD, MBA

Senior Project Manager
Steve Banks

Advertising Executives
Michael McCarthy
Abigail Coombes

Production Manager
Paul Davies

For further information visit:
www.globalbusinessmedia.org

Contents

Foreword

Healthcare providers face mounting challenges in women's health, from rising rates of chronic conditions to increasingly complex pregnancies requiring sophisticated diagnostic and therapeutic approaches. The integration of artificial intelligence into medical imaging, particularly ultrasound technology, represents a transformative advancement that promises to address these challenges while improving diagnostic accuracy and patient outcomes. For both healthcare systems managing resource constraints and practitioners seeking to optimize clinical workflows, implementing innovative approaches to enhance diagnostic capabilities and streamline care delivery has become an increasingly pressing priority.

Through a series of evidence-based articles and expert perspectives, this report explores the revolutionary impact of AI-enhanced ultrasound technology in women's healthcare. The collection begins with an examination of how artificial intelligence is transforming ultrasound imaging, particularly in improving image quality, reducing operator dependency, and enhancing diagnostic accuracy. This is followed by an insightful interview with Dr. Alan Fishman on modernizing ultrasound reporting through AI integration. The third article delves into quality and precision in gynecological ultrasound imaging, highlighting how modern systems incorporating AI and adaptive technologies have significantly improved detection rates while reducing the need for repeat examinations. Dr. Elena Sinkovskaya then provides a comprehensive analysis of AI innovations in fetal neurosonography, focusing on advanced volume techniques for improved maternal and fetal outcomes. This is followed by Dr. Ilan Timor's expert insights into the evolution of gynecologic ultrasound and AI integration. The sixth article, authored by Dr. Martin Chavez and Dr. Julia Kim, examines the progression of AI applications in fetal heart assessment, demonstrating how automation is transforming fetal cardiac diagnostics. The seventh article explores modern solutions for complex obstetric care, examining how patient-centered approaches supported by AI and rapid diagnostics are transforming care delivery in high-risk pregnancies. The final article provides a forward-looking perspective on emerging technologies and their implications for future practice.

Together, these articles and expert perspectives demonstrate how technological innovation is reshaping women's healthcare delivery. From enhanced imaging capabilities and workflow optimization to improved accessibility and cost-effectiveness, AI-powered ultrasound platforms are addressing longstanding challenges in healthcare delivery while expanding access to high-quality diagnostic services. As these technologies continue to evolve – exemplified by systems incorporating sophisticated deep learning algorithms – we will likely witness further improvements in diagnostic accuracy, clinical workflow efficiency, and ultimately, patient outcomes.

Dr. Jonathan D. Agnew
Editor

***Jonathan D. Agnew** PhD, MBA, is a medical writer and Adjunct Professor in the Faculty of Medicine at the University of British Columbia. He holds a PhD in health services research from the University of California, Berkeley, an MBA with distinction from the University of London, and an AB (hons.) in community health from Brown University.*

IMPROVING THE ACCURACY AND EFFICIENCY OF WOMEN'S HEALTH ULTRASOUND AND THE ROLE OF ARTIFICIAL INTELLIGENCE TECHNOLOGY

Advancing Women's Health Through AI-Enhanced Ultrasound Technology

***Jonathan D. Agnew,** PhD, MBA, Adjunct Professor, Faculty of Medicine, University of British Columbia*

Artificial intelligence is revolutionizing ultrasound imaging technology, particularly in women's health applications, where traditional systems have faced limitations in image quality and interpretation consistency. AI-powered platforms incorporate sophisticated deep learning algorithms that automatically optimize image acquisition parameters, reduce operator dependency, and enhance diagnostic accuracy. These advancements, exemplified by systems like the Samsung Z20, are transforming healthcare delivery through improved accessibility, workflow efficiency, and resource utilization, while demonstrating promising cost-effectiveness in clinical settings.

The Evolution of Ultrasound Imaging

The field of medical imaging has witnessed remarkable transformations since the introduction of ultrasound technology in the 1950s. Today, artificial intelligence (AI) is revolutionizing this essential diagnostic tool, particularly in women's health applications, where precise imaging and interpretation are crucial for optimal patient care.

Traditional Ultrasound Limitations and Challenges

Conventional ultrasound technology, while groundbreaking in its time, has faced several significant limitations that impact diagnostic accuracy and workflow efficiency. Image quality has historically been operator-dependent, with variation in interpretation between different clinicians.[1] Traditional systems often struggle with image artifacts, poor tissue contrast in challenging patients, and limited ability to detect subtle anatomical variations. Additionally, the manual adjustment of numerous imaging parameters requires substantial expertise and time, potentially leading to operator fatigue and reduced diagnostic accuracy over long scanning sessions.[2]

AI-powered Platforms

The integration of AI into ultrasound systems represents a paradigm shift in diagnostic imaging. Modern AI-powered platforms incorporate machine learning algorithms that can automatically optimize image acquisition parameters, reduce noise, and enhance tissue differentiation. These systems utilize vast databases of previously analyzed images to improve real-time image processing and assist in pattern recognition.[3] Research indicates that AI-enhanced systems can reduce scanning time by up to 30% while maintaining or improving diagnostic accuracy.[4]

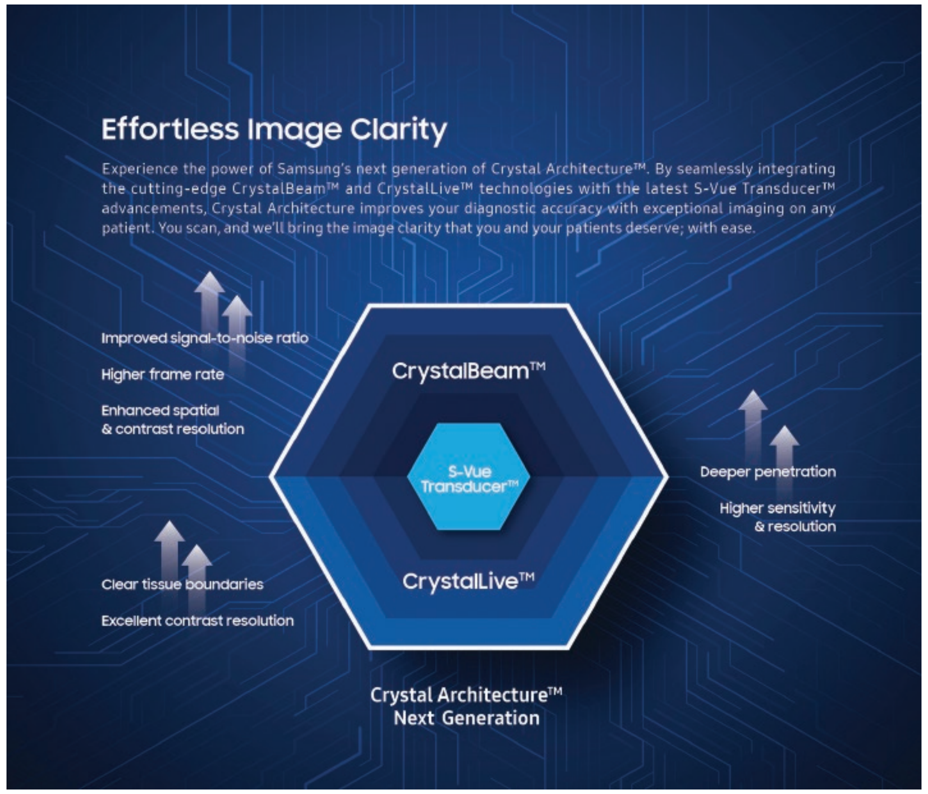
Case Study: Samsung's Z20 Capabilities and Features

The Z20 platform exemplifies the latest advances in AI-enhanced ultrasound technology. This system integrates several cutting-edge features that address historical limitations of traditional ultrasound imaging. The platform's Crystal Architecture™ provides enhanced image clarity through advanced beamforming technology and improved signal processing. Its AI-powered image optimization automatically adjusts over 2000 imaging parameters in real-time, significantly reducing operator dependency and improving consistency across examinations.[5]

Enhanced Imaging Capabilities

The integration of AI into ultrasound systems has dramatically enhanced imaging capabilities, enabling unprecedented levels of detail and diagnostic accuracy. These advancements are particularly significant in women's health applications, where subtle anatomical distinctions can have crucial clinical implications.
Deep Learning Algorithms in Image Processing
Deep learning algorithms have revolutionized ultrasound image processing, offering significant improvements in image quality and clinical workflow. Convolutional neural networks (CNNs) have been particularly effective in enhancing ultrasound imaging.[6,7] These networks can perform tasks such as noise reduction, artifact elimination, and feature detection, leading to improved signal-to-noise ratios and spatial resolution.[8,9] CNNs have demonstrated superior performance in speckle reduction compared to traditional methods while preserving anatomical details.[9-11] Furthermore, deep

Research indicates that AI-enhanced systems can reduce scanning time by up to 30% while maintaining or improving diagnostic accuracy



AI success driven by next-generation architecture

Recent advances in high-resolution ultrasound imaging have significantly improved spatial resolution and tissue penetration. Crystal matrix transducers and adaptive beamforming techniques have enabled visualization of structures as small as 0.3mm

learning approaches have shown promise in super-resolution ultrasound imaging, potentially enabling real-time visualization of microvascular networks.[12] These advancements in AI-powered ultrasound imaging are poised to enhance diagnostic accuracy, optimize clinical workflows, and ultimately improve patient care.[6,8]

High-Resolution Imaging Technologies

Recent advances in high-resolution ultrasound imaging have significantly improved spatial resolution and tissue penetration. Crystal matrix transducers and adaptive beamforming techniques have enabled visualization of structures as small as 0.3mm.[13,14] Innovations in transducer materials, digital signal processing, and beamforming algorithms have enhanced image quality and dynamic range.[15,16] High-frequency (30-40 MHz) miniaturized micro-arrays and specialized beamformers have been developed for minimally invasive surgeries and ophthalmologic applications.[14,17] Advanced techniques like harmonic motion imaging and adaptive beamforming by deep learning have further improved lateral resolution and tissue characterization capabilities.[18,19] These developments have expanded the potential applications of ultrasound imaging, including atherosclerotic plaque analysis, tumor margin detection, and three-dimensional cellular imaging.[18,20]

Advanced 3D/4D Workflow Innovations

Recent advancements in AI have significantly improved 3D/4D ultrasound imaging workflows, enhancing clinical practicality and accessibility. AI-driven innovations include automated volume acquisition, optimization, and smart volume algorithms that reduce operator dependence while ensuring consistent, high-quality datasets.[21,22] These technologies enable real-time 4D imaging with enhanced rendering, facilitating more accurate diagnoses and improved patient communication.[23] AI-powered ultrasound systems can provide instantaneous image quality control, aid in acquiring optimal images, and improve clinical workflow.6 Studies have shown that AI implementations can reduce scanning time while improving diagnostic confidence.[24] Furthermore, AI applications in radiology extend beyond image analysis to workflow optimization, quality and safety improvements, and operational efficiency enhancements.[25,26] These innovations are transforming medical imaging practices, although challenges in standardization and data sharing persist.[27]

Accessibility and Workflow Optimization

The implementation of AI-enhanced ultrasound technology extends beyond improved image quality to address critical aspects of healthcare delivery, including accessibility, workflow efficiency, and resource utilization. These advancements are particularly significant in addressing healthcare disparities and optimizing clinical operations.

Remote Access Capabilities and Implications

Remote access ultrasound technologies improve healthcare delivery to rural and underserved areas through telerobotic systems that enable remote examinations.[28,29] Studies confirm teleultrasound's effectiveness in remote communities and prehospital care.[30,31] Drone delivery and satellite/cellular systems have expanded this reach,[32,33] showing particular promise in obstetric care for low-resource settings.[34] Tele-guidance systems also allow untrained clinicians to perform scans under remote expert supervision in military healthcare settings.[35]

Streamlined Workflow Integration

Modern AI-enhanced ultrasound platforms incorporate workflow optimization features that integrate into clinical processes, automating protocol selection and integrating with electronic health records.[36,37] AI algorithms improve radiology workflow, from order entry to image interpretation,[38] while computerized management systems reduce waiting times and staff stress.[39] Standards-based interoperability facilitates AI integration across systems.[40] Implementation has increased point-of-care ultrasound utilization, improved documentation compliance, and shown potential revenue growth.[41-43]

Impact on Healthcare Delivery Efficiency

AI is transforming healthcare by enhancing efficiency and improving patient outcomes, demonstrating high accuracy in medical image analysis.[44,45] Implementation in radiology shows improved workflow efficiency and diagnostic accuracy,[46,47] with studies reporting 71% reduced wait times and 6% increased equipment utilization.[48] Applications extend to drug discovery and remote monitoring,[49] while supporting hospital administration.[50] Despite its promise, challenges in data quality, interpretability, and ethics need addressing.[44,51]

Cost-effectiveness and Resource Utilization

Studies demonstrate AI's economic impact in healthcare, particularly in ultrasound and echocardiography. AI-enhanced ultrasound shows cost recovery within 18-24 months through improved efficiency,[52] with AI-driven scheduling improving utilization by 25-30%.[6] Healthcare AI implementation could save $200-360 billion in the US.[53] In echocardiography, AI standardizes practice and enhances workflow,[54] while AI-assisted training improves novices' skills.[55] However, more comprehensive economic analyses are needed.[51,56]

Conclusion

The integration of AI into ultrasound technology represents a transformative advancement in women's healthcare, offering substantial improvements in image quality, diagnostic accuracy, and clinical workflow efficiency. As demonstrated through enhanced imaging capabilities, workflow optimization, and promising cost-effectiveness data, AI-powered ultrasound platforms are addressing longstanding challenges in healthcare delivery while expanding access to high-quality diagnostic services. While challenges remain in standardization and data management, the continued evolution of this technology – exemplified by systems like the Samsung Z20 – suggests a future where advanced ultrasound imaging becomes increasingly accessible, accurate, and integral to patient care. This technological progression, supported by growing evidence of its clinical and economic benefits, positions AI-enhanced ultrasound as a cornerstone of modern medical imaging, particularly in women's health applications where precise diagnostics are crucial for optimal patient outcomes.

Studies demonstrate AI's economic impact in healthcare, particularly in ultrasound and echocardiography. AI-enhanced ultrasound shows cost recovery within 18-24 months through improved efficiency, with AI-driven scheduling improving utilization by 25-30%

References:

1 Iacob R, Iacob ER, Stoicescu ER, et al. Evaluating the role of breast ultrasound in early detection of breast cancer in low-and middle-income countries: A comprehensive narrative review. Bioengineering. 2024;11(3):262.

2 Simson W, Zhuang L, Sanabria SJ, Antil N, Dahl JJ, Hyun D. Differentiable beamforming for ultrasound autofocusing. In: Springer; 2023:428-437.

3 Shen D, Wu G, Suk HI. Deep learning in medical image analysis. Annual review of biomedical engineering. 2017;19(1):221-248.

4 Karthik A, Aggarwal K, Kapoor A, et al. Comprehensive assessment of imaging quality of artificial intelligence-assisted compressed sensing-based MR images in routine clinical settings. BMC Medical Imaging. 2024;24(1):284.

5 Samsung Unveils Premium OB/GYN Ultrasound System 'HERA Z20' in ISUOG World Congress 2024 – Samsung Global Newsroom. Accessed December 20, 2024. https://news.samsung.com/global/samsung-unveils-premium-ob-gyn-ultrasound-system-hera-z20-in-isuog-world-congress-2024?utm_source=chatgpt.com

6 Akkus Z, Cai J, Boonrod A, et al. A Survey of Deep-Learning Applications in Ultrasound: Artificial Intelligence–Powered Ultrasound for Improving Clinical Workflow. Journal of the American College of Radiology. 2019;16(9):1318-1328. doi:10.1016/j.jacr.2019.06.004

7 Chartrand G, Cheng PM, Vorontsov E, et al. Deep Learning: A Primer for Radiologists. RadioGraphics. 2017;37(7):2113-2131. doi:10.1148/rg.2017170077

8 Yang F, Mao Q, Shi M, Xie F, Wei Eric Cheng K. Enhancing Ultrasound Imaging through Convolutional Neural Networks: A Health Informatics Approach. In: AHFE International. AHFE International; 2024. doi:10.54941/ahfe1005073

9 Hyun D, Brickson LL, Looby KT, Dahl JJ. Beamforming and Speckle Reduction Using Neural Networks. IEEE Trans Ultrason, Ferroelect, Freq Contr. 2019;66(5):898-910. doi:10.1109/tuffc.2019.2903795

10 Ghaffar M, Fatima R, Bashir W. Deep Learning based Enhanced Adaptive Despeckling for Ultrasound Image s. PJOSR. 2023;3(1):14-19. doi:10.57041/pjosr.v3i1.954

11 Ando K, Nagaoka R, Hasegawa H. Speckle reduction of medical ultrasound images using deep learning with fully convolutional network. Jpn J Appl Phys. 2020;59(SK):SKKE06. doi:10.35848/1347-4065/ab80a5

12 Brown K, Hoyt K. Deep learning in spatiotemporal filtering for super-resolution ultrasound imaging. In: 2019 IEEE International Ultrasonics Symposium (IUS). IEEE; 2019:1114-1117. doi:10.1109/ultsym.2019.8926282

13 Maev RGr. Advances in acoustic microscopy and high resolution ultrasonic imaging: from principles to new applications. In: Bosch JG, Doyley MM, eds. SPIE Proceedings. Vol 9040. SPIE; 2014:904007. doi:10.1117/12.2044402

14 Brown J. A high-resolution ultrafast beamformer for surgical microtransducers. The Journal of the Acoustical Society of America. 2024;155(3_Supplement):A138-A138. doi:10.1121/10.0027080

15 Rizzatto G. Ultrasound transducers. European Journal of Radiology. 1998;27:S188-S195. doi:10.1016/s0720-048x(98)00061-8

16 Whittingham TA. New and Future Developments in Ultrasonic Imaging. British Journal of Radiology. 1997;70(Special-Issue-1):S119-S132. doi:10.1259/bjr.1997.0015

17 Silverman RH. High-resolution ultrasound imaging of the eye – a review. Clinical Exper Ophthalmology. 2009;37(1):54-67. doi:10.1111/j.1442-9071.2008.01892.x

18 T. M, Xuejun Q, C. C, et al. High-resolution harmonic motion imaging (HR-HMI) for tissue biomechanical property characterization. Quantitative Imaging in Medicine and Surgery. Published online 2015. doi:10.3978/j.issn.2223-4292.2014.11.27

19 Ossenkoppele BW, Luijten B, Bera D, de Jong N, Verweij MD, van Sloun RJG. Improving Lateral Resolution in 3-D Imaging With Micro-beamforming Through Adaptive Beamforming by Deep Learning. Ultrasound in Medicine & Biology. 2023;49(1):237-255. doi:10.1016/j.ultrasmedbio.2022.08.017

20 Lidke DS, Lidke KA. Advances in high-resolution imaging – techniques for three-dimensional imaging of cellular structures. Journal of Cell Science. Published online January 1, 2012. doi:10.1242/jcs.090027

21 Obruchkov S. The Technology and Performance of 4D Ultrasound. Crit Rev Biomed Eng. 2008;36(4):267-314. doi:10.1615/critrevbiomedeng.v36.i4.20

22 Li G, Citrin D, Camphausen K, et al. Advances in 4D Medical Imaging and 4D Radiation Therapy. Technol Cancer Res Treat. 2008;7(1):67-81. doi:10.1177/153303460800700109

23 Yeo L, Romero R. Intelligent navigation to improve obstetrical sonography. Ultrasound in Obstet & Gyne. 2015;47(4):403-409. doi:10.1002/uog.12562

24 Olaisen S, Smistad E, Espeland T, et al. Automatic measurements of left ventricular volumes and ejection fraction by artificial intelligence: clinical validation in real time and large databases. European Heart Journal - Cardiovascular Imaging. 2023;25(3):383-395. doi:10.1093/ehjci/jead280

25 Letourneau-Guillon L, Camirand D, Guilbert F, Forghani R. Artificial Intelligence Applications for Workflow, Process Optimization and Predictive Analytics. Neuroimaging Clinics of North America. 2020;30(4):e1-e15. doi:10.1016/j.nic.2020.08.008

26 Allen B Jr, Seltzer SE, Langlotz CP, et al. A Road Map for Translational Research on Artificial Intelligence in Medical Imaging: From the 2018 National Institutes of Health/RSNA/ACR/The Academy Workshop. Journal of the American College of Radiology. 2019;16(9):1179-1189. doi:10.1016/j.jacr.2019.04.014

27 Tenajas R, Miraut D, Illana CI, Alonso-Gonzalez R, Arias-Valcayo F, Herraiz JL. Recent Advances in Artificial Intelligence-Assisted Ultrasound Scanning. Applied Sciences. 2023;13(6):3693. doi:10.3390/app13063693

28 Adams SJ, Burbridge B, Chatterson L, Babyn P, Mendez I. A Telerobotic Ultrasound Clinic Model of Ultrasound Service Delivery to Improve Access to Imaging in Rural and Remote Communities. Journal of the American College of Radiology. 2022;19(1):162-171. doi:10.1016/j.jacr.2021.07.023

29 Adams SJ, Burbridge B, Obaid H, Stoneham G, Babyn P, Mendez I. Telerobotic Sonography for Remote Diagnostic Imaging. J of Ultrasound Medicine. 2020;40(7):1287-1306. doi:10.1002/jum.15525

30 JOHNSON MA, DAVIS P, McEWAN AJ, et al. Preliminary Findings from a Teleultrasound Study in Alberta. Telemedicine Journal. 1998;4(3):267-276. doi:10.1089/tmj.1.1998.4.267

31 Eadie L, Mulhern J, Regan L, et al. Remotely supported prehospital ultrasound: A feasibility study of real -time image transmission and expert guidance to aid diagnosis in remote and rural communities. J Telemed Telecare. 2017;24(9):616-622. doi:10.1177/1357633x17731444

32 Kirkpatrick AW, McKee JL, Moeini S, et al. Pioneering Remotely Piloted Aerial Systems (Drone) Delivery of a Remotely Telementored Ultrasound Capability for Self Diagnosis and Assessment of Vulnerable Populations—the Sky Is the Limit. J Digit Imaging. 2021;34(4):841-845. doi:10.1007/s10278-021-00475-w

33 Popov V, Popov D, Kacar I, Harris RD. The Feasibility of Real-Time Transmission of Sonographic Images from a Remote Location over Low-Bandwidth Internet Links: A Pilot Study. American Journal of Roentgenology. 2007;188(3):W219-W222. doi:10.2214/ajr.05.2148

34 K. S, Lillian M. Global Maternal and Child Health Outcomes: The Role of Obstetric Ultrasound in Low Resource Settings. Published online 2013. doi:10.12691/JPM-1-3-3

35 Blenkinsop G, Heller RA, Carter NJ, Burkett A, Ballard M, Tai N. Remote ultrasound diagnostics disrupting traditional military frontline healthcare delivery. BMJ Mil Health. 2021;169(5):456-458. doi:10.1136/bmjmilitary-2021-001821

36 Blezek DJ, Olson-Williams L, Missert A, Korfiatis P. AI Integration in the Clinical Workflow. J Digit Imaging. 2021;34(6):1435-1446. doi:10.1007/s10278-021-00525-3

37 Pierre K, Haneberg AG, Kwak S, et al. Applications of Artificial Intelligence in the Radiology Roundtrip: Process Streamlining, Workflow Optimization, and Beyond. Seminars in Roentgenology. 2023;58(2):158-169. doi:10.1053/j.ro.2023.02.003

38 Ranschaert E, Topff L, Pianykh O. Optimization of Radiology Workflow with Artificial Intelligence. Radiologic Clinics of North America. 2021;59(6):955-966. doi:10.1016/j.rcl.2021.06.006

39 Li MF, Tsai JC, Chen WJ, Lin HS, Pan HB, Yang TL. Redefining the sonography workflow through the application of a departmental computerized workflow management system. International Journal of Medical Informatics. 2013;82(3):168-176. doi:10.1016/j.ijmedinf.2012.06.001

40 Tejani AS, Cook TS, Hussain M, Sippel Schmidt T, O'Donnell KP, Arzen S. Integrating and Adopting AI in the Radiology Workflow: A Primer for Standards and Integrating the Healthcare Enterprise (IHE) Profiles. Radiology. 2024;311(3). doi:10.1148/radiol.232653

41 Juluru K, Shih HH, Keshava Murthy KN, et al. Integrating AI Algorithms into the Clinical Workflow. Radiology: Artificial Intelligence. 2021;3(6). doi:10.1148/ryai.2021210013

42 DEEPAK V, AHMED H, SHARMA S. A MULTI-SYSTEM INTEGRATIVE WORKFLOW IMPLEMENTATION TO IMPROVE DOCUMENT ATION OF POINT-OF-CARE ULTRASOUND IN MEDICAL INTENSIVE CARE UNIT. CHEST. 2023;164(4):A3817. doi:10.1016/j.chest.2023.07.2485

43 Rong K, Chimileski B, Kaloudis P, Herbst MK. Impact of an epic-integrated point-of-care ultrasound workflow on ultrasound performance, compliance, and potential revenue. The American Journal of Emergency Medicine. 2021;49:233-239. doi:10.1016/j.ajem.2021.06.009

44 Olawade DB, David-Olawade AC, Wada OZ, Asaolu AJ, Adereni T, Ling J. Artificial intelligence in healthcare delivery: Prospects and pitfalls. Journal of Medicine, Surgery, and Public Health. 2024;3:100108. doi:10.1016/j.glmedi.2024.100108

45 Alanazi MMF, Almutairi SFM, Alarjani NO, Alghaylan MYA, Aljawhari MSM, Alkhulaifi AAS. Advancements in AI-driven diagnostic radiology: Enhancing accuracy and efficiency. ijhs. 2024;8(S1):737-749. doi:10.53730/ijhs.v8ns1.14928

46 van Leeuwen KG, de Rooij M, Schalekamp S, van Ginneken B, Rutten MJCM. How does artificial intelligence in radiology improve efficiency and health outcomes? Pediatr Radiol. 2021;52(11):2087-2093. doi:10.1007/s00247-021-05114-8

47 Ge H. The Role of Artificial Intelligence in Streamlining Echocardiography Quantification. Published online 2020.

48 Ambay RS, Jabbari KM, Goel P, Patel SV, Kedar RP. Improving Operational Efficiency in Radiology Using Artificial Intelligence. Journal of Healthcare Management Standards. 2022;2(1):1-9. doi:10.4018/jhms.315617

49 Role of Artificial Intelligence in Enhancing Healthcare Delivery. International Journal of Innovative Science and Modern Engineering. Published online 2023. doi:10.35940/ijisme.a1310.12111223

50 S. E, Nour E. Use of Artificial Intelligence for Improving Patient Flow and Healthcare Delivery. Published online 2019.

51 Jiao W, Zhang X, D'Souza F. The Economic Value and Clinical Impact of Artificial Intelligence in Healthcare: A Scoping Literature Review. IEEE Access. 2023;11:123445-123457. doi:10.1109/access.2023.3327905

52 Bharadwaj P, Nicola L, Breau-Brunel M, et al. Unlocking the Value: Quantifying the Return on Investment of Hospital Artificial Intelligence. Journal of the American College of Radiology. 2024;21(10):1677-1685. doi:10.1016/j.jacr.2024.02.034

53 Alnasser B. A Review of Literature on the Economic Implications of Implementing Artificial Intelligence in Healthcare. ETSN. 2023;12(03):35-48. doi:10.4236/etsn.2023.123003

54 Thachil R, Hanson D. Artificial Intelligence in Echocardiography: A Disruptive Technology for Democratizing and Standardizing Health. Journal of the American Society of Echocardiography. 2022;35(8):A14-A16. doi:10.1016/j.echo.2022.06.001

55 Langet H, Bonopera M, De Craene M, et al. 541 Turning novices into experts: can artificial intelligence transform echocardiography training? European Heart Journal - Cardiovascular Imaging. 2020;21(Supplement_1). doi:10.1093/ehjci/jez319.275

56 Wolff J, Pauling J, Keck A, Baumbach J. Systematic Review of Economic Impact Studies of Artificial Intelligence in Health Care. J Med Internet Res. 2020;22(2):e16866. doi:10.2196/16866

IMPROVING THE ACCURACY AND EFFICIENCY OF WOMEN'S HEALTH ULTRASOUND AND THE ROLE OF ARTIFICIAL INTELLIGENCE TECHNOLOGY

Expert Interview: Modernizing Ultrasound Reporting with AI

Alan Fishman, MD
Medical Director, MFM Telehealth Program, Pediatrix Medical Group

Dr. Alan Fishman is a maternal-fetal medicine specialist who has held leadership positions within a large national medical group practice. As a specialty medical officer (equivalent to chief medical officer) for maternal-fetal medicine, he has extensive experience with clinical systems implementation. Since the early 2000s, Dr. Fishman has been deeply involved in electronic health record transitions, vendor selection, template customization, and the optimization of clinical documentation systems, including PACS systems specific to maternal-fetal medicine.

Sonio: efficiency and quality control

The old system required physicians to hop from server to server to read images remotely. It was very hardware-dependent and resource-intensive, becoming cost-prohibitive from a support perspective

What prompted your organization to change its ultrasound reporting solution?

We were dealing with a transition in technology and architecture for our PACS system. We wanted something that was truly cloud-architected and could provide better stability and performance levels that our users needed. Our previous solution was server-based and was holding us back from achieving our performance goals. We needed an enterprise solution that would allow our physicians to easily access and see studies as they come in, particularly for providing telehealth services and remote ultrasound reads.

The old system required physicians to hop from server to server to read images remotely. It was very hardware-dependent and resource-intensive, becoming cost-prohibitive from a support perspective. Additionally, we wanted a system architected on a single database, rather than individual servers that had to be brought together, which was a nightmare for data aggregation.

What specific performance issues were you experiencing with the previous system?

The main issues were related to accessibility, uptime, system crashes, freezing, and general stability problems. We also faced challenges with image file sizes, which have a large footprint and can cause latency or lag when moving across networks or platforms. We needed something that could work in more real-time for our physicians.

How has the transition to Sonio addressed these challenges?

The stability and performance of Sonio has been excellent, without the system crashes and freezes we experienced previously. We're in a dynamic process of transitioning, with ongoing work by the Sonio team to develop functionality

Sonio visual checklist

We're also dealing with change management, which is particularly challenging with physicians. Some are interested in using new features and functionality, while others just want the system to work like their previous one – they want it to be fast and always available, but don't want anything different

specific to maternal-fetal medicine workflow requirements. While the initial version didn't have all the capabilities users were accustomed to from the legacy product, there's been a rapid development cycle to add core functionality and enhanced features.

We're also dealing with change management, which is particularly challenging with physicians. Some are interested in using new features and functionality, while others just want the system to work like their previous one – they want it to be fast and always available, but don't want anything different. The versatility of the product has allowed us to provide the functionality they need now while incorporating AI enhancements and image recognition that should provide value to everyone from day one.

Where do you anticipate seeing the greatest time savings for providers and sonographers?

There are two main areas where we expect to see significant time savings. First, sonographers can have an exam protocol in front of their eyes that guides them on which images they need to take as they scan. The system can take annotations from the ultrasound machine, translate them into the corresponding structures, and completes a visual checklist. This helps prevent situations where they have to leave the room, work on a computer, and realize they're missing images.

Second, we're looking forward to implementing dynamic protocols. When a patient returns after a first exam where certain anatomy wasn't optimally viewed, the system will automatically recognize what wasn't seen previously and add those items to today's protocol. This could save sonographers about five minutes of pre-exam work and prevent them from missing items that weren't captured in the previous exam.

Sonio Pro Protocol

How has the system improved quality and accuracy in ultrasound reporting?

The system can now identify 25 views and 60 fetal structures, with specific quality criteria for recognition. If a sonographer is looking at a structure, such as the choroid plexus, but not meeting all the required criteria (like proper magnification or visualization of specific anatomical landmarks), the system flags it with a yellow box. This immediate feedback helps sonographers improve their technique.

In practices utilizing this functionality, we've seen rapid adaptation where image quality improves as sonographers learn from these automated assessments. They don't like seeing those yellow boxes – it's like getting a bad grade on a test – so they quickly learn to make the necessary corrections.

Looking to the future, as the system improves, we anticipate it will be able to flag potential abnormalities and assist less experienced sonographers, particularly in areas with limited access to maternal-fetal medicine specialists. It can act like an expert looking over their shoulder, helping them know when to seek consultations and improving the quality of remote image sharing with specialists.

Have you observed any other benefits from the new system?

One significant advantage we've noticed is in onboarding new sonographers. They seem to grasp the system quickly, and the transition isn't particularly challenging. We've had experience bringing in traveling sonographers who have used other products, and they're typically up to speed and running within a day. It's actually easier to plug people in and out of this system and get them running from scratch compared to other systems we've used.

The system can now identify 25 views and 60 fetal structures, with specific quality criteria for recognition

Looking to the future, as the system improves, we anticipate it will be able to flag potential abnormalities and assist less experienced sonographers, particularly in areas with limited access to maternal-fetal medicine specialists

Quality and Precision in Gynecological Ultrasound Imaging

Jonathan D. Agnew, *PhD, MBA, Adjunct Professor, Faculty of Medicine, University of British Columbia*

Advanced ultrasound imaging technology has revolutionized gynecological diagnostics through improvements in resolution, contrast optimization, and signal processing capabilities. Modern systems incorporating artificial intelligence and adaptive technologies have significantly enhanced detection rates for subtle pathologies while reducing the need for repeat examinations. These technological developments, combined with standardized quality assurance protocols, have fundamentally transformed patient care by enabling more precise, non-invasive diagnostic capabilities and supporting evidence-based clinical decision-making.

Higher frequencies provide superior resolution for transvaginal examinations but with limited depth penetration, while lower frequencies allow greater penetration for transabdominal imaging at the cost of reduced spatial resolution

Critical Aspects of Image Quality

The foundation of accurate gynecological diagnosis through ultrasound imaging rests upon achieving and maintaining optimal image quality. This fundamental aspect encompasses multiple technical parameters that must be precisely controlled and optimized to ensure diagnostic accuracy and reliability. Understanding these critical elements is essential for both imaging specialists and clinicians interpreting the results.

Resolution Parameters and Their Significance

Ultrasound image resolution in gynecological applications comprises three distinct but interconnected parameters: spatial resolution, contrast resolution, and temporal resolution. Spatial resolution, particularly important in identifying small anatomical structures such as early gestational sacs or ovarian follicles, depends on both axial and lateral resolution capabilities of the ultrasound system.[1] In transvaginal ultrasonography, higher frequency transducers are employed, offering superior axial resolution compared to lower-frequency transabdominal probes. This enhanced resolution facilitates the early detection and detailed assessment of intrauterine pregnancies.[2]

The relationship between frequency selection and penetration depth presents a crucial trade-off in gynecological imaging. Higher frequencies provide superior resolution for transvaginal examinations but with limited depth penetration, while lower frequencies allow greater penetration for transabdominal imaging at the cost of reduced spatial resolution.[3]

Contrast Optimization Techniques

Contrast resolution, essential for distinguishing between different tissue types and identifying pathological changes, has seen significant advancement through dynamic range optimization and harmonic imaging techniques. Research has demonstrated that appropriate adjustment of dynamic range can significantly improve the detection rate of endometrial abnormalities compared to standard settings.[4] The implementation of tissue harmonic imaging has particularly enhanced the visualization of subtle tissue interfaces and fluid-filled structures, crucial for identifying various gynecological conditions.

Modern ultrasound systems incorporate sophisticated contrast optimization algorithms that automatically adjust gain, time-gain compensation, and dynamic range based on tissue characteristics. These adaptive technologies have shown particular value in challenging diagnostic scenarios, such as distinguishing between hemorrhagic cysts and endometriomas, where subtle differences in echogenicity are critical for accurate diagnosis.[5]

Signal Processing Advancements

Recent developments in signal processing have revolutionized the quality of gynecological ultrasound imaging. Advanced signal processing algorithms, including speckle reduction imaging and compound imaging techniques, have significantly improved image clarity and diagnostic confidence. Studies have shown that the implementation of advanced signal processing can reduce image noise while preserving important tissue detail, leading to improved detection rates for subtle gynecological pathologies.[6]

The integration of artificial intelligence-based signal processing has further enhanced image quality through real-time optimization of multiple parameters simultaneously. These systems can analyze incoming ultrasound data and adjust processing parameters to maintain optimal image quality across different patient characteristics and examination conditions.[7]

The impact of these technological advancements extends beyond mere image aesthetics. Enhanced signal processing capabilities have been shown to improve the reproducibility of measurements and increase diagnostic confidence among sonographers and interpreting physicians. Research indicates that modern signal processing techniques can significantly reduce inter-observer variability in gynecological measurements compared to conventional imaging approaches.[8]

Overcoming Technical Challenges

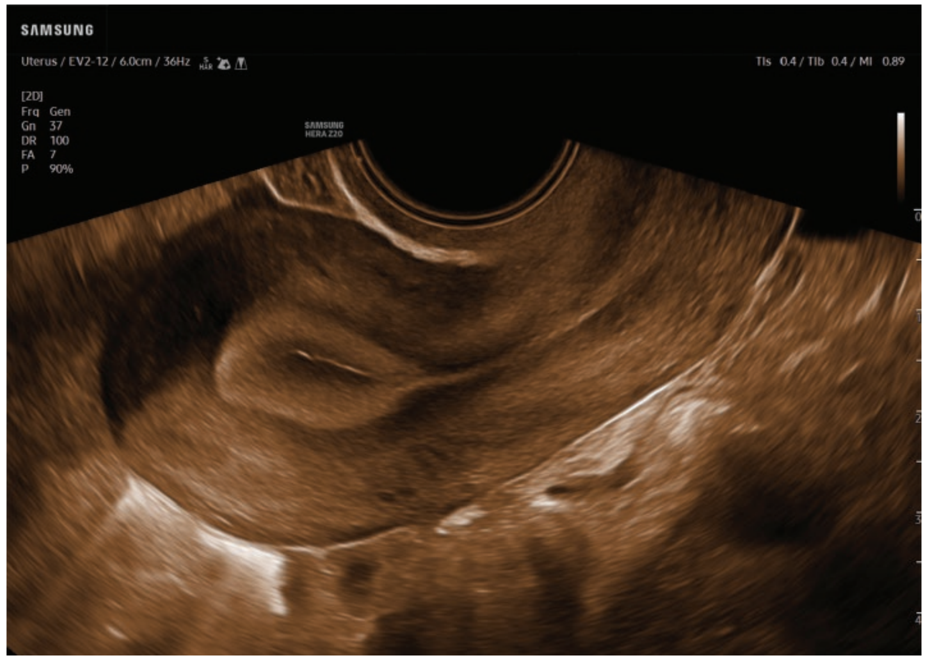
The optimization of gynecological ultrasound imaging frequently encounters various technical obstacles that can impact diagnostic accuracy. Understanding and implementing effective solutions to these challenges is crucial for maintaining high-quality imaging standards and ensuring reliable diagnostic outcomes.

Solutions for Difficult-to-Scan Patients

Gynecological ultrasound imaging faces various technical challenges, particularly in obese patients and those with complex pelvic anatomy. Obesity can significantly impact image quality and require specific protocols to improve visualization by up to 40%.[9] For patients with extensive scarring, multi-angle compound imaging techniques can enhance border detection and reduce acoustic shadowing by approximately 30%.[10] Three-dimensional ultrasonography has emerged as a useful tool for clinical problem-solving in gynecology, especially for imaging the uterus and uterine cavity.[11] Advanced imaging modalities like MRI are increasingly being used alongside ultrasound for more precise diagnoses.[12] To overcome these challenges, practitioners must familiarize themselves with equipment, optimize imaging techniques, and adapt to new technologies.[13] Continuous improvement in imaging technology and protocols is essential for maintaining high-quality standards and ensuring reliable diagnostic outcomes in gynecological ultrasound.[14,15]

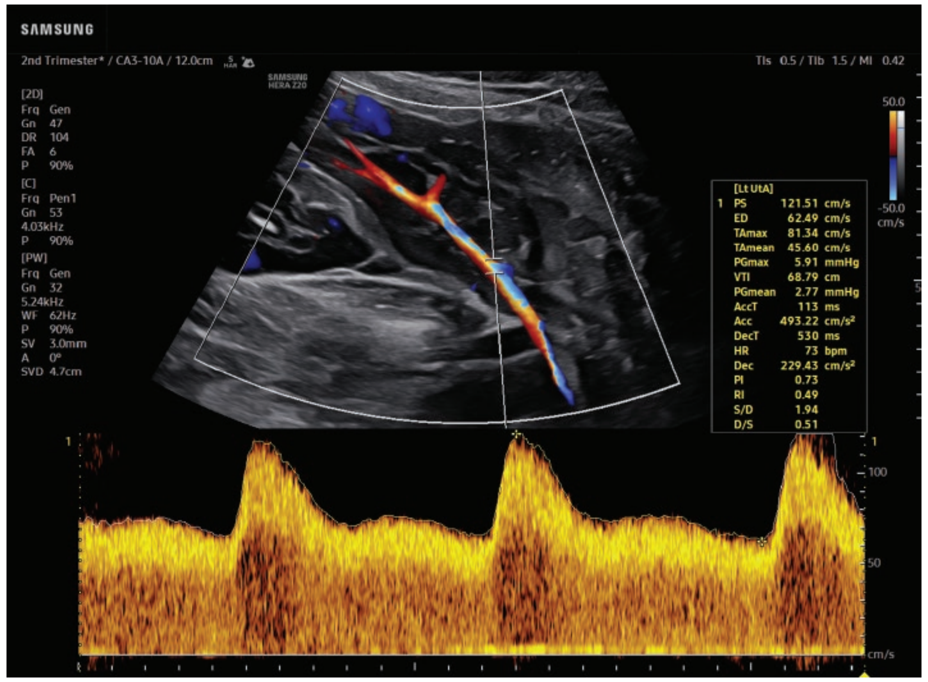
Adaptive Imaging Technologies

Recent advances in adaptive imaging technologies have significantly improved ultrasound image quality and efficiency. Adaptive beamforming techniques, including minimum variance methods, have shown enhanced resolution and contrast compared to traditional delay-and-sum approaches.[16,17] Deep learning algorithms have been successfully applied to various aspects of ultrasound imaging, from beamforming to advanced applications, demonstrating improved performance and efficiency.[18,19] Real-time adaptive filters have been developed to reduce noise and artifacts while enhancing edge definition and tissue texture.[20] These adaptive technologies have been shown to decrease scanning time by up to 25% and reduce the number of keystrokes required during examinations.[21] Implementation



A-Focus provides real-time gain adjustments

Adaptive technologies have shown particular value in challenging diagnostic scenarios, such as distinguishing between hemorrhagic cysts and endometriomas, where subtle differences in echogenicity are critical for accurate diagnosis



ClearVision reduces speckle artifacts in tissues

High-resolution transvaginal ultrasound now enables detection of subtle tissue changes, improving diagnostic accuracy for conditions like adenomyosis and endometriosis

of adaptive imaging systems has progressed from early prototypes to more advanced systems capable of updating aberration profiles at quasi-real-time rates, revolutionizing ultrasound imaging across various clinical applications.[22,23]

Quality Assurance Protocols

Quality assurance protocols are vital for consistent ultrasound imaging across operators and equipment. Regular system calibration reduces technical failures through testing procedures and performance limits.[24,25] Methods include transducer testing, phantom measurements, and visual fault checks.[26] A software-based protocol using in-air reverberation shows promise.27 Tests evaluate safety, display, uniformity, and resolution.[28] Implementation varies between institutions,[29] though standardization can address inconsistencies.[30] QA programs remain essential for preventing errors.[31]

Real-time Image Optimization

Real-time image optimization techniques in ultrasound have enhanced diagnostic accuracy and efficiency. Systems include automatic artifact detection and correction, while Easy Adjustment Technology simplifies setup, reducing musculoskeletal strain.[32] Dynamic optimization decreases examination time by 9.6% and keystrokes by 21.3%.[21] Real-time lag-one coherence enables patient-specific optimization.[33] ClearVision is a proprietary noise reduction filter that improves tissue interface definition and creates sharper 2D images for optimal diagnostic performance.

Clinical Impact of Enhanced Imaging

The evolution of gynecological ultrasound technology has fundamentally transformed diagnostic capabilities and patient care delivery. Beyond mere technical improvements, these advancements have reshaped clinical decision-making processes and patient experiences in profound ways.

Improved Diagnostic Accuracy

Enhanced imaging techniques have revolutionized the diagnosis and management of gynecological conditions. High-resolution transvaginal ultrasound now enables detection of subtle tissue changes, improving diagnostic accuracy for conditions like adenomyosis and endometriosis.[36,37] Three-dimensional ultrasound has particularly advanced adenomyosis evaluation.[38,39] While traditionally diagnosed through hysterectomy, adenomyosis can now be identified non-invasively using ultrasound and MRI.[40] These imaging modalities help distinguish between different forms of adenomyosis and guide treatment decisions.[39] Contrast-enhanced ultrasound shows promise in diagnosing various uterine disorders by visualizing microvasculature.[41] The evolution of gynecological imaging has improved diagnostic capabilities, reduced the need for invasive procedures, and enhanced surgical planning for complex cases.[42,43] This progress has significantly impacted clinical decision-making and patient care in gynecology.

Reduced Repeat Examination Rates

Enhanced imaging technologies and protocols reduce repeat examinations and improve

IMPROVING THE ACCURACY AND EFFICIENCY OF WOMEN'S HEALTH ULTRASOUND AND THE ROLE OF ARTIFICIAL INTELLIGENCE TECHNOLOGY

healthcare efficiency. Harmonic imaging enhancement systems decrease repeat imaging by 25-67% across modalities.[44-46] Shared diagnostic imaging repositories reduce repeat imaging by 19.4% and shorten surgical wait times.[5] Integrated CPOE/RIS/PACS systems decrease X-ray and CT procedures.[47] Quality initiatives reduce unnecessary follow-up imaging by 58%.[48]

Patient Satisfaction Metrics

Patient satisfaction in gynecological ultrasound is generally high, with research reporting satisfaction rates of 95% or above.[49] Bedside ultrasound has been associated with improved patient satisfaction, potentially due to reduced time to diagnosis and shorter hospital stays.[50] Patients appreciate the caring and friendly attitude of obstetricians and gynecologists compared to other specialists.[51] Factors influencing satisfaction include staff-patient interaction, waiting times, and organizational behavior.[52] Interestingly, ultrasound was preferred by patients over CT and MRI for ovarian cancer staging, despite being associated with more pain during the examination.[53] However, gender bias may impact patient satisfaction scores, with female gynecologists receiving lower ratings than their male counterparts.[54] Overall, bedside ultrasonography has transformed the approach to female patients with pelvic complaints in acute care settings.[55]

Conclusion

The continuous advancement of gynecological ultrasound imaging technology represents a significant milestone in modern diagnostic medicine. Through the integration of sophisticated signal processing algorithms, adaptive imaging technologies, and artificial intelligence-based optimization, contemporary ultrasound systems have achieved unprecedented levels of diagnostic accuracy and efficiency. The implementation of these enhanced imaging capabilities, coupled with standardized quality assurance protocols and real-time optimization techniques, has yielded tangible clinical benefits, including improved detection rates for subtle gynecological pathologies, reduced repeat examination rates, and increased patient satisfaction. As evidenced by the documented improvements in spatial resolution, contrast optimization, and diagnostic confidence, these technological innovations have not only transformed the landscape of gynecological imaging but have also fundamentally enhanced the delivery of patient care by enabling more precise, non-invasive diagnostic capabilities and supporting more informed clinical decision-making processes.

The evolution of gynecological imaging has improved diagnostic capabilities, reduced the need for invasive procedures, and enhanced surgical planning for complex cases

The implementation of these enhanced imaging capabilities, coupled with standardized quality assurance protocols and real-time optimization techniques, has yielded tangible clinical benefits, including improved detection rates for subtle gynecological pathologies, reduced repeat examination rates, and increased patient satisfaction

References:

1. Økland I, Bjåstad T, Johansen T, Gjessing H, Grøttum P, Eik-Nes S. Narrowed beam width in newer ultrasound machines shortens measurements in the lateral direction: fetal measurement charts may be obsolete. Ultrasound in obstetrics & gynecology. 2011;38(1):82-87.
2. Murugan VA, Murphy BO, Dupuis C, Goldstein A, Kim YH. Role of ultrasound in the evaluation of first-trimester pregnancies in the acute setting. Ultrasonography. 2019;39(2):178.
3. Lucas VS, Burk RS, Creehan S, Grap MJ. Utility of high-frequency ultrasound: moving beyond the surface to detect changes in skin integrity. Plastic and Aesthetic Nursing. 2014;34(1):34-38.
4. Zander D, Hüske S, Hoffmann B, et al. Ultrasound image optimization ("knobology"): B-mode. Ultrasound international open. 2020;6(01):E14-E24.
5. Hallet J, Coburn NG, Alberga A, et al. Reducing repeat imaging in hepato-pancreatico-biliary surgical cancer care through shared diagnostic imaging repositories. HPB. 2019;21(1):96-106. doi:10.1016/j.hpb.2018.06.1807
6. Narayanan SK, Wahidabanu R. A view on despeckling in ultrasound imaging. International Journal of Signal Processing, Image Processing and Pattern Recognition. 2009;2(3):85-98.
7. Okuyelu O, Adaji O. AI-Driven Real-time Quality Monitoring and Process Optimization for Enhanced Manufacturing Performance. Journal of Advances in Mathematics and Computer Science. 2024;39(4):81-89.
8. Smith L, Perron A, Persico A, Stravinskas E, Cournoyea D. Enhancing image quality using advanced signal processing techniques. Journal of Diagnostic Medical Sonography. 2008;24(2):72-81.
9. Uppot RN. Technical challenges of imaging & image-guided interventions in obese patients. BJR. Published online June 5, 2018:20170931. doi:10.1259/bjr.20170931
10. Chesebro AL, Chikarmane SA, Ritner JA, Birdwell RL, Giess CS. Troubleshooting to Overcome Technical Challenges in Image-guided Breas t Biopsy. RadioGraphics. 2017;37(3):705-718. doi:10.1148/rg.2017160117
11. Bega G, Lev-Toaff AS, O'Kane P, Becker E Jr, Kurtz AB. Three-dimensional Ultrasonography in Gynecology. J of Ultrasound Medicine. 2003;22(11):1249-1269. doi:10.7863/jum.2003.22.11.1249
12. Ville Y. 'Mirror, mirror, on the wall …………' Ultrasound in Obstet & Gyne. 2004;25(1):1-2. doi:10.1002/uog.1825
13. Jayaprakasan K, Polanski L, Ojha K. Gynaecological Ultrasound Scanning. Published online February 27, 2020. doi:10.1017/9781108149877
14. Iyer V, Lee S. Gynecologic imaging. Journal of Postgraduate Medicine. 2010;56(2):117-124. doi:10.4103/0022-3859.65285
15. Department of Radiology LBH The University of Tennes see Health Science Center, Memphis, Tennessee, USA. Challenges in Imaging the Obese Patients. Series of Clinical and Medical Case Reports and Reviews. Published online 2023. doi:10.54178/2993-3579.v1i1a1994
16. Synnevag JF, Austeng A, Holm S. Adaptive Beamforming Applied to Medical Ultrasound Imaging. IEEE Trans Ultrason, Ferroelect, Freq Contr. 2007;54(8):1606-1613. doi:10.1109/tuffc.2007.431
17. Hasegawa H. Advances in ultrasonography: image formation and quality assessment. J Med Ultrasonics. 2021;48(4):377-389. doi:10.1007/s10396-021-01140-z
18. Luijten B, Cohen R, De Bruijn FJ, et al. Adaptive ultrasound beamforming using deep learning. IEEE Transactions on Medical Imaging. 2020;39(12):3967-3978.
19. van Sloun RJG, Cohen R, Eldar YC. Deep Learning in Ultrasound Imaging. Proc IEEE. 2020;108(1):11-29. doi:10.1109/jproc.2019.2932116
20. Ahman H, Thompson L, Swarbrick A, Woodward J. Understanding the Advanced Signal Processing Technique of Real-Time Adaptive Filters. Journal of Diagnostic Medical Sonography. 2009;25(3):145-160. doi:10.1177/8756479309334354
21. Barr RG, Grajo JR. Dynamic Automatic Ultrasound Optimization. Ultrasound Quarterly. 2009;25(2):63-65. doi:10.1097/ruq.0b013e3181a424e2
22. G. T, D. Z, S.W. S, J.A. M. A system for real-time, adaptive ultrasonic imaging. Proceedings - IEEE Ultrasonics Symposium. Published online 1989. doi:10.1109/ULTSYM.1989.67113
23. Dahl J, Mcaleavey S, Pinton G, Soo M, Trahey G. Adaptive imaging on a diagnostic ultrasound scanner at quasi real-time rates. IEEE Trans Ultrason, Ferroelect, Freq Contr. 2006;53(10):1832-1843. doi:10.1109/tuffc.2006.115
24. Grazhdani H, David E, Ventura Spagnolo O, et al. Quality assurance of ultrasound systems: current status and review of literature. J Ultrasound. 2018;21(3):173-182. doi:10.1007/s40477-018-0304-7
25. Hykes DL, Hedrick WR, Milavickas LR, Starchman DE. Quality Assurance for Real-Time Ultrasound Equipment. Journal of Diagnostic Medical Sonography. 1986;2(3):121-133. doi:10.1177/875647938600200302
26. Sipilä O, Mannila V, Vartiainen E. Quality assurance in diagnostic ultrasound. European Journal of Radiology. 2011;80(2):519-525. doi:10.1016/j.ejrad.2010.11.015
27. Hyldgaard N, Bolander Malvang L, Brix L. Five-year evaluation of a low-cost quality assurance protocol for clinical ultrasound transducers. Ultrasound. 2022;31(1):71-78. doi:10.1177/1742271x221091721
28. Tsapaki V, Tsalafoutas IA, Triantopoulou SS, Triantopoulou C. Development and implementation of a quality control protocol for B-mod e ultrasound equipment. J Ultrasound. 2021;25(2):155-165. doi:10.1007/s40477-021-00579-7
29. Martin K. Quality assurance – A special issue. Ultrasound. 2014;22(1):5-5. doi:10.1177/1742271x13518283
30. Hall BA, Krupinski EA, Reich S, Duong PA, Moreno CC. Implementation of Machine-Based Protocols to Standardize Performance of Diagnostic Ultrasound in a Six-Hospital System. Journal of the American College of Radiology. 2017;14(9):1222-1224. doi:10.1016/j.jacr.2017.01.029
31. Triantopoulou S, Theocharis S, Tsapaki V. [OA259] Development of a quality assurance program for B-mode ultrasound equipment: One – year experience. Physica Medica. 2018;52:97. doi:10.1016/j.ejmp.2018.06.331
32. Borreani G, Biagini C, Pesce R, Bombino L, Forzoni L. Intuitive Real-Time Multidimensional Diagnostic Ultrasound Image Optimization Technology. In: Communications in Computer and Information Science. Springer International Publishing; 2017:511-518. doi:10.1007/978-3-319-58750-9_71
33. Bottenus N, Long W, Long J, Trahey G. A Real-Time Lag-One Coherence Tool for Adaptive Imaging. In: 2018 IEEE International Ultrasonics Symposium (IUS). IEEE; 2018:1-4. doi:10.1109/ultsym.2018.8580071
34. Meuwly JY, Thiran JP, Gudinchet F. Application of Adaptive Image Processing Technique to Real-Time Spatia l Compound Ultrasound Imaging Improves Image Quality. Investigative Radiology. 2003;38(5):257-262. doi:10.1097/01.rli.0000057032.41715.14
35. Poggenborg J, Yaroshenko A, Wieberneit N, Harder T, Gossmann A. Impact of AI-based Real Time Image Quality Feedback for Chest Radiographs in the Clinical Routine. medRxiv. Published online June 10, 2021. doi:10.1101/2021.06.10.21258326
36. Cooke CM, Flaxman TE, La Russa DJ, Duigenan S, Singh SS. Endometriosis Imaging: Enter the Metaverse of Possibilities. Journal of Obstetrics and Gynaecology Canada. 2023;45(5):309-313. doi:10.1016/j.jogc.2023.02.011
37. HOYOS LR, BENACERRAF B, PUSCHECK EE. Imaging in Endometriosis and Adenomyosis. Clinical Obstetrics & Gynecology. 2017;60(1):27-37. doi:10.1097/grf.0000000000000265
38. Chapron C, Vannuccini S, Santulli P, et al. Diagnosing adenomyosis: an integrated clinical and imaging approach. Human Reproduction Update. 2020;26(3):392-411. doi:10.1093/humupd/dmz049
39. Bourdon M, Santulli P, Marcellin L, et al. Adenomyosis: An update regarding its diagnosis and clinical features. Journal of Gynecology Obstetrics and Human Reproduction. 2021;50(10):102228. doi:10.1016/j.jogoh.2021.102228
40. Struble J, Reid S, Bedaiwy MA. Adenomyosis: A Clinical Review of a Challenging Gynecologic Condition. Journal of Minimally Invasive Gynecology. 2016;23(2):164-185. doi:10.1016/j.jmig.2015.09.018
41. Stoelinga B, Juffermans L, Dooper A, et al. Contrast-Enhanced Ultrasound Imaging of Uterine Disorders: A Systematic Review. Ultrason Imaging. 2021;43(5):239-252. doi:10.1177/01617346211017462
42. Timmerman D, Valentin L. Imaging in gynecological disease. Ultrasound in Obstet & Gyne. 2007;29(5):483-484. doi:10.1002/uog.4025
43. P. B, R. I. Diagnostic imaging in gynecologic malignancy. Minerva Ginecologica. Published online 2008.
44. Lammers EJ, Adler-Milstein J, Kocher KE. Does Health Information Exchange Reduce Redundant Imaging? Evidence From Emergency Departments. Medical Care. 2014;52(3):227-234. doi:10.1097/mlr.0000000000000067
45. Vest JR, Jung HY, Ostrovsky A, Das LT, McGinty GB. Image Sharing Technologies and Reduction of Imaging Utilization: A Systematic Review and Meta-analysis. Journal of the American College of Radiology. 2015;12(12):1371-1379.e3. doi:10.1016/j.jacr.2015.09.014
46. J. V, R. K, Michael DS, K. H, L. K. Health information exchange and the frequency of repeat medical imaging. American Journal of Managed Care. Published online 2014.
47. E. V, A. G. Integrating the Radiology Information System with Computerised Provide r Order Entry: The Impact on Repeat Medical Imaging Investigations. Australian National Health Informatics Conference. Published online 2016. doi:10.3233/978-1-61499-666-8-126
48. Hui JS, Kramer DJ, Blackmore CC, Hashimoto BE, Coy DL. A Quality Improvement Initiative to Reduce Unnecessary Follow-up Imaging for Adnexal Lesions. Journal of the American College of Radiology. 2014;11(4):373-377. doi:10.1016/j.jacr.2013.07.002
49. Pandit MJ, Mackenzie IZ. Patient satisfaction in gynaecological outpatient clinic attendances. Journal of Obstetrics and Gynaecology. 1999;19(5):511-515. doi:10.1080/01443619964337
50. Howard ZD, Noble VE, Marill KA, et al. Bedside Ultrasound Maximizes Patient Satisfaction. The Journal of Emergency Medicine. 2014;46(1):46-53. doi:10.1016/j.jemermed.2013.05.044
51. Patel I, Chang J, Srivastava J, Feldman S, Levender, Balkrishnan R. Patient satisfaction with obstetricians and gynecologists compared with other specialties: analysis of US self-reported survey data. PROM. Published online January 2011:21. doi:10.2147/prom.s15747
52. A. U, Kenneth NA, O. E, Emerson O, C. O, L. CO. Patient satisfaction with obstetric ultrasonography. Radiologic Technology. Published online 2007.
53. Pinto P, Valentin L, Borčinová M, et al. Patient satisfaction with ultrasound, whole-body CT and whole-body diffusion-weighted MRI for pre-operative ovarian cancer staging: a multicenter prospective cross-sectional survey. Int J Gynecol Cancer. Published online March 26, 2024:ijgc-2023-005264. doi:10.1136/ijgc-2023-005264
54. Rogo-Gupta LJ, Haunschild C, Altamirano J, Maldonado YA, Fassiotto M. Physician Gender Is Associated with Press Ganey Patient Satisfaction S cores in Outpatient Gynecology. Women's Health Issues. 2018;28(3):281-285. doi:10.1016/j.whi.2018.01.001
55. Sohoni A, Bosley J, Miss JC. Bedside Ultrasonography for Obstetric and Gynecologic Emergencies. Critical Care Clinics. 2014;30(2):207-226. doi:10.1016/j.ccc.2013.10.002

IMPROVING THE ACCURACY AND EFFICIENCY OF WOMEN'S HEALTH ULTRASOUND AND THE ROLE OF ARTIFICIAL INTELLIGENCE TECHNOLOGY

Enhancing Ultrasound Interrogation of the Fetal Brain with AI Innovations

Elena Sinkovskaya, MD,
Professor of Obstetrics and Gynecology
Director of Ultrasound Research & Education
Program Director of the Fetal Cardiology Fellowship
Macon & Joan Brock Virginia Health Sciences at Old Dominion University, Norfolk, VA

A closer look at AI-driven advancements in fetal neurosonography including advanced volume techniques to improve maternal and fetal outcomes.

Introduction

EAs clinicians deeply involved in prenatal care, we recognize the pivotal role prenatal detection of fetal brain pathologies plays in improving maternal and fetal outcomes. A detailed understanding of normal fetal brain anatomy, accurate delineation of diagnostic planes, and the ability to quickly identify Central Nervous System (CNS) abnormalities during conventional 2D ultrasound exams are essential for accurate fetal CNS evaluation. These tasks, which are highly operator-dependent, can hinder the early detection of subtle anatomical changes, impacting decision-making on further genetic testing, fetal surgery, or pregnancy termination.

Although many congenital CNS anomalies can be identified during routine anatomical ultrasound surveys, detection rates still vary considerably. Despite significant advances in ultrasound technology over the past few decades, prenatal detection of fetal cerebral anomalies remains a challenge. These include difficulties in acquiring the appropriate diagnostic imaging planes, operator-dependent variability, and the inherent limitations in visualizing complex anatomical structures such as the fetal brain. The human eye can miss subtle abnormalities, particularly in the intricate fetal brain during routine screening examination, highlighting the need for improved imaging techniques.

In this article, we will discuss how a suite of artificial intelligence (AI) technologies are enhancing the visualization and confidence in detailed assessment of the fetal brain. By improving the interrogation of the fetal brain, these technologies not only advance diagnostic accuracy but also pave the way for better maternal and fetal health outcomes.

The Role of AI in Fetal Neurosonography

The incremental integration of artificial intelligence (AI) into medical imaging is set to revolutionize the field, with significant advancements seen in areas such as prenatal ultrasound. Over recent years, automated software utilizing machine learning (ML) algorithms has increasingly been adopted into clinical practice. In particular, AI-driven technologies for image recognition and reconstruction are playing an increasingly pivotal role in transforming clinical workflows, training methods, and diagnostic accuracy, especially in prenatal ultrasound. Automated tools assist in analyzing highly complex three-dimensional (3D) anatomical structures, such as the fetal heart and central nervous system (CNS). The application of these tools has shown considerable potential in improving the accuracy and efficiency of prenatal examinations by standardizing imaging across different practitioners, reducing interoperator variability that can otherwise affect diagnostic quality[1-3].

AI-powered software solutions can be beneficial to both novice and experienced examiners. Inexperienced operators can rely on these tools for more accurate basic examinations and biometric measurements, while experienced sonographers can use them to efficiently perform comprehensive fetal neurosonograms, conserving time and resources. However, it is important to note that advanced software solutions are not yet widely accessible in routine clinical practice, and traditional ultrasound neuro-imaging techniques still need to be taught and mastered. Ongoing developments in AI and ultrasound software will continue to enhance the clinical utility of these technologies, and further studies are needed to evaluate their effectiveness in clinical settings [4-6].

AI Technologies for Neurosonography

A comprehensive evaluation of the fetal CNS

The incremental integration of artificial intelligence (AI) into medical imaging is set to revolutionize the field, with significant advancements seen in areas such as prenatal ultrasound

Live ViewAssist™ ViewAssist™ and Biometry Assist™ automatically recognizes the standard imaging planes, labels anatomical landmarks, and automatically provides biometric measurements while live scanning and extracts targeted images and measurements with no user interaction required

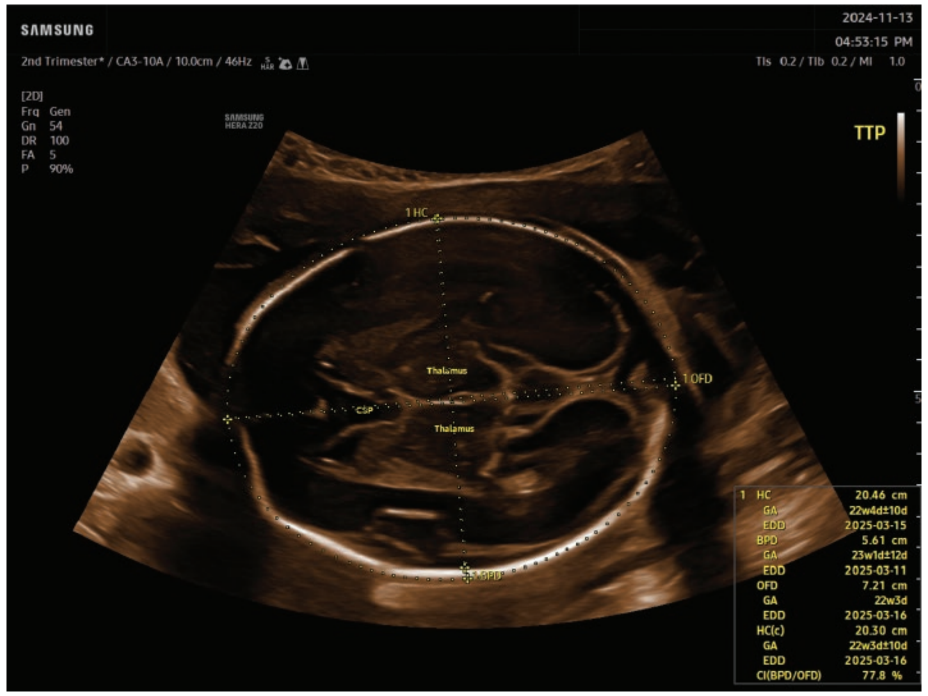


Figure 1: Assist technologies label/measure fetal brain

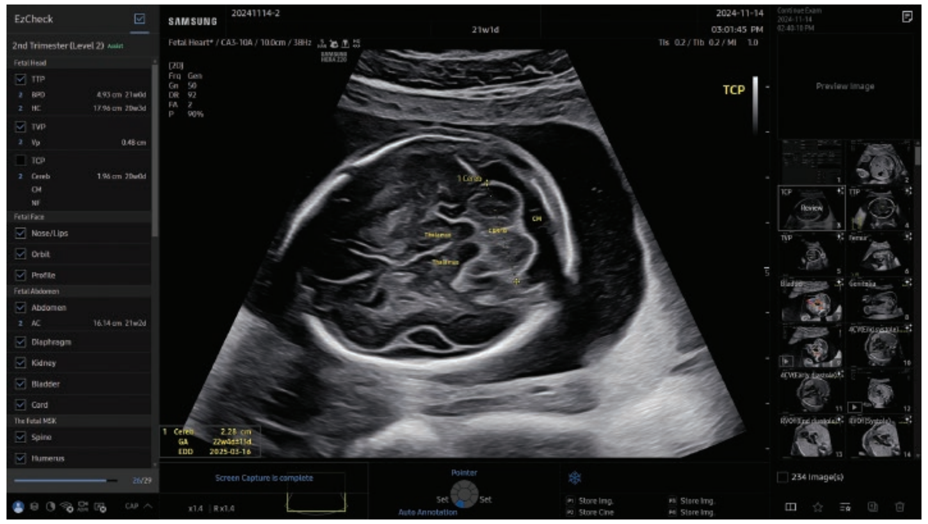


Figure 2: Live ViewAssist automatically captures fetal images

includes labeling and measuring key anatomical structures in the brain. Neurosonography requires visualizing very small and complex three-dimensional structures which can be difficult to delineate. When assessing the fetal brain in 3D, the exam complexity and manipulation can be even more challenging and require significant expertise which includes advanced manipulation of the 3D volume.

Live ViewAssist™ [Fig. 2] and associated licensed technologies such as ViewAssist™ [Fig. 1] and Biometry Assist™ [Fig. 1] (Samsung, Seoul, South Korea) automatically recognizes the standard imaging planes, labels anatomical landmarks, and automatically provides biometric measurements while live scanning and extracts targeted images and measurements with no user interaction required [Fig. 2].

In the advanced 3D assessment of the fetal brain, 5D CNS+ (Samsung, Seoul, South Korea) is an automatic 3D feature for fetal brain assessment & biometric measurements. Provides 9 fetal brain views for diagnosis following the ISUOG guidelines. Displays axial, sagittal, and coronal views and 6 measurements from 3 transverse views generated from a single volume which reduces the complexity related to 3D Volume manipulation.

AI technologies utilizing three-dimensional (3D) ultrasound - 5D CNS+

The integration of high-resolution ultrasound probes and the expansion of 3D ultrasound into routine prenatal practice have improved the detection and diagnosis of CNS anomalies

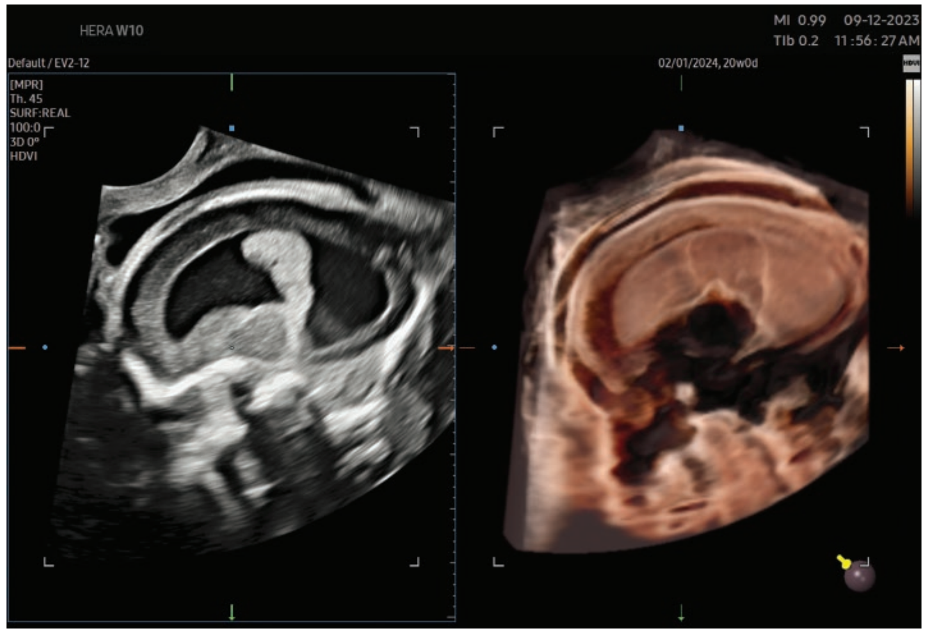


Figure 3-CrystalVue™ 3D rendered fetal brain ventriculomegaly

[Fig. 3] The advantages of three-dimensional (3D) ultrasound in examining the fetal brain have been well-documented, but challenges remain. These include issues with fetal orientation within the 3D volume, difficulty in manipulating images across the x, y, and z planes, and a lack of standardization in the technique. The ability to correctly identify diagnostic planes for detailed neurosonography from 3D volumes is highly operator-dependent and requires significant expertise[7], with notable intra- and interobserver variability and low reproducibility. Samsung's 5D CNS+™ is a notable advancement in addressing these challenges. By offering automated imaging planes, labeling, and measurements, this technology significantly reduces the reliance on manual input. This reduces variability across different practitioners and helps ensure that each patient receives consistent, high-quality care, regardless of the facility or operator.

Key Features of 5D CNS+ include:

Enhanced Visualization: The 5D CNS+ [Fig. 4] offers multi-dimensional imaging, providing a detailed, comprehensive view of the fetal brain. It automatically produces all the required diagnostic imaging planes, facilitating a thorough neurosonogram that complies with clinical guidelines.

AI-driven automatically generate the necessary measurements of fetal brain structures, eliminating human error and the time spent on manual calculations algorithms

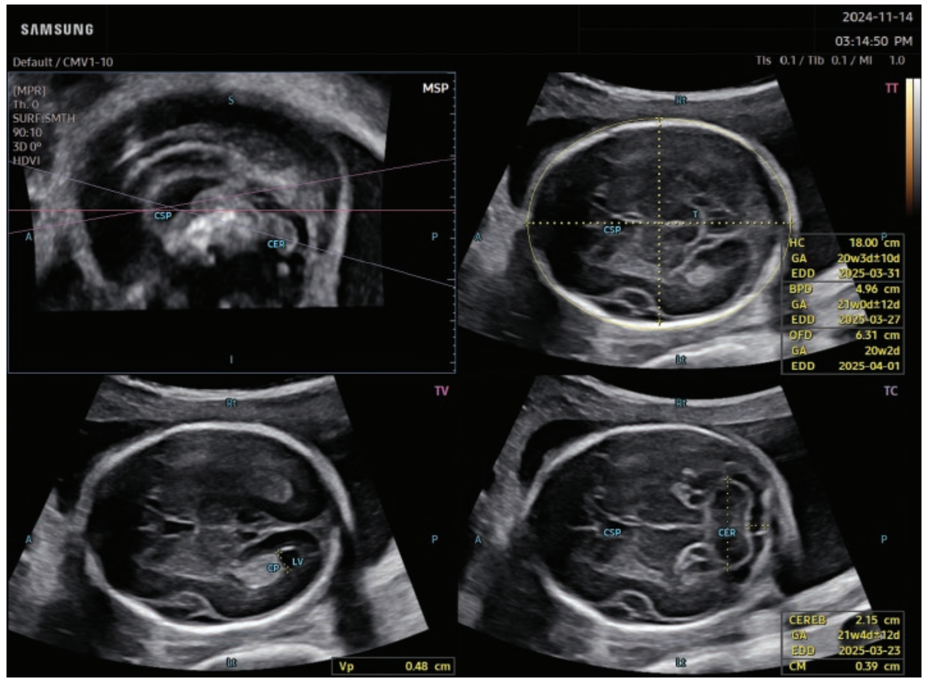


Figure 4: Automatically generated measurements from 3D volume

Automated Measurements: AI-driven algorithms automatically generate the necessary measurements of fetal brain structures[Fig.4], eliminating human error and the time spent on manual calculations. This feature ensures greater consistency and improves diagnostic accuracy.

Improved Workflow: With AI automating image acquisition, labeling, and measurement, clinicians can focus more on interpretation and decision-making rather than adjusting imaging planes or taking repeated measurements. This leads to faster diagnoses, better patient care, and more efficient use of resources.

The Impact of AI on Clinical Practices

In clinical practice, the impact of AI on fetal assessments is profound. These technologies streamline the ultrasound process, ensuring that we capture all relevant anatomical landmarks with greater precision. In my experience, this means that clinicians can focus on the interpretation of the images, rather than the technicalities of image acquisition. This shift ultimately benefits patient care, as it allows us to provide faster, more accurate diagnoses.

Furthermore, AI technologies can serve as a valuable educational tool for medical professionals. As we continually refine our skills in interpreting complex fetal images, AI can help us learn more effectively. Through training modules and simulations, AI can assist in honing ultrasound interpretation skills, especially in areas like fetal brain pathology where expertise is critical.

While transitioning to new technologies may pose challenges, such as resistance from practitioners accustomed to traditional methods, I believe that ongoing education and training can ease this process. Ensuring that clinicians are well-supported and understand the potential benefits of AI will be key to the successful integration of these technologies in prenatal care.

Conclusion

The integration of AI into ultrasound technology represents a transformative shift in how we evaluate the fetal brain. By overcoming the limitations of traditional 2D imaging, these technologies not only enhance diagnostic accuracy but also enable more efficient workflows, helping us provide better care for expectant mothers and their babies. As AI continues to evolve, the future of prenatal care looks even brighter, with the potential for more accurate, timely, and personalized interventions. As clinicians, it's essential that we stay abreast of these technological advancements and continue to incorporate them into our practices. With AI, we have the opportunity to enhance both our diagnostic capabilities and patient care, ultimately improving outcomes for both mother and child.

As clinicians, it's essential that we stay abreast of these technological advancements and continue to incorporate them into our practices

References:

Yeo, L.; Romero, R. Fetal Intelligent Navigation Echocardiography (FINE): A novel method for rapid, simple, and automatic examination of the fetal heart. Ultrasound Obstet. Gynecol. 2013, 42, 268–284.

Kusunose, K.; Abe, T.; Haga, A.; Fukuda, D.; Yamada, H.; Harada, M.; Sata, M. A Deep Learning Approach for Assessment of Regional Wall Motion Abnormality from Echocardiographic Images. JACC Cardiovasc. Imaging 2019, 13 Pt 1, 374–381.

Arnaout, R.; Curran, L.; Zhao, Y.; Levine, J.C.; Chinn, E.; Moon-Grady, A.J. An ensemble of neural networks provides expert-level prenatal detection of complex congenital heart disease. Nat. Med. 2021, 27, 882–891.

British Isles Network of Congenital Anomaly Registers. Congenital Anomaly Statistics England and Wales. 2012. Available from: http://www.binocar.org/content/Annualreport2012_FINAL_nologo.pdf.

Chaoui R, Heling KS, Kainer F, Karl K. Fetale Neurosonografie mittels 3-dimensionaler multiplanarer Sonografie. Z Geburtshilfe Neonatol. 2012;216(1):54–62.

Chen X, Li S-L, Luo G-Y, Norwitz ER, Ouyang S-Y, Wen H-X, Yuan Y, Tian X-X, He J-M. Ultrasonographic characteristics of cortical sulcus development in the human fetus between 18 and 41 weeks of gestation. Chin Med J. 2017;130(8):920–928.

Morris, J.K.; Wellesley, D.G.; Barisic, I.; Addor, M.-C.; Bergman, J.E.H.; Braz, P.; Cavero-Carbonell, C.; Draper, E.S.; Gatt, M.; Haeusler, M.; et al. Epidemiology of congenital cerebral anomalies in Europe: A multicentre, population-based EUROCAT study. Arch. Dis. Child. 2019, 104, 1181–1187.

Author:

Elena Sinkovskaya, MD, graduated from Russian State Medical University with an MD and undergraduate degree. She completed a residency in cardiology and cardiac imaging at the Bakoulev Center for Cardiovascular Surgery, completed a fellowship in prenatal medicine at Uni-Klinikum Bonn and a postdoctoral program at the Bakoulev Center for Cardiovascular Surgery. She currently is a Professor of Obstetrics and Gynecology at Macon & John Brock Virginia Health Sciences at Old Dominion University, where she serves as the Director of Ultrasound Research & Education and the Program Director of the Fetal Cardiology Fellowship. In addition to her academic and clinical roles, she is an esteemed member of the Children's Hospital of King's Daughters Advisory Council, where she represents Maternal-Fetal Medicine. She also serves as Chair of the Continuing Medical Education (CME) Committee and as a member of the Executive Committee of Women in Medicine and Science, as well as the Institutional Review Board (IRB) Committee.

Expert Interview: The Evolution of Gynecologic Ultrasound and AI Integration

Ilan Timor-Tritsch, MD, FAIUM
Hackensack Meridian School of Medicine, New Jersey
Department of Ob/Gyn, Mount Sinai Medical Center, New York
Maternal Resources, New Jersey

Dr. Ilan Timor-Tritsch is a distinguished figure in obstetrics and gynecology, having graduated from the Hebrew University in Jerusalem in 1962. After serving in the Israeli military, he completed his OBGYN residency in Haifa, Israel. His interest in electronics and engineering led him to spend a year conducting research at the Israeli Technion. Through a connection with an engineer from his naval service, he helped develop one of the first transvaginal ultrasound probes in Israel during the late 1970s. Dr. Timor is widely recognized for introducing transvaginal ultrasound in the United States, having authored over 150 articles on the subject. His early work with pattern recognition in ultrasound laid the groundwork for today's AI applications in the field.

How has traditional ultrasound practice evolved in gynecology over the years?

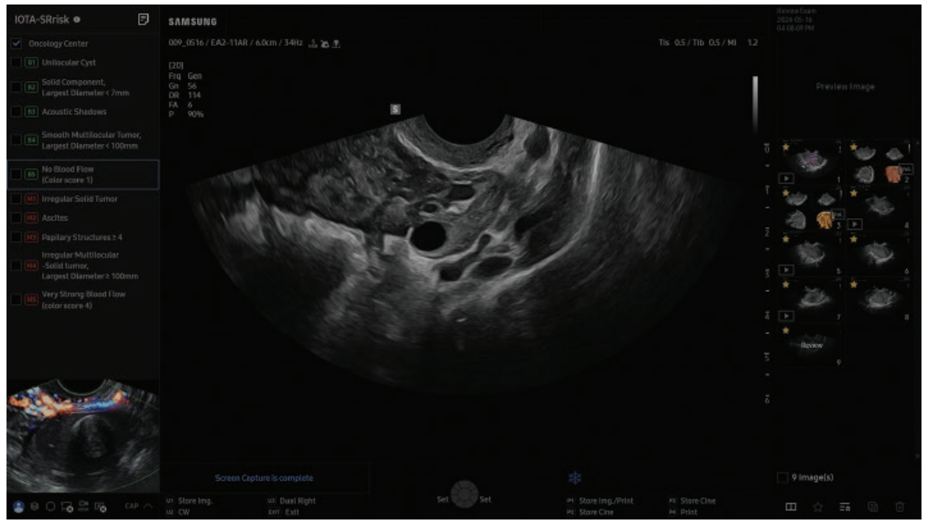
The history of gynecological ultrasound over the past 40 years has seen significant changes. Initially, OBGYNs lost ground to radiologists because they weren't interested in the technology. While this has largely changed in Europe and many other countries, gynecological ultrasound in the United States is still predominantly performed by radiologists. I've written several articles voicing my disagreement with this practice.

I believe gynecological ultrasound is more than just imaging – it's an extension of the bimanual pelvic exam. The transvaginal approach complements the pelvic examination by providing detailed visualization of the ovaries and other pelvic structures. Even at major institutions where I've worked, like Columbia Presbyterian, NYU, and Hackensack Medical Center, most gynecologic ultrasound is still outsourced to radiology. At NYU, I managed to reclaim about 60% of these procedures during my 21-year tenure.

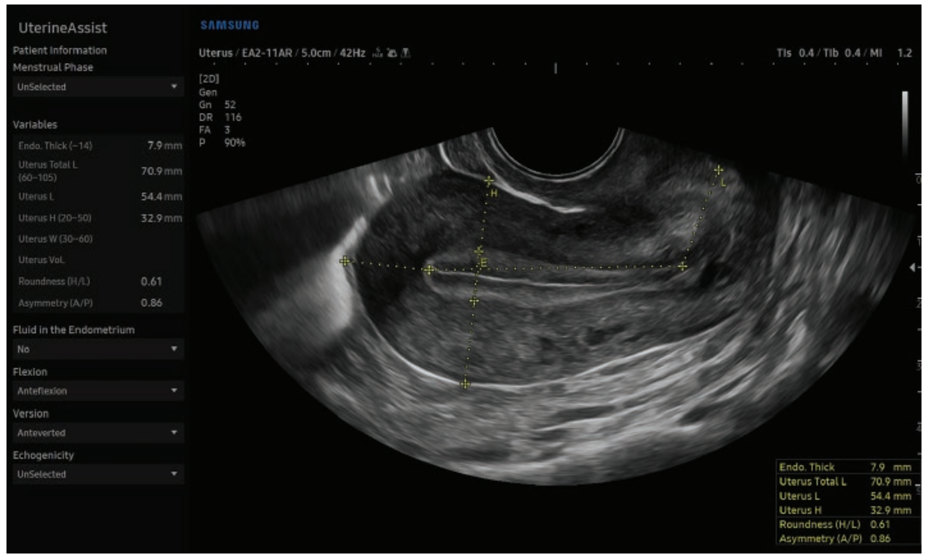
What are some key advancements in AI and automation that are transforming gynecologic ultrasound?

AI offers numerous advantages in diagnosis, treatment planning, and patient care. It

AI offers numerous advantages in diagnosis, treatment planning, and patient care. It improves interpretation through pattern recognition, particularly in detecting and characterizing gynecologic pathology, especially ovarian lesions and endometriosis



IOTA-SRisk calculates ovarian tumor risks



UterineAssist™ measures uterus and aids in detecting abnormalities

AI can provide more precise and accurate management by delineating the borders of different structures through analysis

improves interpretation through pattern recognition, particularly in detecting and characterizing gynecologic pathology, especially ovarian lesions and endometriosis. One specific example is the detection of borderline ovarian tumors, which show typical microcystic appearances in their solid components. These tumors primarily affect young women, and early detection through AI-assisted recognition could help primary care gynecologists make timelier diagnoses.

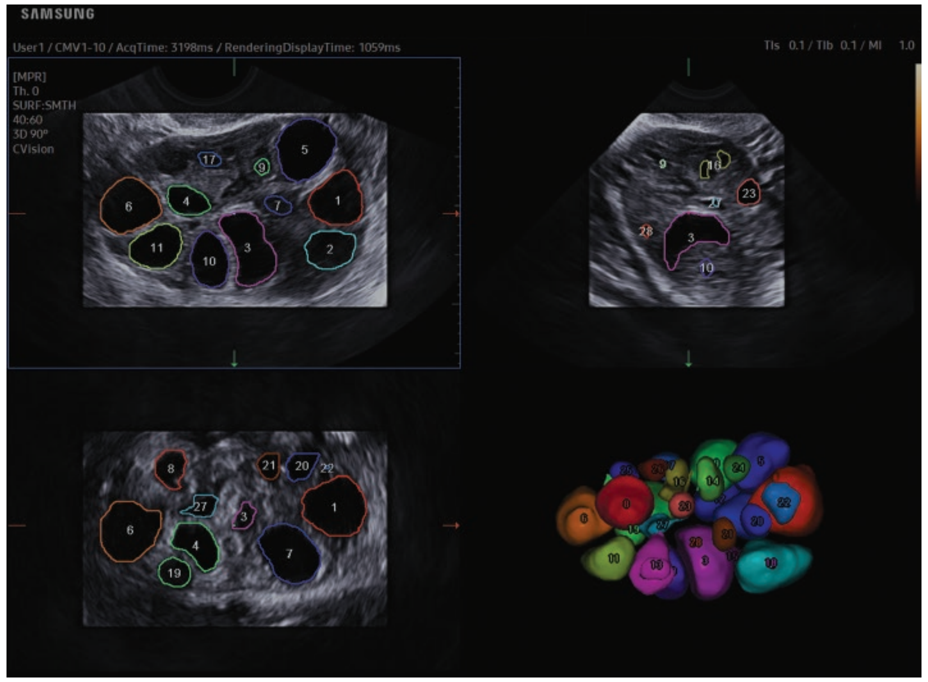
AI can also automate measurements of structures like the uterus, cervix, ovarian volume, and endometrial thickness, making these assessments faster and more reliable than manual measurements. The technology can generate automatic reports and potentially predict outcomes, particularly in differentiating between benign and malignant ovarian tumors. This ties into the work of the International Ovarian Tumor Analysis (IOTA) group, led by Dirk Timmerman in Europe, which has established clear criteria for distinguishing benign from malignant features that AI can recognize.

Furthermore, AI can provide real-time feedback during examinations, potentially shortening the time between examination and diagnosis. It can suggest additional views or measurements that might be needed, improving the completeness of the examination.

How do you see AI algorithms improving the accuracy and efficiency of ultrasound imaging?

AI can provide more precise and accurate management by delineating the borders of different structures through analysis. I've observed this capability in some current machines that can evaluate the uterus, perform measurements, and assess tissue structure almost instantaneously. This provides immediate feedback that enhances diagnostic accuracy.

A particularly interesting application is in follicular counting for fertility treatment. While early attempts at automated 3D follicle counting had limitations due to resolution issues, today's high-resolution transvaginal ultrasound, combined with AI, can better differentiate and measure individual follicles. In the past, when follicles were close together, they would appear merged in the image, making accurate counting impossible. However, with today's improved resolution and AI assistance, we can clearly distinguish separate follicles, measure them, and track them over time. This is especially valuable for reproductive endocrinologists monitoring patients undergoing fertility treatments.



5D Follicle™ identifies and measures ovarian follicles

What do you see as the major barriers to widespread adoption of AI in ultrasound imaging?

First, practitioners need to be convinced that AI is reliable and based on actual clinical data, especially given recent controversies about AI in other fields. There's considerable skepticism about AI's accuracy and reliability, partly due to its misuse in other contexts. We need to demonstrate that medical AI applications are based on sound, real-world clinical data.

Second, users need proper training in how to utilize AI tools effectively. When I recently examined a Samsung system with AI capabilities for uterine measurements, it became clear that practitioners need to know how to engage with the system and ask the right questions. Application specialists who provide training when new ultrasound systems are installed are crucial in this process. They serve as essential intermediaries between manufacturers and clinicians, teaching us not only what AI can do but also when and how to use it effectively.

Clinicians need to understand what algorithms are available, which cases they apply to, how results are displayed, and how reliable the information is. For example, if AI reports that an ovary has 15 follicles greater than 10 millimeters, clinicians need to know how reliable that count is. Without this knowledge transfer, many valuable AI capabilities may go unused.

Can you share any personal experiences with using AI in your research?

I recently wrote an article about cesarean scar pregnancy, a controversial topic where there's debate about whether to classify it as an ectopic pregnancy. I used AI to help me analyze the different perspectives and find ways to reconcile opposing viewpoints. The AI provided fact-based, research-supported insights that I hadn't considered, though I had to modify and adapt these insights rather than use them directly. While journal editors are increasingly requiring authors to disclose AI use, I found it valuable as a tool for expanding my thinking and generating new approaches to complex clinical issues.

Clinicians need to understand what algorithms are available, which cases they apply to, how results are displayed, and how reliable the information is

There's considerable skepticism about AI's accuracy and reliability, partly due to its misuse in other contexts. We need to demonstrate that medical AI applications are based on sound, real-world clinical data

Progression of Artificial Intelligence in Prenatal Ultrasound: Advancing AI Applications in Fetal Heart Assessment

Martin Chavez, MD[1] and Julia Kim, MD[1]

[1]Division of Maternal-Fetal Medicine, Department of Obstetrics and Gynecology, New York University Langone Hospital Long Island, New York University Grossman Long Island School of Medicine, Mineola, NY.

Exploring how AI technologies are transforming fetal diagnostics with precision and efficiency through automation

AI's ability to process vast amounts of data, recognize patterns, and generate novel solutions at unprecedented speeds could catalyze advancements across various fields, from medicine and environmental science to space exploration and beyond

Introduction

The concept of artificial intelligence (AI) in the last few years has taken off in society at speeds not seen most likely since the industrial revolution. The advent of artificial intelligence (AI) is poised to have a transformative impact on society, comparable to the sweeping changes brought about by the Industrial Revolution over 200 years ago. However, while the Industrial Revolution primarily affected how tasks were performed mechanically, AI's influence extends far beyond, fundamentally altering our cognitive capabilities and productivity[1].

AI has the potential to dramatically compress the time required for human achievements. Tasks that once took years or even decades could potentially be accomplished in a fraction of the time. This acceleration of progress is not limited to physical labor but extends to intellectual pursuits, creative endeavors, and complex problem-solving.

Imagine a scenario where scientific breakthroughs that might have taken a century of cumulative human effort could be realized within a single generation. AI's ability to process vast amounts of data, recognize patterns, and generate novel solutions at unprecedented speeds could catalyze advancements across various fields, from medicine and environmental science to space exploration and beyond.

As we embrace the possibilities of AI, it's crucial to steer its development and application towards enhancing human potential rather than replacing it, ultimately aiming for a symbiotic relationship between human creativity and artificial intelligence. As maternal-fetal medicine specialists, we are captivated by the potential symbiosis between artificial intelligence and our field. Our daily practice involves meticulously evaluating pregnancies to detect anomalies that could significantly impact fetal development and maternal health. This detection process serves the important purpose of guiding us in optimizing pregnancy management.

Congenital heart disease (CHD) stands out as a prevalent and severe birth defect globally, ranking as the leading cause of death among infants born with congenital anomalies[2-4]. Making it a perfect opportunity to form a symbiotic relationship melding our field with this groundbreaking technology, which offers unprecedented efficiency, adaptability, and transformative potential across our field, particularly in the area of prenatal ultrasound.

Current estimates indicate that CHD affects approximately 9.4 out of every 1,000 live births worldwide[3]. Even with prenatal ultrasound routinely implemented as a screening tool, detection rates for fetal anomalies vary widely, ranging from 13% to 80%. This significant variation depends on several factors, including the specific literature reviewed, the geographical location where screening is performed, and the policies in place at healthcare facilities. The effectiveness of prenatal ultrasound screening is influenced by factors such as the expertise of the sonographer, the quality of the equipment used, and the gestational age at which the scan is conducted[5].

Current State

As we delve into this topic, it's essential to first acknowledge the challenges our professional societies face in keeping pace with technological advancements. One notable example is the requirement by many journals for authors to disclose the use of artificial intelligence (AI) in manuscript submissions. It raises an intriguing question: will we eventually need to disclose to colleagues, patients, or other stakeholders when AI has been utilized in making a diagnosis? This transparency isn't inherently negative; in fact, it's crucial for maintaining trust and integrity in patient care. However, it's important to remain mindful of these considerations as we continue to advance and integrate AI into medical practice.

Research has already been published on the evaluation of fetal heart anatomical images using artificial intelligence (AI) algorithms, such as HeartAssist™ (Samsung, Seoul, South Korea)[6]. This study compares the performance of AI with that of expert clinicians who routinely assess fetal heart anatomy between 19 and 23 weeks of gestation. Specifically, the study focused on key views such as the four-chamber view, left and right outflow tracts, and the three-vessel view. This research involved 120 consecutive low-risk singleton pregnancies undergoing second-trimester ultrasounds. The findings indicate that technologies like HeartAssist™ can achieve accuracy comparable to expert visual assessments, suggesting their potential utility in evaluating fetal heart structures during the second trimester. In simple terms, the study showed that AI system and clinical experts have high levels of agreement when it comes to identifying the four fetal cardiac views in the study. This means that AI is nearly as effective as clinical experts in evaluating these views. Such findings highlight the potential of AI to support healthcare professionals by providing

Figure 1: HeartAssist™ quickly measures fetal heart

Our findings demonstrate that the AI technology not only has a synergistic effect but also an additive effect that enhances overall outcomes by working in harmony with current practices and contributing additional benefits

Figure 2: Ultrasound challenges

IMPROVING THE ACCURACY AND EFFICIENCY OF WOMEN'S HEALTH ULTRASOUND AND THE ROLE OF ARTIFICIAL INTELLIGENCE TECHNOLOGY

Using the Live ViewAssist technologies may reduce scanning keystrokes an average of 89%, streamlining processes, improving workflow efficiency, and reducing user variability in fetal imaging

reliable diagnostic assistance, although it is important to note that AI should complement rather than replace human expertise. This growing synergy between AI and clinical experts could enhance diagnostic accuracy and efficiency in medical practice.

We leveraged the insights gained from this study to explore the integration of AI technology, HeartAssist™, into our busy ultrasound unit, which conducts over 29,000 ultrasounds annually, including approximately 4,500 anatomical scans and 400 fetal cardiac ultrasounds each year[Figure 1]. We were particularly intrigued by the potential of this technology to serve multiple purposes during our evaluation process. In a busy academic practice, it is essential to balance work efficiently while maximizing educational opportunities for team members, all without compromising patient care. This can be achieved by integrating education into daily clinical routines and leveraging technology. Creating a positive learning environment is crucial; this involves fostering clear communication, providing a balance of autonomy and supervision, and maintaining enthusiasm for teaching. By embedding education within the clinical workflow, academic practices can ensure that learning is continuous and aligned with patient care priorities. This approach not only enhances the skills of healthcare providers but also improves the overall quality of care delivered to patients. Incorporating AI technology into clinical settings has proven to be immensely valuable, as it enhances skill development for beginners and boosts productivity for experienced team members. Initially, there was some skepticism about the integration of this technology. However, it quickly became apparent that AI serves not only as an impressive tool but also as an effective teaching aid and a significant time saver. By facilitating skill sharpening for novices and streamlining workflows for seasoned professionals, AI technology supports a more efficient and educationally enriching environment in clinical practices.

By integrating AI technology into our workflow, we successfully demonstrated its dual role as both a teaching tool and a catalyst for embracing technological advancements among our team members. Considering the concept of uncovering opportunities through challenges, we initiated discussions to introduce AI technology, which we believe would be highly beneficial[Figure 2]. This integration allowed sonographers to receive real-time educational support while performing their tasks, thereby enhancing their skills and efficiency. Importantly, we were able to illustrate to the team the tangible benefits of adopting this technology, which included a significant reduction in the time required to evaluate, identify, and label fetal cardiac images, averaging a 5 to 10% decrease per patient. This improvement not only streamlined operations, but also highlighted the value of AI in enhancing both educational and practical aspects of our practice. Some additional aspects of implementing this technology also were brought to light. When we inquired from our team about the utilization of the technology, we were pleasantly surprised to hear about additional benefits that we had not considered prior to implementation. It allowed the users to create a self base method with the technology to build confidence as well as skill level. The more seasoned sonographers also voice that they felt that the system was a fun way to test their skills against the artificial technology.

Future State

Our findings, along with those from other centers, demonstrate that the AI technology not only has a synergistic effect but also an additive effect. This means that when combined with existing methods, the technology enhances overall outcomes by working in harmony with current practices and contributing additional benefits. This dual impact underscores the potential of integrating advanced technology into various fields to improve efficiency and effectiveness of humans.

We are continuously evaluating AI software to enhance both our workflow and educational goals across various levels of expertise. AI has the potential to significantly improve personalized learning by tailoring educational experiences to individual student needs, accommodating different learning paces and preferences. In terms of workflow enhancements, AI streamlines various tasks, optimizes resource allocation within educational environments.

At our facility, we adopt a step-by-step approach to integrating AI into our workflow. Initially, we assess the AI system in a dedicated workstation, separate from our routine operations. This "offline" evaluation method enables us to thoroughly test the AI software without disrupting our regular processes. By using typical prenatal images within the program, we can effectively assess its performance and capabilities in a controlled environment.

We are currently assessing Samsung's Live ViewAssist™ AI deep learning technology within this controlled environment. This advanced system automatically recognizes the specific views needed during live scanning and after performing a quality assessment of specific

Figure 3: Live ViewAssist automatically acquires fetal images

views, will extract them without any user interaction[Figure 3]. For the views extracted, the system will automatically annotate 47 different anatomical structures with up to 92% accuracy[7]. Live ViewAssist will also measure 46 different anatomical structures using the licensed View Assist™ | Biometry Assist™ | Heart Assist™ technologies[7]. This setup allows us to thoroughly evaluate the technology's capabilities and effectiveness in a controlled setting. We have been pleased with the findings so far. These features have the potential to reduce scanning time and enhance consistency by minimizing user variability. Additionally, features such as EzCheck™ monitor exam progress, while EzReport™ provides instant access to measurement results. Using the Live ViewAssist technologies may reduce scanning keystrokes an average of 89%[7], streamlining processes, improving workflow efficiency, and reducing user variability in fetal imaging.

We will be rolling this program out to our team in a metered fashion to see if the same potential will translate to the ultrasound exam in our busy clinical environment.

Conclusion

The integration of Live ViewAssist AI deep learning technology into our workflow demonstrates significant clinical and operational benefits. By automatically recognizing and extracting specific views during live scanning, the system reduces scanning time and enhances consistency, minimizing user variability. This technology supports tools like BiometryAssist, ViewAssist, and HeartAssist, and features such as EzCheck and EzReport further streamline processes by monitoring exam progress and providing instant measurement results. As we continue to evaluate its effectiveness in a controlled environment, we are optimistic about its potential to improve workflow efficiency and reduce keystrokes. We plan to gradually implement this technology across our team to enhance both educational and practical aspects of our practice, ultimately aiming to improve patient care in our busy clinical setting. The future of prenatal ultrasound with AI integration is incredibly promising, and we are excited to contribute to this transformative process.

Author:

Dr. Martin R. Chavez is a Professor of Obstetrics & Gynecology at NYU Grossman Long Island School of Medicine and Director of Maternal Fetal Medicine and Fetal Surgery at NYU Langone Hospital-Long Island. With over two decades of experience, he specializes in high-risk pregnancies and advanced fetal interventions. Dr. Chavez established a comprehensive fetal surgery program offering specialized services like fetal shunt placements, in utero transfusions, and fetoscopic laser procedures. His research focuses on advancements in prenatal ultrasound and genetic screening.
A respected educator and speaker, Dr. Chavez presents at national and international conferences on topics ranging from prenatal ultrasound to AI applications in obstetrics and gynecology. He is a core faculty member for both the Maternal Fetal Medicine fellowship and ObGyn residency program. Recognized for his contributions, Dr. Chavez has been consistently named a Top Doctor in the New York Metro Area.
He is a Fellow of the American College of Obstetrics & Gynecology and the American Institute of Ultrasound in Medicine. Dr. Chavez's innovative approach extends to exploring AI technologies in obstetrics and gynecology, demonstrating his commitment to advancing the field.

References:

1. Amodei, D. Machines of Loving Grace. 2024 [cited 2024 10/20/24]; Available from: https://darioamodei.com/machines-of-loving-grace.
2. Ailes, E.C., et al., Prenatal diagnosis of nonsyndromic congenital heart defects. Prenat Diagn, 2014. 34(3): p. 214-22.
3. Verdurmen, K.M., et al., A systematic review of prenatal screening for congenital heart disease by fetal electrocardiography. Int J Gynaecol Obstet, 2016. 135(2): p. 129-134.
4. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet, 2018. 392(10159): p. 1789-1858.
5. Bakker, M.K., et al., Prenatal diagnosis and prevalence of critical congenital heart defects: an international retrospective cohort study. BMJ Open, 2019. 9(7): p. e028139.
6. Pietrolucci, M.E., et al., Evaluation of an artificial intelligent algorithm (Heartassist™) to automatically assess the quality of second trimester cardiac views: a prospective study. J Perinat Med, 2023. 51(7): p. 920-924.
7. Data on file. Many variables exist in the customer environment including user techniques, which may affect individual customer experience. Keystroke is defined as any interaction with the ultrasound machine including touchscreen taps and swipes, mouse movement, flat key presses, soft key twists, and soft key presses.

Modern Solutions for Complex Obstetric Care

Jonathan D. Agnew,
PhD, MBA, Adjunct Professor, Faculty of Medicine, University of British Columbia

The evolving landscape of maternal healthcare presents mounting challenges, from rising obesity rates to advanced maternal age complications. Healthcare providers must navigate these complexities while embracing technological innovations, particularly in fetal medicine and telemedicine applications. Patient-centered approaches, supported by AI and rapid diagnostics, are transforming care delivery and improving outcomes in high-risk pregnancies.

Chronic conditions affect over 25% of pregnant women, with nearly half being overweight or obese, contributing to a 26% rise in complications like pulmonary embolism and renal failure

Rising Complexity in Pregnancy Cases

Chronic conditions affect over 25% of pregnant women, with nearly half being overweight or obese, contributing to a 26% rise in complications like pulmonary embolism and renal failure.[1] Obesity during pregnancy increases maternal and fetal risks, including gestational diabetes, hypertensive disorders, and preterm birth.[2] Obesity also complicates antenatal care, increasing the likelihood of undetected fetal anomalies and postoperative complications such as infections and venous thromboembolism.[3]

Impact of Increasing Maternal Age

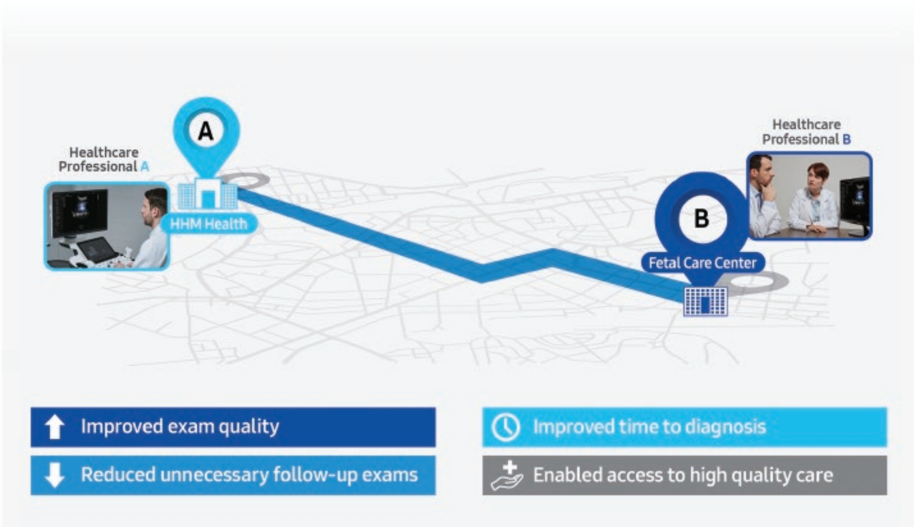
Deferring pregnancy to later in life increases risks due to pre-existing conditions like hypertension and diabetes. Indirect causes, including mental health issues, now lead global maternal mortality rates, particularly among women with pre-existing conditions. Additionally, pregnancy can unmask latent medical conditions, highlighting the need for comprehensive care and long-term health monitoring.[4]

Multiple Gestation Management

The prevalence of multiple gestations has risen significantly due to advances in assisted reproductive technologies. These pregnancies are associated with elevated risks such as preterm labor, low birth weight, and increased maternal complications. These cases highlight the unique challenges posed by carrying multiple fetuses.[5]

Ergonomic Considerations for Healthcare Providers

Obstetric care places physical strain on healthcare providers, with activities like prolonged monitoring and assisting with deliveries causing musculoskeletal stress. Ergonomic hazards such as heavy lifting and



SonoSync™ bridges gap to accessible healthcare.[8]

Samsung's SonoSync™ allows remote control during consultations

long shifts also heighten risks for pregnant healthcare workers, necessitating workplace adjustments to ensure safety.[6]

Technological Innovations in Fetal Medicine

Real-Time Image Sharing Capabilities

Telemedicine consultations have proven transformative in fetal medicine. They enable remote diagnosis with high accuracy, with studies confirming antenatal diagnoses made via telemedicine were validated postnatally. Such consultations also improve clinical outcomes by altering diagnoses in 45.8% of cases and management plans in 33.3%. Moreover, patients, clinicians, and subspecialists report high satisfaction and confidence in these services.[7]

Telesonography Applications

Telesonography, including robotic arm-assisted ultrasound, offers significant benefits in remote and hazardous environments.[9] It provides diagnostic accuracy comparable to in-person sonography, especially for acute conditions. Moreover, novice operators can produce usable images through tele-mentored guidance, showcasing its feasibility in diverse settings.[10]

Dr. Quintero Case Study and Laser Coagulation

The development of fetoscopic laser coagulation techniques has drastically improved survival rates in twin-to-twin transfusion syndrome cases. Over 25 years, the survival rate for both twins rose from 35% to 65%, while at least one twin's survival increased from 70% to 88%. These advancements reflect the efficacy of evolving laser methods, maintaining stable mean gestational age at birth.[11]

Integration with Fetal Therapy Procedures

Advancements in imaging technologies, such as sonography and MRI, have significantly enhanced fetal therapy. These tools support the evaluation and treatment of anomalies, including myelomeningocele and congenital cystic adenomatoid malformation, improving success rates. However, some procedures, like tracheal clip application for congenital diaphragmatic hernia, have been discontinued due to poor outcomes.[12]

Patient-Centered Care Enhancement

Management of Anxiety-Inducing Symptoms

Empathic, patient-centered interventions have been shown to reduce preoperative anxiety and pain, leading to better surgical recovery, increased daily activity, and improved satisfaction with care. These interventions also result in enhanced wound healing outcomes compared to standard approaches.[13]

AI-Assisted Clinical Insights

Artificial intelligence is transforming clinical care by enabling the prediction of diseases through patterns in patient data. AI-driven predictive analytics have proven effective in identifying risk factors for conditions such as diabetes, cardiovascular disease, and certain cancers, significantly enhancing early detection.[14]

Machine learning models provide personalized treatment plans by integrating patient-specific data, such as medical history and genetics, optimizing therapeutic outcomes and minimizing risks. For instance, tailored medication dosages based on individual profiles have demonstrated improved efficacy.[14]

Telemedicine consultations have proven transformative in fetal medicine. They enable remote diagnosis with high accuracy, with studies confirming antenatal diagnoses made via telemedicine were validated postnatally

Advancements in imaging technologies, such as sonography and MRI, have significantly enhanced fetal therapy. These tools support the evaluation and treatment of anomalies, including myelomeningocele and congenital cystic adenomatoid malformation, improving success rates

In medical imaging, AI algorithms rapidly identify anomalies in X-rays and MRIs, enabling timely interventions. This has been instrumental in detecting conditions like tumors, improving diagnostic accuracy and clinical decision-making.[14]

Rapid Diagnosis Capabilities

The healthcare landscape increasingly relies on point-of-care and home-based testing technologies for faster, efficient diagnoses. These advancements address the growing need for timely medical decision-making in an aging population. Portable diagnostic tools enable clinicians to detect diseases like infections more rapidly and efficiently than traditional methods, reducing delays in care.[15]

Emerging technologies, including CRISPR-based diagnostics and portable PCR machines, have expanded diagnostic capabilities significantly. These tools provide highly accurate results quickly, enhancing the ability to manage acute and chronic conditions effectively. For example, portable PCR machines are used to identify pathogens on-site, minimizing the need for centralized lab testing.[15]

Patient Education and Communication Tools

Effective communication between healthcare providers and patients is a cornerstone of patient-centered care. Clear explanations, patient-led decision-making, and discussions about treatment outcomes significantly enhance care quality and patient satisfaction. Addressing barriers to communication remains vital to achieving these goals.[16,17]

Impact on Treatment Planning and Outcomes

Patient-centered communication, particularly in finding common ground, improves health outcomes such as symptom recovery, emotional well-being, and reduced medical utilization. Studies show that patient-centered practices lead to fewer diagnostic tests and referrals, increasing healthcare efficiency.[18] Additionally, patient-centered approaches improve treatment satisfaction and adherence by aligning care with patient preferences and needs.

Research also highlights that patient-centeredness, specifically in medical rehabilitation, enhances self-management and empowerment. These factors contribute significantly to better living conditions and health status over time.[19] Clear communication and collaborative decision-making not only improve outcomes but also foster trust between patients and healthcare providers, creating a supportive environment for recovery and long-term health improvements.

Conclusion

The evolving landscape of medical care, particularly in maternal-fetal medicine, demonstrates significant advances in technological capabilities while highlighting persistent challenges in managing complex pregnancies. From the rising prevalence of obesity and chronic conditions in pregnant women to the transformation of care delivery through telemedicine and AI-assisted diagnostics, healthcare providers must navigate an increasingly sophisticated environment of patient care. The integration of patient-centered approaches, supported by technological innovations such as telesonography and AI-driven predictive analytics, has markedly improved diagnostic accuracy, treatment planning, and patient outcomes. These developments, coupled with enhanced communication tools and rapid diagnostic capabilities, suggest a future where personalized medicine and remote care delivery will play pivotal roles in addressing the complex needs of high-risk pregnancies while maintaining high standards of patient satisfaction and clinical outcomes. However, the success of these advancements ultimately depends on their thoughtful implementation alongside traditional patient-centered care principles, ensuring that technological progress enhances rather than replaces the human element in healthcare delivery.

IMPROVING THE ACCURACY AND EFFICIENCY OF WOMEN'S HEALTH ULTRASOUND AND THE ROLE OF ARTIFICIAL INTELLIGENCE TECHNOLOGY

References:

1. Rosene-Montella K, Lowe S, Nelson-Piercy C. The growing importance of medical problems in pregnancy. Obstetric Medicine. 2010;3(1):1-1.
2. Liat S, Cabero L, Hod M, Yogev Y. Obesity in obstetrics. Best Practice & Research Clinical Obstetrics & Gynaecology. 2015;29(1):79-90.
3. Gilmandyar D, Zozzaro-Smith P, Thornburg LL. Complications and challenges in management of the obese expectant mother. Expert Review of Obstetrics & Gynecology. 2012;7(6):585-593.
4. Magee LA, Lowe S, Nelson-Piercy C. How we deliver obstetric care. Obstetric Medicine. 2016;9(3):101-101.
5. D'Alton M, Breslin N. Management of multiple gestations. International Journal of Gynecology & Obstetrics. 2020;150(1):3-9.
6. Francis F, Johnsunderraj SE, Divya K, et al. Ergonomic Stressors Among Pregnant Healthcare Workers: Impact on pregnancy outcomes and recommended safety practices. Sultan Qaboos University Medical Journal. 2021;21(2):e172.
7. Chan F, Soong B, Lessing K, et al. Clinical value of real-time tertiary fetal ultrasound consultation by telemedicine: preliminary evaluation. Telemedicine Journal. 2000;6(2):237-242.
8. Magee K, Jarett L, Carini B, Carini O. Bridging the Gap to Accessible Healthcare: SonoSyncTM Real-Time Collaborative Solution - Google Search. Accessed January 8, 2025. https://21291849.fs1.hubspotusercontent-na1.net/hubfs/21291849/Whitepapers/SonoSync%20Whitepaper_1-USS_143rev00.pdf
9. Swerdlow DR, Cleary K, Wilson E, Azizi-Koutenaei B, Monfaredi R. Robotic arm–assisted sonography: Review of technical developments and potential clinical applications. American Journal of Roentgenology. 2017;208(4):733-738.
10. Marsh-Feiley G, Eadie L, Wilson P. Telesonography in emergency medicine: a systematic review. PloS one. 2018;13(5):e0194840.
11. Akkermans J, Peeters SH, Klumper FJ, Lopriore E, Middeldorp JM, Oepkes D. Twenty-five years of fetoscopic laser coagulation in twin-twin transfusion syndrome: a systematic review. Fetal diagnosis and therapy. 2015;38(4):241-253.
12. Coleman BG, Adzick NS, Crombleholme TM, et al. Fetal therapy: state of the art. Journal of ultrasound in medicine. 2002;21(11):1257-1288.
13. Pereira L, Figueiredo-Braga M, Carvalho IP. Preoperative anxiety in ambulatory surgery: The impact of an empathic patient-centered approach on psychological and clinical outcomes. Patient education and counseling. 2016;99(5):733-738.
14. Rana MS, Shuford J. AI in Healthcare: Transforming Patient Care through Predictive Analytics and Decision Support Systems. Journal of Artificial Intelligence General Science (JAIGS) ISSN: 3006-4023. 2024;1(1).
15. Bissonnette L, Bergeron MG. Diagnosing infections—current and anticipated technologies for point-of-care diagnostics and home-based testing. Clinical Microbiology and Infection. 2010;16(8):1044-1053.
16. Kwame A, Petrucka PM. A literature-based study of patient-centered care and communication in nurse-patient interactions: barriers, facilitators, and the way forward. BMC nursing. 2021;20(1):158.
17. Lane S, Szabo S, Halbert R, et al. Enhancing patient-health care provider (HCP) communication in oncology care in the United States. Published online 2016.
18. Oates J, Weston WW, Jordan J. The impact of patient-centered care on outcomes. Fam Pract. 2000;49(9):796-804.
19. Plewnia A, Bengel J, Körner M. Patient-centeredness and its impact on patient satisfaction and treatment outcomes in medical rehabilitation. Patient Education and Counseling. 2016;99(12):2063-2070.

Machine learning models provide personalized treatment plans by integrating patient-specific data, such as medical history and genetics

From the rising prevalence of obesity and chronic conditions in pregnant women to the transformation of care delivery through telemedicine and AI-assisted diagnostics, healthcare providers must navigate an increasingly sophisticated environment of patient care

Future Outlook

Jonathan D. Agnew,
PhD, MBA, Adjunct Professor, Faculty of Medicine, University of British Columbia

Rapid technological advancements in obstetric care, particularly in AI algorithms and advanced imaging modalities, are reshaping the landscape of maternal-fetal medicine. While these innovations offer unprecedented opportunities for improved diagnostics and personalized care, the field faces significant challenges including workforce shortages and regulatory oversight concerns. The integration of telehealth and remote monitoring capabilities has emerged as a crucial bridge in addressing healthcare access disparities, particularly for high-risk pregnancies in resource-limited settings.

The integration of artificial intelligence with these imaging modalities has enabled automated image analysis, reducing inter-observer variability and enhancing diagnostic precision

Emerging Technologies

Next-generation AI Algorithms

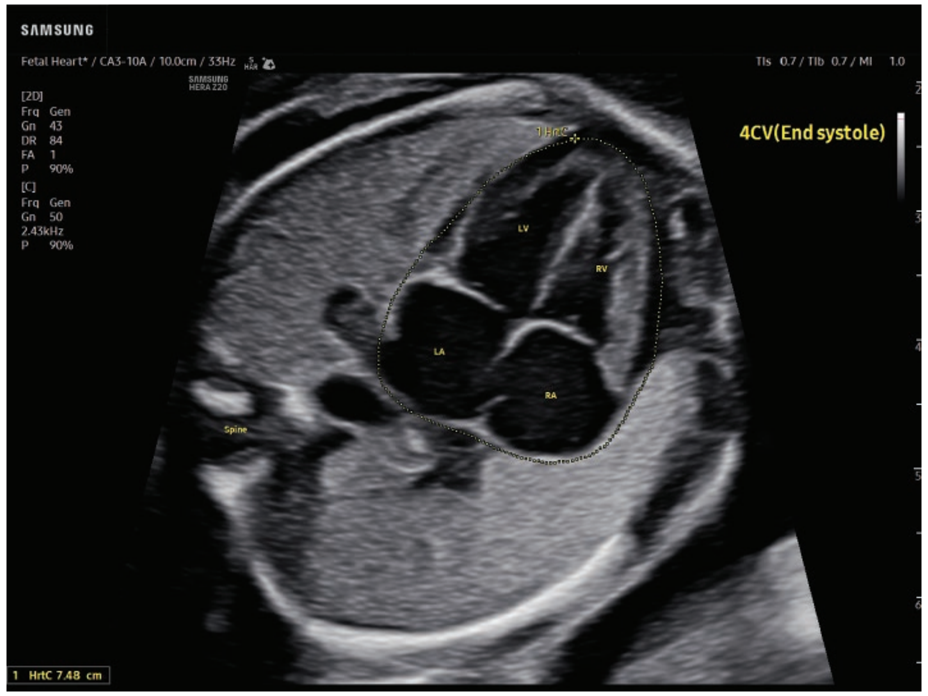
The integration of artificial intelligence in obstetric care represents a transformative advancement in healthcare delivery. Deep learning and transfer learning technologies are enabling unprecedented extraction of medical insights from diverse personal health data sources.[1] These developments are particularly significant in their ability to enhance personalized medicine approaches and improve patient engagement through AI-powered technologies that facilitate more accurate diagnoses and treatment optimization.[2]

Advanced Imaging Modalities

Modern diagnostic imaging techniques have revolutionized the visualization of anatomical and physiological processes, with particular relevance to obstetric care. The evolution of imaging technologies, including advanced ultrasound modalities, has led to improved diagnostic accuracy and enhanced patient safety. Notably, newer hybrid imaging systems such as 3D USCT provide higher resolution and increased reliability in diagnosing and managing complex obstetric conditions.[3] The integration of artificial intelligence with these imaging modalities has enabled automated image analysis, reducing inter-observer variability and enhancing diagnostic precision. Particularly in fetal imaging, machine learning algorithms have demonstrated remarkable accuracy in detecting structural anomalies and assessing fetal growth parameters.

Integration with Diagnostic Tools

The convergence of diagnostic and communication technologies has created new possibilities in obstetric care delivery.



HeartAssist™ detects, labels and measures heart anatomy

IMPROVING THE ACCURACY AND EFFICIENCY OF WOMEN'S HEALTH ULTRASOUND AND THE ROLE OF ARTIFICIAL INTELLIGENCE TECHNOLOGY

This integration manifests primarily in three key areas: point-of-care testing, micro-electromechanical systems, and biomarker discovery.[4] The advancement of miniaturization, nanotechnology, and microfluidics is driving the development of low-cost, user-friendly diagnostic devices with enhanced molecular-level sensitivity.[5]

Potential Breakthrough Technologies

Emerging biomedical technologies show particular promise for obstetric applications. Advanced biomaterials, including hydrogels and cryogels, are revolutionizing tissue engineering and drug delivery systems. Notably, developments in Lab-on-a-Chip technology facilitate rapid diagnostics and molecular analysis, while microneedle technology offers minimally invasive drug administration options.6 In the context of maternal-fetal medicine, nanomaterial-based biosensors are emerging as powerful tools for continuous monitoring of maternal and fetal health parameters. These technologies enable real-time detection of biochemical markers associated with pregnancy complications, potentially revolutionizing the management of high-risk pregnancies.

Clinical Practice Evolution

Changing Role of Healthcare Providers

The field of obstetrics is facing a projected shortage of obstetrician-gynecologists (OB-GYNs), driven by population growth and limited capacity in residency programs. Concurrently, generational changes within the profession are leading to trends such as increased subspecialization, a preference for part-time work, and earlier retirement.[7] These factors collectively exacerbate workforce challenges, potentially impacting the accessibility and quality of care for patients in need of obstetric services.

Impact on Medical Education and Training

Simulation has come to play a larger role in obstetrics and gynecology training. Research demonstrates that simulation improves participant confidence, technical skills, clinical behaviors, and patient outcomes. As its effectiveness becomes increasingly evident, simulation is being widely integrated into the education and practice of obstetrician-gynecologists, becoming a standard component of training programs.[8]

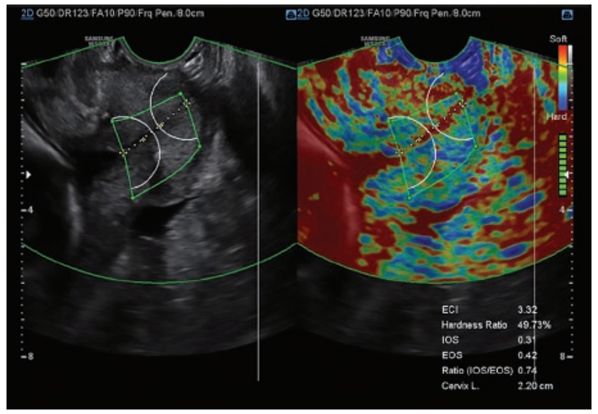
Workflow Optimization Potential

Implementing frameworks such as the Six Sigma strategy optimizes the scheduling and preoperative preparation for cesarean sections and significantly reduce workflow delays in labor and delivery units. Baseline data revealed that 85.87% of scheduled cesarean deliveries experienced delays, with a median delay of 5 hours and 7 minutes, and 8.9% of patients faced postponements to the following day.[9] After the new process was introduced, delays decreased to 75.61%, the median delay time dropped to 3 hours and 43 minutes, and no patients were delayed to the next day. The reduction in mean delay time was statistically significant, demonstrating the effectiveness of this approach. LaborAssist™ provides information of the progress of delivery by the automatic measurement of AoP* (Angle of Progression) and the direction of the fetal head.[10] This not only helps in effective communication between the healthcare professionals and mothers, but also assists in making delivery decisions for the healthcare professionals. E-Cervix™ is another helpful tool. E-Cervix™ is an elastography tool to provide a semi-quantitative assessment of cervical tissue stiffness to aids in determining premature cervical softening associated with premature labor.[11] It enhances reproducibility and reduces inter-observer variation through

Recent advances in wearable technology have particularly impacted prenatal care, with continuous monitoring devices capable of detecting early signs of complications such as preeclampsia and gestational diabetes

LaborAssist™ automatically measures the AoP

The implementation of machine learning algorithms in analyzing these metrics has enabled healthcare systems to identify patterns and predict potential complications before they manifest clinically



E-Cervix™ uses elastography to determine cervical softening.[11,12]

non-user dependent compressions. It uses nearby arterial pulsations, respiration, bowel, etc. for tissue compressions.[12]

Remote Healthcare Delivery Advancement

Telehealth and remote patient monitoring technologies are increasingly vital in obstetric care delivery.[13] These systems enable proactive interventions through detailed health data capture and analysis.[14] The integration of peripheral devices and high-definition imaging capabilities has created an information-rich environment for remote healthcare delivery.15 Recent advances in wearable technology have particularly impacted prenatal care, with continuous monitoring devices capable of detecting early signs of complications such as preeclampsia and gestational diabetes. These innovations have proven especially valuable in managing high-risk pregnancies in resource-limited settings, where access to specialized care may be restricted.

Healthcare System Impact

Cost Implications and Economic Benefits

The increasing incidence of cesarean delivery has been shown to have widespread beneficial effects across countries. Providing cesarean delivery to 90% of obstructed labor cases in 49 countries could avert 59,100 instances of obstetric fistula and save 16,800 maternal lives.[16] The cost per disability-adjusted life-year averted ranges from $251 to $3,462, with a median of $304, demonstrating cost-effectiveness in addressing this critical need. Additionally, the benefit-cost ratio, ranging from 0.6 to 69.9 with a median of 6.0, underscores that the economic benefits substantially outweigh the costs in most countries.

Access to Care Improvements

By allowing healthcare workers to maintain better communicate with patients, Telehealth interventions demonstrated improved obstetric outcomes, particularly in smoking cessation and breastfeeding support.[17] They reduced the need for in-office visits for high-risk obstetric monitoring while maintaining maternal and fetal health outcomes. One study reported a decrease in diagnosed preeclampsia among women with gestational hypertension. Telehealth effectively supported the continuation of oral and injectable contraception, with a text-based intervention increasing oral contraceptive use at six months. Telehealth provision of medication abortion services showed comparable clinical outcomes to in-person care while enhancing access to early abortion. Additionally, limited studies highlighted the potential of telehealth for improving notification of sexually-transmitted infections and app-based interventions for urinary incontinence management.

Quality Metrics and Outcomes

Health-weighted composite quality metrics are emerging as valuable tools for measuring healthcare system performance. These metrics, combined with patient-reported outcome measures and experience measures (PREMs), provide comprehensive insights into care quality and patient satisfaction.[18,19] The implementation of machine learning algorithms in analyzing these metrics has enabled healthcare systems to identify patterns and predict potential complications before they manifest clinically. This predictive capability has demonstrated particular value in reducing maternal morbidity rates and improving neonatal outcomes in high-risk populations. Indeed, reports on decision support systems and electronic health records indicate three major benefits on quality: increased adherence to guideline-based care, enhanced surveillance and monitoring, and decreased medication errors.20 The primary domain of improvement was preventive health, and the major efficiency benefit shown was decreased utilization of care.

Regulatory Considerations and Challenges

Recent controversies around obstetrics and gynecology devices, such as sterilization devices and pelvic meshes, emphasize regulatory challenges. A review of U.S. FDA premarket approvals from 2000 to 2015 identified 18 device approvals, with common indications for endometrial ablation (33%), contraception (28%), and fetal monitoring (17%).[21] Approval times ranged from 178 to 1,399 days, and 42% of devices relied on nonrandomized trials. Post-market surveillance was required for only 67% of devices, and three were later withdrawn due to safety concerns or lack of clinical benefit. These findings highlight weaknesses in device regulation and the need for greater specialty oversight to ensure safety and efficacy.

Global Healthcare Implications

Efforts to improve women's health globally have led to positive changes, particularly in obstetrics and gynecology, but significant challenges remain. Maternal mortality has been significantly reduced in regions with access to antibiotics, emergency obstetric care, and safe blood transfusions.[22] In Nordic countries, low maternal mortality ratios and effective maternity services contrast sharply with many parts of the world where limited infrastructure and skilled obstetric care contribute to high maternal death rates. Historical analyses emphasize the importance of improved patient transportation, organized maternity care, and access to skilled obstetric assistance in reducing deaths due to obstetric hemorrhage.

Changing reproductive health priorities, such as postponing pregnancies to advanced age, have increased the use of assisted reproduction technologies, introducing new challenges and ethical dilemmas. Additionally, advances in education and training for specialists in obstetrics and gynecology are needed to address evolving priorities and ensure quality care. Clinical practices and maternity care services must continue to adapt, with a focus on patient safety, informed choice, and shared decision-making remaining central to improving outcomes in women's healthcare.

Conclusion

The landscape of obstetric care continues to evolve rapidly, driven by technological innovation and changing healthcare delivery models. The convergence of AI-powered diagnostics, advanced imaging technologies, and remote monitoring capabilities presents unprecedented opportunities to enhance patient care, while challenges persist in workforce availability, regulatory oversight, and global healthcare disparities. As the field moves forward, success will depend on thoughtful integration of emerging technologies with traditional clinical practice, while ensuring advances in obstetric care translate into meaningful improvements in maternal and fetal health outcomes across all populations.

The convergence of AI-powered diagnostics, advanced imaging technologies, and remote monitoring capabilities presents unprecedented opportunities to enhance patient care, while challenges persist in workforce availability, regulatory oversight, and global healthcare disparities

References:

1 Mamoshina P, Ojomoko L, Yanovich Y, et al. Converging blockchain and next-generation artificial intelligence technologies to decentralize and accelerate biomedical research and healthcare. Oncotarget. 2017;9(5):5665.
2 Velagaleti S, Krishna A, Lakshmi D. Improving performance of clinical and operational workflows in health tech domain using artificial intelligence. Int J Res Appl Sci Eng Technol. 2023;11(6):3929-3932.
3 Hussain S, Mubeen I, Ullah N, et al. Modern diagnostic imaging technique applications and risk factors in the medical field: a review. BioMed research international. 2022;2022(1):5164970.
4 Malik NN. Integration of diagnostic and communication technologies. Journal of telemedicine and telecare. 2009;15(7):323-326.
5 Zarei M. Advances in point-of-care technologies for molecular diagnostics. Biosens Bioelectron. 2017;98:494-506. doi:10.1016/j.bios.2017.07.024
6 Bhat S, Kumar A. Biomaterials and bioengineering tomorrow's healthcare. Biomatter. 2013;3(3):e24717.
7 Rayburn WF, Tracy EE. Changes in the Practice of Obstetrics and Gynecology. Obstetrical & gynecological survey. 2016;71(1):43-50. doi:10.1097/OGX.0000000000000264
8 Dillon S. Simulation in Obstetrics and Gynecology: A Review of the Past, Present, and Future. Obstetrics and gynecology clinics of North America. 2021;48(4):689-703. doi:10.1016/j.ogc.2021.07.003
9 Maines JL, Shollenberger C, Brinton A, et al. 1029: Optimization of labor and delivery procedure flow using six sigma. American journal of obstetrics and gynecology. 2019;220(1):S660-S660. doi:10.1016/j.ajog.2018.11.1053
10 Oh MJ. LaborAssist: An Automatic Measurement Tool for Labor Assessment and Management. Samsung https://images.samsung.com/is/content/samsung/assets/pl/business/ultrasonograf/wiedza/white_paper_LaborAssist_HS60_50_Korea_2019.pdf
11 Park HS, Kwon H, Kwak DW, et al. Addition of cervical elastography may increase preterm delivery prediction performance in pregnant women with short cervix: a prospective study. Journal of Korean medical science. 2019;34(9):e68.
12 Patberg ET, Wells M, Vahanian SA, et al. Use of cervical elastography at 18 to 22 weeks' gestation in the prediction of spontaneous preterm birth. American Journal of Obstetrics and Gynecology. 2021;225(5):525-e1.
13 Magee K, Jarett L, Carini B, Carini O. Bridging the Gap to Accessible Healthcare: SonoSyncTM Real-Time Collaborative Solution - Google Search. Accessed January 8, 2025. https://21291849.fs1.hubspotusercontent-na1.net/hubfs/21291849/Whitepapers/SonoSync%20Whitepaper_1-USS_143rev00.pdf
14 Jeddi Z, Bohr A. Remote patient monitoring using artificial intelligence. In: Artificial Intelligence in Healthcare. Elsevier; 2020:203-234.
15 Wilson LS, Maeder AJ. Recent directions in telemedicine: review of trends in research and practice. Healthcare informatics research. 2015;21(4):213-222.
16 Alkire BC, Vincent JR, Burns CT, Metzler IS, Farmer PE, Meara JG. Obstructed labor and caesarean delivery: the cost and benefit of surgical intervention. Dietz HP, ed. PloS one. 2012;7(4):e34595-e34595. doi:10.1371/journal.pone.0034595
17 DeNicola N, Grossman D, Marko K, et al. Telehealth Interventions to Improve Obstetric and Gynecologic Health Outcomes: A Systematic Review. Obstetrics and gynecology (New York 1953). 2020;135(2):371-382. doi:10.1097/AOG.0000000000003646
18 Braithwaite S, Stine N. Health-weighted Composite Quality Metrics Offer Promise to Improve Health Outcomes in a Learning Health System. eGEMs. 2013;1(2).
19 Kingsley C, Patel S. Patient-reported outcome measures and patient-reported experience measures. Bja Education. 2017;17(4):137-144.
20 CHAUDHRY B, WANG J, WU S, et al. Systematic review : Impact of health information technology on quality, efficiency, and costs of medical care. Annals of internal medicine. 2006;144(10):742-752. doi:10.7326/0003-4819-144-10-200605160-00125
21 Walter JR, Hayman E, Tsai S, Ghobadi CW, Xu S. Medical Device Approvals Through the Premarket Approval Pathway in Obstetrics and Gynecology From 2000 to 2015: Process and Problems. Obstetrics and gynecology (New York 1953). 2016;127(6):1110-1117. doi:10.1097/AOG.0000000000001430
22 Acharya G. Changing priorities in women's health. Acta obstetricia et gynecologica Scandinavica. 2015;94(6):559-560. doi:10.1111/aogs.12659