INPLASY

INPLASY2024100118
doi: 10.37766/inplasy2024.10.0118
Received: 27 October 2024
Published: 27 October 2024

Self and family caregiver-operated ultrasound: A scoping review

Tonkikh, O; Specktor-Fadida, B.

Corresponding author:
Orly Tonkikh

otonkikh@univ.haifa.ac.il

Author Affiliation:
University of Haifa.

ADMINISTRATIVE INFORMATION

Support - None.

Review Stage at time of this submission - The review has not yet started.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY2024100118

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 27 October 2024 and was last updated on 27 October 2024.

INTRODUCTION

Review question / Objective To investigate the current status of patient- and family-performed sonography including its application types, quality, outcomes, user perspectives, implementation challenges, and the potential role of AI in addressing these challenges and improving outcomes.
(1) To identify application types and patterns of patient- and family-performed (non-professional) sonography
(2) To identify challenges related to implementation of patient- and family-performed sonography in each application
(3) to describe patient-, family- and healthcare professional perspectives on the implementation of self-performed sonography
(4) to identify the outcomes of patient- and family-performed sonography
(5) to review AI applications that address patient- and family-performed sonography challenges.

Background Ultrasound (US) technology has been used for decades in clinical practice for a wide range of applications, including prenatal care, cardiovascular monitoring, musculoskeletal assessments, and the detection of abdominal or pelvic conditions. The aging population has created a need for innovative healthcare solutions that can optimize the capacity of healthcare resources. Traditionally confined to clinical settings, US technology is increasingly being adapted for home use, with the potential to help patients and families to perform these procedures themselves [1]. This shift has been facilitated by the development of small, portable devices that maintain high imaging quality while being accessible to non-professional users [2].
At the same time, the advancement of Artificial Intelligence (AI) technologies has a potential to enhance clinical decision making based on novice US user scans. AI can be used to help with guiding image acquisition, improving quality of scans, providing real time guidance of probe positioning, and assisting in the interpretation of results [3].

These advancements support the growing trend of transitioning care from healthcare institutions to the community, allowing for better monitoring of various clinical conditions and early identification of pathology [4-6]. It may increase access to medical imaging services in a timely manner for poorly supported geographical areas or for individuals with mobility limitations.

Self-performed US empowers patients and families by enabling them to take a more active role in managing their health [7], which can lead to reduced healthcare utilization, including fewer hospital admissions and emergency department visits [4,5]. Additionally, these technologies provide valuable decision support for both clinicians and families, ultimately improving patient and caregiver outcomes.

Patient or family-performed US may allow patients and caregivers to better manage their care according to their preferences and needs by offering flexibility in when and where imaging is performed. This personalized approach enables timely monitoring of health conditions without the constraints of clinic visits, allowing patients and families to follow their routines [4,6].

Rationale The use of self-administered US is rapidly growing due to its potential to enhance patient outcomes, despite its reliance on the operator's proficiency. Yet, the scope of its utilization across clinical applications and its implementation in healthcare systems remained mostly fragmented.

One of the most significant gaps lies in understanding the capabilities of novice operators in making clinical decisions across different application types. While the technology offers the potential for use among non-professional users such as patients and family caregivers, there is limited understanding of how effectively these scans can be interpreted and used for clinical decisions. This raises concerns about diagnostic accuracy, the risk of misinterpretation, and the overall reliability of the technology in real-world settings when operated by users with minimal training. The development of AI technologies offers a promising solution to some of these challenges.

Previous reviews on handheld US mainly focuses on clinician-guided scans in both clinical and non-clinical settings [3, 8-10]. These reviews investigated point-of-care (POC) and telemedicine US performed by providers with varying levels of sonography expertise. These reviews demonstrate the feasibility of POC sonography and its potential to improve access to care in remote and low-resource settings, ultimately enhancing the quality of care. One review also examined the application of AI in this setting [3]. These studies are interesting as they show the ability of less experienced sonography users and portable US devices and potentially with reduced quality to contribute sonography-based decision making [3, 8-10].

To the best of our knowledge, only one review has synthesized findings from studies focused on self-operated ultrasound; yet focused only on pregnancy use case [10]. This review highlighted the potential feasibility of self-administered ultrasound and reported high levels of patient satisfaction. Our aim is to expand this scope by reviewing a variety of use cases for self-operated ultrasound across different acute and chronic conditions. This includes patients with various clinical, functional, and cognitive capabilities, as well as different degrees of family involvement in medical and nursing care tasks. By integrating evidence from these diverse applications, we aim to assess the readiness of self-performed ultrasound technologies and evaluate their impact on patient and family outcomes. Additionally, mapping AI tools supporting probe positioning, quality enhancement and results interpretation could facilitate layperson performance of ultrasound scans and identify unexplored challenges.

METHODS

Strategy of data synthesis We plan to search in the following databases: PubMed, Cochrane, SCOPUS, Web of Science, and CINAHL. We will focus on three concept categories: ultrasound, operation and patient and family self operation. The first concept includes terms capturing ultrasound imaging and device, such as sonography, Echocardiography, doppler. The second concept captures the scanning process, including performed, operated. The third concept indicates scanning by patients and families, including self, patient, family, layperson and unprofessional. If applicable, truncations will be incorporated. The search strategy will include co-occurrence of terms from the three concepts in title, abstract and key words. Items focused on non-relevant strategies will be excluded using the operator NOT (e.g., ultrasound operated procedures). Relevant thesaurus terms for each concept will be applied for PubMed and CINAHL searches.

Eligibility criteria The inclusion criteria include studies focused on ultrasound imaging, administered/ operated by laypersons, such as patients, family members, and paid caregivers in non-clinical settings. Types of studies include peer-reviewed publications of observational, case studies, randomized controlled trials, quantitative and qualitative studies. This scoping review will exclude any imaging technology besides sonography, scans administered by healthcare professionals, robots and non-human scans.

Source of evidence screening and selection Inter rater reliability of source selection process will be performed by two reviewers, independently. Any disagreements will be solved by consensus or by the decision of a third reviewer.
Title and abstract screening will be conducted in duplicate, with both researchers independently marking studies for inclusion, exclusion, or uncertain status. After evaluating 10% of the studies, the researchers will discuss any discrepancies in their screening process. If necessary, adjustments to the screening process will be made. In cases where agreement cannot be reached, a third researcher, blinded to the prior decisions, will make the final decision.
Following the title and abstract screening, two researchers will assess eligibility of at least five randomly selected full texts. Discrepancies will be discussed and adjustments to the eligibility assessment process will be made if needed. In cases where agreement cannot be reached, a third researcher will make the final determination.
Insights from the eligibility assessment will inform adjustments to the data extraction tool. Full-text retrieval will be conducted by at least one researcher. After extracting data from 10% of the studies, findings will be reviewed for inconsistencies. Adjustments to the extraction approach will be made as needed. A third researcher will provide guidance in cases of disagreement.

Data management Data management will be performed using Covidence tool. The search results will be exported to Covidence and duplicates will be removed. The following information for each included full-text will be retrieved: Study characteristics (e.g., year, country, design, population), type of the ultrasound device, quality, setting, operator (e.g., patient, family, paid caregiver), guidance by professionals, training, interpretation, utilization (e.g., diagnostic/therapeutic, real time, automatic), AI applications, Outcomes, user and other stakeholders perspectives. The extraction tool will be adjusted according to the accumulated knowledge.

Reporting results / Analysis of the evidence We anticipate methodological heterogeneity across the studies, encompassing both quantitative and qualitative research. The data collected for the review will be synthesized in tables summarizing information according to the extraction tool described. The purpose of the studies and major findings will be coded and synthesized according to the specific aims.

Presentation of the results Prisma flow chart and tables summarizing study characteristics, sonography characteristics, applications and perceptions will be presented as applicable. Figures will be considered according to synthesis process.

Language restriction None.

Country(ies) involved Israel.

Keywords ultrasound; sonography; self-operated ultrasound; self-scanning; artificial intelligence; home ultrasound; non-professional operator; handheld sonography; ultraportable sonography; patient-performed ultrasound; family-performed ultrasound; telemedicine.

Dissemination plans Peer-reviewed paper and conference presentations.

Contributions of each author
Author 1 - Bella Specktor-Fadida - Developing the search strategy and executing it, conducting title/abstract and full-text screening, synthesizing, evaluating and reporting the results, generating the manuscript, and addressing review comments.
Email: bspecktor@univ.haifa.ac.il
Author 2 - Orly Tonkikh - Developing the search strategy and executing it, conducting title/abstract and full-text screening, synthesizing, evaluating and reporting the results, generating the manuscript, and addressing review comments.
Email: otonkikh@univ.haifa.ac.il

References:
1. Kirkpatrick, A. W., McKee, J. L., Couperus, K., & Colombo, C. J. (2022). Patient self-performed point-of-care Ultrasound: using Communication technologies to empower patient self-care. Diagnostics, 12(11), 2884.
2. Hu, H., Hu, C., Guo, W., Zhu, B., & Wang, S. (2024). Wearable ultrasound devices: An emerging era for biomedicine and clinical translation. Ultrasonics, 107401.
3. Kim, S., Fischetti, C., Guy, M., Hsu, E., Fox, J., & Young, S. D. (2024). Artificial Intelligence (AI) Applications for Point of Care Ultrasound (POCUS) in Low-Resource Settings: A Scoping Review. Diagnostics, 14(15), 1669.
4. Nir, O., Dvir, G., Galler, E., Axelrod, M., Farhi, A., Barkai, G., ... & Tsur, A. (2024). Integrating technologies to provide comprehensive remote

fetal surveillance: A prospective pilot study. International Journal of Gynecology & Obstetrics, 164(2), 662-667.
5. Malia, L., Nye, M. L., & Kessler, D. O. (2024). Exploring the Feasibility of At-Home Lung Ultra-Portable Ultrasound: Parent-Performed Pediatric Lung Imaging. Journal of Ultrasound in Medicine, 43(4), 723-728.
6. Muta, M., Takahashi, T., Tamai, N. et al. (2024). Pelvic floor muscle contraction automatic evaluation algorithm for pelvic floor muscle training biofeedback using self-performed ultrasound. BMC Women's Health, 24, 219. https://doi.org/10.1186/s12905-024-03041-y
7. Mor, L., Weiner, E., Marom, O., Tairy, D., Nardi-Arad, M., Barda, G., ... & Levy, M. (2024). The effect of home ultrasound on maternal anxiety in patients with previous recurrent pregnancy loss: A randomized control trial. American Journal of Obstetrics & Gynecology MFM, 6(10), 101447.
8. Gharahbaghian, L., Anderson, K. L., Lobo, V., Huang, R. W., Poffenberger, C. M., & Nguyen, P. D. (2017). Point-of-Care Ultrasound in Austere Environments: A Complete Review of Its Utilization, Pitfalls, and Technique for Common Applications in Austere Settings. Emergency medicine clinics of North America, 35(2), 409–441. https://doi.org/10.1016/j.emc.2016.12.007
9. Alhussein M. (2024). Use of Real-Time Remote Tele-mentored Ultrasound Echocardiography for Cardiovascular Disease Diagnosis in Adults: A Systematic Review. Ultrasound in medicine & biology, 50(6), 779–787. https://doi.org/10.1016/j.ultrasmedbio.2024.01.073
10. Kariman, S. S., van den Heuvel, J. F. M., Adriaanse, B. M. E., Oepkes, D., & Bekker, M. N. (2024). The Potential of Tele-Ultrasound, Handheld and Self-Operated Ultrasound in Pregnancy Care: A Systematic Review. Prenatal diagnosis, 10.1002/pd.6679. Advance online publication. https://doi.org/10.1002/pd.6679.