

Silva, D., Baptista, R., & Fernandes, M. (2025). Nurses' Use of Ultrasonography in Emergency Departments: a Scoping Review Protocol. *Doente Crítico* – Revista Científica da Sociedade Portuguesa de Enfermagem em Doente Crítico, 1(1).
<https://doi.org/10.63176/tnpgpy51>

ARTIGO ORIGINAL | ORIGINAL ARTICLE | ARTÍCULO ORIGINAL

Nurses' Use of Ultrasonography in Emergency Departments: a Scoping Review Protocol.

Uso de Ecografia por Enfermeiros em Serviços de Urgência: Protocolo de uma Scoping Review.

Uso de ecografia por enfermeiros en servicios de urgencias: protocolo de scoping review.

David Silva^{1*} , Rui Baptista¹ , Maria Fernandes¹ 

Afilições

¹ Escola Superior de Enfermagem de Coimbra; Unidade de Investigação em Ciências da Saúde: Enfermagem (UICISA:E), Coimbra

Palavras-chave

Ecografia; Serviço de Urgência; Enfermeiros; Revisão de Escopo

Keywords

Ultrasonography; Hospital Emergency Service; Nurses; Scoping Review

Palabras clave

Ecografía; Servicio de Urgencias; Enfermeros; Revisión de Alcance

Autor Correspondente/Corresponding Author*: David Silva

Correio eletrónico: davidvitoriasilva@esenfc.pt

Received: 23th april 2025 | **Submissão:** 23 abril 2025

Accepted: 26th june 2025 | **Aceitação:** 26 junho 2025

ABSTRACT

Introduction: Ultrasonography is a non-invasive, cost-effective imaging tool that uses high-frequency sound waves to generate images of internal organs and tissues. Its integration into nursing practice, especially in emergency departments (EDs), has the potential to enhance patient care, reduce healthcare costs, and improve outcomes. Despite growing evidence supporting nurses' use of ultrasonography in various settings, its application in EDs remains underexplored.

Objective: This scoping review aims to map the evidence regarding ultrasonography use by nurses in EDs, focusing on its clinical applications and contributions to nursing practice.

Methods: Following the Joanna Briggs Institute (JBI) framework, this protocol adheres to PRISMA-ScR guidelines. Studies involving nurses in EDs, published within the last five years in English, Portuguese, or Spanish, will be included. Databases such as MEDLINE and CINAHL will be searched using a comprehensive strategy, and results will be managed with Rayyan. Data will be extracted using a JBI template and analyzed through tables and narrative synthesis to identify themes and gaps in the literature.

Results: The findings are expected to highlight how nurses in EDs use ultrasonography on their interventions, its clinical benefits, and its potential to improve patient outcomes and workflow efficiency.

Conclusion: This review will provide evidence-based insights to inform future research, guide training initiatives, and support the integration of ultrasonography into ED nursing practice.

RESUMO

Introdução: A ecografia é uma ferramenta de imagem não invasiva e económica que utiliza ondas sonoras de alta frequência para gerar imagens de tecidos e órgãos internos. A sua integração na prática de enfermagem, especialmente nos serviços de

urgência (SU), tem o potencial de melhorar os cuidados aos utentes, reduzir os custos em saúde e otimizar os resultados clínicos. Apesar das evidências crescentes que apoiam a utilização da ecografia por enfermeiros em vários contextos, a sua aplicação nos SU permanece pouco explorada.

Objetivo: Esta *scoping review* visa mapear a evidência sobre o uso da ecografia na intervenção dos enfermeiros no serviço de urgência, com foco nas suas aplicações clínicas e contribuições para a prática de enfermagem.

Métodos: Seguindo a metodologia do *Joanna Briggs Institute* (JBI), este protocolo está em conformidade com as diretrizes PRISMA-ScR. Serão incluídos estudos sobre enfermeiros em SU, publicados nos últimos cinco anos em inglês, português ou espanhol. Será realizada uma pesquisa em bases de dados como MEDLINE e CINAHL utilizando uma estratégia abrangente, sendo os resultados geridos através do Rayyan. Os dados serão extraídos utilizando o modelo JBI e analisados, sistematizados em tabelas e síntese narrativa para identificar temas e lacunas na literatura.

Resultados: Espera-se que os resultados evidenciem como os enfermeiros dos SU utilizam a ecografia nas suas intervenções, os seus benefícios clínicos e o seu potencial para melhorar os resultados dos utentes e a eficiência dos fluxos de trabalho.

Conclusão: Esta revisão irá fornecer informações baseadas na evidência para orientar futuras investigações, apoiar iniciativas de formação e promover a integração da ecografia na prática da enfermagem em serviços de urgência.

RESUMEN

Introducción: La ecografía es una herramienta de imagen no invasiva y rentable que utiliza ondas sonoras de alta frecuencia para generar imágenes de tejidos y órganos internos. Su integración en la práctica de enfermería, especialmente en los servicios de urgencias (SU), tiene el potencial de mejorar la atención al paciente, reducir los costos sanitarios y optimizar los resultados clínicos. A pesar de la creciente evidencia que respalda su uso por enfermeros en diversos entornos, su aplicación en los SU sigue siendo poco explorada.

Objetivo: Este protocolo de *scoping review* tiene como objetivo mapear la evidencia sobre el uso de la ecografía en la intervención de los enfermeros en los SU, centrándose en sus aplicaciones clínicas y contribuciones a la práctica de enfermería.

Métodos: Siguiendo el marco del Instituto Joanna Briggs (JBI), este protocolo cumple con las directrices PRISMA-ScR. Se incluirán estudios sobre enfermeros en SU, publicados en los últimos cinco años en inglés, portugués o español. Se realizará una búsqueda en bases de datos como MEDLINE y CINAHL utilizando una estrategia exhaustiva, y los resultados se gestionarán a través del Rayyan. Los datos serán extraídos con una plantilla JBI y analizados mediante tablas y síntesis narrativa para identificar temas y vacíos en la literatura.

Resultados: Se espera que los hallazgos destaquen cómo los enfermeros en los SU utilizan la ecografía para sus intervenciones, sus beneficios clínicos y su potencial para mejorar los resultados del paciente y la eficiencia del flujo de trabajo.

Conclusión: Esta revisión proporcionará información basada en evidencia para orientar investigaciones futuras, guiar iniciativas de capacitación y respaldar la integración de la ecografía en la práctica de la enfermería en servicios de urgencias.

INTRODUCTION

Ultrasonography is a type of medical imaging that uses sound with high-frequency waves (ultrasound) to generate images of internal organs and tissues, being painless, relatively inexpensive, and considered extremely safe (Mafraji, 2023). It can be accurately used by nurses to benefit patient care in both specialty and primary care settings, narrowing healthcare costs and improving access to more advanced healthcare for patients in rural and remote communities (Fraleigh & Duff, 2022).

STATE OF THE ART

Ultrasonography has seen an emergence in nursing care during the last couple decades, mostly regarding the peripheral cannulation of patients with difficult intravenous access (Morata et al., 2020). This procedure increases satisfaction in patients and helps in providing safer interventions, due to fewer attempts being required and reducing the risk of needing a central catheter (Assis et al., 2022; Morata et al., 2020). The newest UK Vessel Health and Preservation Framework even recommends that if a patient has no palpable or visible veins, a cannulation using ultrasonography must be performed by trained competent personnel (Hallam et al., 2020). There is also evidence that nurses can use it to insert Peripherally Inserted Central Catheters (PICC), with fewer attempts required in both adult and pediatric population (Pereira et al., 2023).

Despite being mostly used for peripheral cannulation, when used by nurses, ultrasonography has nearly endless other possibilities. There is strong evidence that after some training, nurses can reliably use ultrasonography to guide them during specific interventions, showing a rapid learning trajectory (Burton et al., 2022; Smits et al., 2023). One of its other uses, regarding vascular accesses, is for Radial Artery Cannulation (RAC) in Intensive Care Units (ICU).

Imbriaco et al. (2020) showed that nurses could effectively place a RAC using this technique, while showing a preference over

the blind technique. Using ultrasonography, these nurses could place the RAC in the median third of the forearm, where it was concluded that these accesses were almost twice as durable as the ones placed near the wrist, saving resources and pain to the patient (Imbriaco et al., 2020).

In the ICU context, there is also evidence nurses can use ultrasonography to perform some less common interventions that can be reflected in health gains for patients. Kumar et al. (2019) confirm nurses can reliably measure the quadricep thickness using ultrasonography. Quadricep muscle thickness is significantly positively correlated with upper and lower muscle strength and leg skeletal muscle index, and can replace full body muscle assessment, being an indicator of muscle mass loss and, consequently, of mortality (Ogawa et al., 2023). In the same context, the use of thoracic and lung ultrasonography by nurses helps in diagnosing and guiding therapy management (Smits et al., 2023; Corcoran et al., 2023).

Nurses can also use ultrasonography to verify nasogastric tube positioning, instead of using x-ray, the current gold standard for it (Robles-González, 2024). In the long run, it might replace the radiation patients get to have this tube checked. Cao et al. (2020) even refer that it can also help in assessing gastric residual volume, which can also be used to verify nasogastric tube positioning while also helping to assess a patient's aspiration risk.

Regarding nurses' interventions, this technology can also be used to determine bladder volume to assist in the decision on whether to catheterize the patient or not, as well as to determine post-void residual volume, helping in the identification of patients at risk for voiding dysfunction (Schallom et al., 2020; Shogenji et al., 2024). On the other hand, it can also be used to assess the constipation type the patient has and to help nurses select the appropriate defecation care (Matsumoto et al., 2021). Cao et al. (2020) even state that nurses can use ultrasonography to screen thrombosis and deep tissue injury in pressure ulcers, which in turn can help in guiding the intervention towards the needed results.

In the prehospital setting, there is evidence regarding the nurses' use of ultrasonography to perform Extended Focused Assessment with Sonography in Trauma (E-FAST) and to evaluate pneumothorax in critical patients (Griffiths, 2021; Nguyen, 2024). Dewar et al. (2022) indicate that in this context, a needle thoracostomy can be done by nurses using ultrasonography as an effective life-saving procedure. Outside the hospital setting, ultrasonography can also be used by community nurses for in-home assessment, namely focused lung ultrasound which may give clinical support for acute disease, without the need for patients to access an emergency department (ED), which in turn is safer and more accessible for the patient and helps in draining hospitals (Smedemark et al., 2022).

All the above interventions are known to be effective and efficient when done by nurses. They can also minimize time spent ordering diagnostics and reduce the number of return visits for diagnostic follow-up appointments (Fraleigh & Duff, 2022). However, dynamism and the need to be compliant with the ED timings can't always incorporate these time-consuming practices into the daily life of ED nurses. This has led to our research question: how can nurses employ ultrasonography in EDs and what are its contributions to nursing practice?

By focusing on this question, this scoping review aims to map the evidence regarding ultrasonography use by nurses in EDs, focusing on its clinical applications and contributions to nursing practice.

This scoping review is motivated by the absence of systematic or scoping reviews that specifically address the use of ultrasonography by nurses in emergency departments. A preliminary search in databases revealed the existence of a few recent studies on the topic, but none offer a comprehensive and aggregated overview of the available evidence. This gap highlights the need to synthesize and aggregate current knowledge, thereby contributing to the improvement of nursing practice in this clinical context.

METHODS

This scoping review protocol uses the Joanna Briggs Institute's (JBI) guidance (Peters et al., 2020) and aims to map the evidence regarding ultrasonography use by nurses in EDs, focusing on its clinical applications and contributions to nursing practice. It is supported by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines (Tricco et al., 2018).

INCLUSION CRITERIA

The inclusion criteria will be defined by the PCC mnemonic – Population, Concept, Context:

- **Population:** The review will focus on studies involving nurses of any level of experience or specialization, including advanced practice nurses, that work in emergency departments. It will not include studies where nurses are not involved in.
- **Concept:** It will examine the use of ultrasonography either as a supplement to nursing interventions or as part of advanced nursing practices.
- **Context:** The review will include studies conducted in emergency departments worldwide, considering various healthcare systems. It will not include any other hospital departments or pre-hospital setting.
- **Types of Sources:** The review will include studies employing quantitative, qualitative, and mixed-methods research designs,

along with systematic reviews, to provide a broad and comprehensive understanding of the available evidence. In cases where the studies do not have free full access, the corresponding author will be contacted, asking if they can give the article away.

- **Publication Period:** Only studies published in the last five years will be considered, ensuring that the evidence remains actual and relevant. This time frame was chosen to ensure that the review reflects the most current evidence, practices, and technologies related to the use of ultrasonography by nurses in emergency departments. Given the rapid evolution of this intervention and its increasing integration into nursing roles in recent years, focusing on recent literature will provide findings that are most relevant to contemporary clinical practice and decision-making.
- **Language of Publication:** The review will incorporate studies written in English, Portuguese, and Spanish. This choice leverages the language skills of the review team, enabling a high-quality and thorough analysis. By including studies from diverse linguistic contexts in nursing education, the approach promotes inclusivity while maintaining manageable selection and data extraction processes, ensuring the validity of the findings.

SEARCH STRATEGY

The search strategy is designed to locate both primary studies and reviews. It was collaboratively developed by two reviewers and peer-reviewed by a third expert (Peters et al., 2020). An initial search was carried out in MEDLINE (via PubMed) and CINAHL Complete (via EBSCOhost) to identify pertinent articles and refine the comprehensive search strategy. This strategy will be customized for each database to account for specific features and requirements. Keywords and MeSH terms related to “ultrasonography”, “nurses”, and “emergency department” will be systematically combined. Additionally, the reference lists of all included articles will be manually examined to uncover any additional relevant studies.

The search will include the following databases: MEDLINE (via PubMed) and Academic Search Complete, MedicLatina and CINAHL (via EBSCOhost). Below is the full strategy search for MEDLINE (via Pubmed): ((ultrasound[Title/Abstract]) OR (sonograph*[Title/Abstract]) OR (sonogram[Title/Abstract]) OR (ultrasonography[Title/Abstract]) OR (pocus[Title/Abstract]) OR ("Focused Assessment with Sonography for Trauma"[MeSH]) OR (ultrasonography[MeSH])) AND ((nurs*[Title/Abstract]) OR (nurses[MeSH])) AND (("emergency department"[Title/Abstract]) OR (ED[Title/Abstract]) OR (critic*[Title/Abstract]) OR ("first aid"[MeSH]) OR ("critical care"[MeSH]) OR (emergencies[MeSH])).

And below is the strategy that will be employed for the EBSCOhost databases: (AB (ultrasound OR sonograph* OR sonogram OR ultrasonography OR pocus) OR TI (ultrasound OR sonograph* OR sonogram OR ultrasonography OR pocus) OR SU ("Focused Assessment with Sonography for Trauma" OR ultrasonography)) AND (AB nurs* OR TI nurs* OR SU nurses) AND (AB ("emergency department" OR ed OR a&e OR critic*) OR TI ("emergency department" OR ed OR a&e OR critic*) OR SU ("first aid" OR "critical care" OR emergencies)).

STUDY SELECTION

All records identified through the database search will be organized and managed using Rayyan (Ouzzani et al., 2016), ensuring efficient removal of duplicates. The process of screening and selecting studies will involve multiple stages to uphold rigorous inclusion criteria and ensure the relevance and quality of the evidence included in the review.

Initially, two independent reviewers will evaluate the titles and abstracts of retrieved records to determine their eligibility based on predefined inclusion criteria. Following the preliminary screening, studies deemed potentially eligible will undergo a detailed assessment. This will involve retrieving the full texts and evaluating them against the inclusion criteria, considering factors such as comprehensive alignment with the criteria and relevance to the research questions. Reasons for excluding studies at this stage will be documented to ensure transparency and provide clarity on the selection process. At this stage the reviewers will also do a critical appraisal of the studies through the JBI Critical Appraisal Tools, ensuring that only high-quality studies are included in this review.

In cases of disagreement between the reviewers during any stage of the selection process, differences will be resolved through discussion or, if necessary, consultation with a third reviewer. This collaborative approach ensures decisions are made collectively and remain consistent with the review’s methodological framework.

The search results and study selection process will be thoroughly documented in the final scoping review and illustrated using a flow diagram based on the PRISMA-ScR guidelines (Tricco et al., 2018). This diagram will visually summarize the progression of the search and selection process, showing the flow of information across the various stages of the review and detailing the number of studies included and excluded at each step.

DATA EXTRACTION

Data will be extracted from the included studies using a template recommended by the JBI, which will be adapted as needed to align with the specific goals of this review (Peters et al., 2020). Two independent reviewers will carry out the data extraction process, organizing the information based on the JBI template. Extracted data will include study details (i.e., authors, publication year, study design), ultrasonography use by nurses in ED setting, its contribution to nursing practice, and key findings pertinent to the review questions.

The data extraction tool will remain flexible and subject to updates throughout the review to ensure all relevant data points

are captured comprehensively. In cases where data is missing or clarification is needed, the authors of the included studies will be contacted to obtain additional information. This step is critical for ensuring the completeness and accuracy of the data.

If disagreements arise between the two reviewers during the data extraction process, a third reviewer will be consulted to resolve any conflicts and achieve consensus. This collaborative approach enhances the reliability and rigor of data extraction. In instances where preliminary studies or multiple reports on the same dataset are included, the most comprehensive or recent study will be prioritized to avoid redundancy.

Extracted data will be synthesized and presented in line with the review's objectives, potentially using tables and narrative synthesis. This structured approach will provide a clear and detailed understanding of how ED nurses use ultrasonography and its implications for the improvement of nursing practice.

DATA ANALYSIS AND INTERPRETATION

Data gathered from the included studies will be carefully analyzed and presented to align with the main objectives of this scoping review (Peters et al., 2020). Key details and findings from the studies will be systematically organized into tables to provide a concise and structured overview of each included study. These tables will capture study characteristics, ultrasonography uses, clinical outcomes, and key findings. This format will enable straightforward comparison between studies, making it easier to identify patterns, trends, and gaps in the data.

In addition to this, a narrative synthesis will explore thematic findings in greater depth. This analysis will examine how ED nurses use ultrasonography, focusing on themes such as types of use (i.e. diagnostics, procedural guidance), impacts on clinical outcomes (i.e. improved accuracy, faster decision-making), and perceived benefits and challenges (i.e. enhanced efficiency, technical difficulties, training needs). By uncovering these themes, the narrative synthesis will provide qualitative insights that go beyond the surface-level data, revealing complexities that may not be captured through quantitative methods alone.

A descriptive summary will accompany the tables and narrative synthesis, offering a concise overview of the extracted data. This summary will highlight the key insights and findings, directly addressing the research questions and goals of the review.

The analysis will also aim to explore the contextual factors influencing ultrasonography use by ED nurses, providing a nuanced understanding of this phenomenon. By systematically organizing and synthesizing the data, this section of the review will deliver a comprehensive and detailed interpretation of how ultrasonography is used in emergency nursing practice and its implications for patient care and clinical workflows.

RESULTS / DISCUSSION

This scoping review focuses on studies published in three languages, aiming to encompass a broad range of research from diverse linguistic and cultural contexts. While this approach enhances inclusivity and ensures access to a variety of evidence on the topic, it may also result in the exclusion of potentially valuable insights from studies published in other languages, representing a limitation of the review.

The findings are expected to shed light on the various applications of ultrasonography by nurses in EDs, examining its clinical advantages and the benefits for its inclusion in a daily basis. By mapping the current evidence of its application, the review aims to provide an understanding of the contribution of ultrasonography in ED nurses' practice. This evidence can support healthcare leaders in the inclusion and investment in the training of ED nurses in this technology.

This review is particularly timely given the rapid pace of technological advancements in healthcare and the shifting demands of global health crises. These challenges have underscored the need for adaptive and resilient approaches to clinical training. By highlighting the role of ultrasonography in emergency nursing education, this review may emphasize the importance of equipping nurses with the tools and skills needed to respond effectively to future healthcare challenges.

CONCLUSION

This scoping review will offer a detailed overview of the existing evidence on the use of ultrasonography by nurses in ED settings. By mapping the current literature, the review aims to identify the clinical implications of its use and its contributions to nursing practice. These findings will enlighten future research and support the development of targeted training programs and strategies, ultimately assisting nursing educators and healthcare leaders in effectively integrating ultrasound technology to enhance nursing practice and meet the active demands of emergency healthcare in a dynamic health system.

CONTRIBUTORSHIP STATEMENT

DS: Conceptualization, Data Processing, Research, Methodology, Resources, Software, Visualization and Writing - Original Draft Preparation.

RB: Data Processing, Formal Analysis, Research, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization and Writing - Review and Editing.

MF: Data Processing, Formal Analysis, Research, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization and Writing - Review and Editing.

All authors approved the final version to be published.

ETHICAL DISCLOSURES

Conflicts of Interest: The authors have no conflicts of interest to declare.

REFERENCES

- Assis, L., Monteiro, D., Bezerra, M., Contim, D., Santos, M., & Toffano, S. (2022). Tomada De Decisão Para O Uso De Ultrassonografia Para Punção Venosa Periférica Difícil Em Adultos: Revisão Integrativa. *RECIEN: Revista Científica de Enfermagem* 12(37), 315–322. <https://doi.org/10.24276/recien2022.12.37.315-322>
- Blanco, P. (2019). Ultrasound-guided peripheral venous cannulation in critically ill patients: a practical guideline. *Ultrasound J* 11, 27. <https://doi.org/10.1186/s13089-019-0144-5>
- Burton, S., Donovan, J., Jones, S., & Meadley, B. (2022). Can Non-Physician Providers Use Ultrasound to Aid in Establishing Peripheral IV Access in Patients Who are Difficult to Cannulate? A Scoping Review. *Prehospital and Disaster Medicine* 37(4), 535–546. <https://doi.org/10.1017/S1049023X22000796>
- Cao, L., Zhang, L., Wang, X., & Chinese Critical Ultrasound Study Group (2020). Ultrasound applications to support nursing care in critically ill COVID-19 patients. *Intensive & critical care nursing* 61, 102918. <https://doi.org/10.1016/j.iccn.2020.102918>
- Corcoran, E., Hopkins, P., Fisher, R., Wong, A., & Rose, L. (2023). Intensive care nurse-led point of care ultrasound in the assessment and management of the critically ill COVID-19 patient: A single centre case series. *Nursing in Critical Care* 28(5), 781–788. <https://doi.org/10.1111/nicc.12871>
- Dewar, Z., Ko, S., Rogers, C., Oropallo, A., Augustine, A., Pamula, A. & Berry, C. (2022). Prehospital portable ultrasound for safe and accurate prehospital needle thoracostomy: a pilot educational study. *Ultrasound J* 14, 23. <https://doi.org/10.1186/s13089-022-00270-w>
- Fraleigh, C., & Duff, E. (2022). Point-of-care ultrasound: An emerging clinical tool to enhance physical assessment. *The Nurse practitioner* 47(8), 14–20. <https://doi.org/10.1097/01.NPR.0000841944.00536.b2>
- Griffiths, E. (2021). Helicopter emergency medical services use of thoracic point of care ultrasound for pneumothorax: a systematic review and meta-analysis. *Scand J Trauma Resusc Emerg Med* 29, 163. <https://doi.org/10.1186/s13049-021-00977-0>
- Hallam, C., Denton, A., Weston, V., Dunn, H., Jackson, T., Keeling, S., & Hill, S. (2020). UK Vessel Health and Preservation (VHP) Framework: a commentary on the updated VHP 2020. *Journal of Infection Prevention* 22(4), 147–155. <https://doi.org/10.1177/1757177420976806>
- Imbriaco, G., Monesi, A., Giugni, A., & Cilloni, N. (2020). Radial artery cannulation in intensive care unit patients: Does distance from wrist joint increase catheter durability and functionality? *The Journal of Vascular Access* 22(4), 561–567. <https://doi.org/10.1177/1129729820953020>
- Kumar, R., Shah, T., Hadda, V., Tiwari, P., Mittal, S., Madan, K., Khan, M., & Mohan, A. (2019). Assessment of quadriceps muscle thickness using bedside ultrasonography by nurses and physicians in the intensive care unit: Intra- and inter-operator agreement. *World J Crit Care Med* 8(7), 127–134 <https://doi.org/10.5492/wjccm.v8.i7.127>
- Mafraji, M. (2023). Ultrasound. MSD Manual. <https://www.msmanuals.com/home/special-subjects/common-imaging-tests/ultrasound>
- Matsumoto, M., Yoshida, M., Miura, Y., Sato, N., Okawa, Y., Yamada, M., Otaki, J., Nakagami, G., Sugama, J., Okada, S., Ohta, H., & Sanada, H. (2021). Feasibility of the constipation point-of-care ultrasound educational program in observing fecal retention in the colorectum: A descriptive study. *Japan Journal of Nursing Science* 18(1), 1–9. <https://doi.org/10.1111/jjns.12385>

- Morata, L., & Bowers, M. (2020). Ultrasound-Guided Peripheral Intravenous Catheter Insertion: The Nurse's Manual. *Critical Care Nurse* 40(5), 38–46. <https://doi.org/10.4037/ccn2020240>
- Nguyen, C., Hartmann, K., Goodmurphy, C., & Flamm, A. (2024). E-FAST Ultrasound Training Curriculum for Prehospital Emergency Medical Service (EMS) Clinicians. *JETem* 9(1), C41-97. <https://doi.org/10.21980/J8S060>
- Ogawa, M., Matsumoto, T., Harada, R., Yoshikawa, R., Ueda, Y., Takamiya, D., & Sakai, Y. (2023). Reliability and Validity of Quadriceps Muscle Thickness Measurements in Ultrasonography: A Comparison with Muscle Mass and Strength. *Progress in rehabilitation medicine* 8, 20230008. <https://doi.org/10.2490/prm.20230008>
- Ouzzani, M., Hammady, H., Fedorowicz, Z., & Elmagarmid, A. (2016). Rayyan — a web and mobile app for systematic reviews. *Systematic Reviews* 5, 210. <https://doi.org/10.1186/s13643-016-0384-4>
- Pereira, H., Secco, I., Arrué, A., Pontes, L., & Danski, M. (2023). Implementation of modified Seldinger technology for percutaneous catheterization in critically ill newborns. *Revista da Escola de Enfermagem da USP* 57, e20220347. <https://doi.org/10.1590/1980-220X-REEUSP-2022-0347en>
- Peters, M., Marnie, C., Tricco, A., Pollock, D., Munn, Z., Alexander, L., McInerney, P., Godfrey, C., & Khalil, H. (2020). Updated methodological guidance for the conduct of scoping reviews. *JBIM Evidence Synthesis* 18(10), 2119–2126. <https://doi.org/10.11124/JBIES-20-00167>
- Robles-González, M., Arrogante, O., Sánchez Giralt, J. A., Ortuño-Soriano, I., & Zaragoza-García, I. (2024). Verification of Nasogastric Tube Positioning Using Ultrasound by an Intensive Care Nurse: A Pilot Study. *Healthcare* 12(16), 1618. <https://doi.org/10.3390/healthcare12161618>
- Schallom, M., Prentice, D., Sona, C., Vyders, K., Arroyo, C., Wessman, B., & Ablordeppey, E. (2020). Accuracy of Measuring Bladder Volumes With Ultrasound and Bladder Scanning. *Am J Crit Care* 29(6) 458–467. <https://doi.org/10.4037/ajcc2020741>
- Shogenji, M., Yoshida, M., & Kitagawa, Y. (2024). Epidemiological survey of post-void residual urine volume in older adult patients in an acute-care hospital: A cross-sectional observational study. *Japan Journal of Nursing Science* 21(1), 1–9. <https://doi.org/10.1111/jjns.12557>
- Smedemark, S., Laursen, C., Jarbøl, D., Rosenvinge, F., & Andersen-Ranberg, K. (2022). Improving in-home diagnostics by the use of Point of Care Technology in the acute home care setting; a pilot and feasibility study. *International Journal of Integrated Care* 22, 1. <https://doi.org/10.5334/ijic.ICIC22352>
- Smits, T., Heldeweg, M., Tulleken, A., Verlaan, B., Floor, L., Eijssenga, A., Lust, E., Gelissen, H., Girbes, A., Elbers, P., & Tuinman, P. (2023). Effects of nurse delivered thoracic ultrasound on management of adult intensive care unit patients: A prospective observational study. *International Journal of Nursing Studies Advances* 5, 100135. <https://doi.org/10.1016/j.ijnsa.2023.100135>
- Tricco, A., Lillie, E., Zarin, W., Brien, K., Colquhoun, H., Levac, D., Moher, D., Peters, M., Ma, Q., Horsley, T., Weeks, L., Hartling, L., Aldcroft, A., Hons, B., Wilson, M., & Garritty, C. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of Internal Medicine*. <https://doi.org/10.7326/M18-0850>