

Point-of-Care Ultrasound in the Assessment of Gastric Residual Volume: A Protocol of Scoping Review

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Abstract

Background: Pulmonary aspiration, defined as the entry of oropharyngeal or gastric contents into the lower airways (1), is a serious complication that can lead to aspiration pneumonia and other potentially fatal conditions (2–4). Elderly male patients, those with enteral feeding tubes, and those with neurological, gastrointestinal, or pulmonary disorders are at increased risk for this event (4–6). In anesthetic settings, gastric content aspiration is associated with high mortality rates and permanent injuries, especially when due to failures in implementing safe practices (7).

Previous studies have shown an aspiration incidence of 2 to 7 per 20,000 anesthetic procedures, reaching 0.5% in emergency surgeries performed in surgical centers, and rising to 2.7% in emergency procedures outside of surgical environments(8). Among patients receiving enteral nutrition, aspiration pneumonia is also common, with a prevalence ranging from 4% to 95% and mortality rates between 17% and 62% (5).

One of the main risk factors for aspiration is elevated gastric residual volume (GRV), which indicates impaired gastrointestinal motility, intolerance to enteral nutrition, and delayed gastric emptying (5,9). These conditions contribute to reflux and vomiting, increasing the risk of pulmonary aspiration, especially in patients with a body mass index (BMI) over 30 and in those with type 2 diabetes mellitus undergoing anesthetic induction (5). Traditional GRV measurement involves active aspiration using a syringe or passive drainage by gravity. However, these techniques are limited by result variability and a lack of standardization (9,10).

In this context, point-of-care ultrasound (PoCUS) stands out as a promising alternative method for GRV assessment. PoCUS involves the use of portable ultrasound performed directly by the healthcare provider at the point of care for diagnostic or clinical monitoring purposes in real time. This is an objective, focused approach integrated into clinical reasoning, enabling faster and safer decision-making in acute and dynamic environments (11).

Regarding GRV estimation, PoCUS allows the evaluation of gastric contents by visualizing the gastric antrum in the transverse plane, usually with the patient in the right lateral decubitus position. This structure (Figure 1), located between the left liver lobe and the aorta or superior mesenteric artery, is measured and converted into an estimated volume using validated formulas such as the one proposed by Perlas and colleagues (12), offering a non-invasive and effective alternative to traditional methods. Moreover, this method aids in aspiration risk stratification and enhances the safety of enteral nutrition and preoperative fasting (5,9).

Figure 1 - PoCUS illustration of the gastric antrum

L: Liver. A: Antrum. SMA: Superior Mesenteric Artery. AA: Abdominal Aorta

A recent study showed that ultrasound performed by nurses in intensive care units for GRV assessment and nasogastric tube positioning correlates strongly with conventional methods, proving to be safe, simple, and effective (13). While most commonly

used GRV thresholds for enteral nutrition interruption range from 200 to 250 mL (14), the current American Society for Parenteral and Enteral Nutrition (ASPEN) guidelines recommend suspending enteral nutrition in critically ill patients only when GRV exceeds 500 mL in the absence of other signs of intolerance (15). Meanwhile, the European Society for Clinical Nutrition and Metabolism (ESPEN) suggests delaying enteral nutrition administration in patients with GRV > 500 mL, without distinguishing between different patient populations (16).

Despite advances in the clinical use of PoCUS, significant gaps remain in the literature regarding specific techniques used to assess GRV in adults. A preliminary search in the PROSPERO, OSF, Web of Science, and Cochrane Library databases revealed no review protocols on this topic. Moreover, no consolidated guidelines or standardized protocols currently support safe and effective PoCUS use for this purpose by nurses. Therefore, this scoping review was proposed to map and synthesize the available evidence on procedures used to assess GRV via PoCUS in adult patients.

Objective: review aims to identify the clinical indications, image acquisition techniques, sonographic interpretation methods, and applications in medical decision-making related to GRV estimation using PoCUS across diverse clinical settings. Secondary objectives include:

? To classify the reported procedural techniques according to the I-AIM framework (Indication, Acquisition, Interpretation, Medical decision-making) (17).

? To identify gaps in the literature regarding standardization and training for PoCUS-based GRV assessment.

? To inform future guidelines and educational strategies for the safe and effective implementation of PoCUS in nursing and other healthcare professions.

Methods: Protocol and registration

This scoping review will be conducted in accordance with the JBI Collaboration (18) and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols – Extension for Scoping Reviews (PRISMA-ScR) (19).

The review protocol was registered on the Open Science Framework (OSF) platform under DOI: 10.17605/OSF.IO/CQ8S3 (20).

Research question

To formulate the research question, the PCC mnemonic—Population, Concept, and Context—was applied. In this framework, the Population (P) comprised adults and older adults (? 18 years); the Concept (C) involved the assessment of GRV using PoCUS; and the Context (C) included the various clinical settings in which PoCUS is employed for this purpose. Accordingly, the central question guiding this scoping review is: What procedures are used in the application of PoCUS to assess gastric residual volume in adult patients across clinical care settings?

Eligibility Criteria

Eligible sources will include primary studies, reviews, and clinical guidelines that focus on the use of PoCUS for GRV assessment in adult patients (?18 years). Exclusion criteria include: studies involving children or animals; abstracts, letters, expert opinion; protocols, trial registrations; studies not focused on the stomach (e.g., ultrasound of other organs); studies published in languages that do not use the Latin-Roman alphabet—modern Latin alphabet. No date or language restriction (except for script) will be applied.

Information source

Systematic searches will be conducted in the following databases: MEDLINE (via PubMed), CINAHL (via EBSCOhost), Embase (via Elsevier), Scopus (via Elsevier), Cochrane Library (via Wiley), and LILACS (via BVS). Grey literature will be searched via Google Scholar, ProQuest Dissertations & Theses Global, and institutional websites. To ensure comprehensive identification of relevant evidence, additional search strategies will be employed. Specifically, a backward citation tracking approach (ascendancy) will be used by manually screening the reference lists of all included studies, reviews, and guidelines to identify additional eligible sources that may not have been retrieved in the initial database search.

Search strategy

The search strategy was developed to address the research question (PCC) by combining MeSH terms and DeCS descriptors with relevant keywords and synonyms (see Frame 1 and Supplemental Material). Terms were refined using Boolean operators. The initial search was conducted in PubMed.

Frame 1. PCC framework applied to the research question and search terms

PCC elements Description Search terms employed

Population (P) Adults and older adults (? 18 years) (Adult* OR "Older adult*" OR Elderly OR "Aged" OR "?18 years")

Concept

(C) Assessment of gastric residual volume (GRV) using point-of-care ultrasound (PoCUS) (Ultrasound OR Ultrasonography OR "Diagnostic Ultrasounds" OR "Ultrasound Imaging" OR "Bedside Test" OR "Bedside Testing" OR "Bedside Technology" OR "Bedside Technologies" OR "Point of Care" OR "Point-of-Care" OR "Point of Care Systems" OR "Point-of-Care Systems" OR

“Point-of-Care System” OR “Point of Care System” OR “Point of Care Technology” OR “Point-of-Care Technology” OR “Point of Care Testing” OR POCUS OR “Point-of-care ultrasonography” OR “Point of care ultrasonography” OR “Point-Of-Care Ultrasound” OR “Point Of Care Ultrasound” OR Sonography OR Ultrasonic* OR ultraso* AND “Gastrointestinal Contents” OR “Gastric Residual Volume” OR “residual gastric volume” OR “gastric volume” OR “gastric content” OR “Gastric residuals” OR antrum OR “antral area”) AND (assess* OR Evaluation OR avalia*)

Context (C) Clinical settings where PoCUS is employed for GRV assessment Perioperative care, intensive care, emergency, anesthesia, critical care

A search validation procedure was employed. A set of known key studies and guidelines relevant to the use of PoCUS for GRV assessment in adult patients was pre-identified by the review team based on prior knowledge and preliminary exploration of the literature. These studies will serve as benchmark references to validate the comprehensiveness and sensitivity of the search strategy. The initial search will be tested to ensure retrieval of these benchmark studies. If any of them are not retrieved, the search strategy will be refined accordingly by adjusting keywords, controlled vocabulary (e.g., MeSH, DeCS), and Boolean logic until all key studies are successfully captured.

For the purposes of this scoping review, PoCUS was defined as the use of portable ultrasound performed directly by a healthcare provider at the point of care, for real-time diagnostic or clinical monitoring purposes (21). Gastric residual volume is widely recognized as a surrogate parameter for identifying gastrointestinal motility disorders, particularly delayed gastric emptying. Its measurement has traditionally been used in clinical practice as an indirect indicator of enteral nutrition intolerance and increased risk of complications such as pulmonary aspiration (22).

Screening and Selection Process of Included Studies

Search results will be imported into Rayyan for deduplication and blinded screening. Two reviewers will independently screen titles/abstracts and then full texts and discrepancies will be resolved by a third reviewer. Reasons for full-text exclusion will be recorded and reported using a PRISMA-ScR flow diagram (19).

Study authors will be contacted when clarification is needed regarding study eligibility, missing or unclear methodological details, or incomplete data relevant to the review objectives. The initial contact will be made via email using a standardized message template adapted from the OSF repository (<https://osf.io/q8stz/>). Authors will be given two weeks to respond. If no reply is received, a single follow-up message will be sent.

Consultation with content experts in the fields of clinical nutrition, PoCUS, and nursing will be conducted to identify unpublished data, practice guidelines, or ongoing research that could contribute to the review will also be performed.

Data items and extraction process

A customized data charting form, adapted from the JBI template (23), will be used. Two reviewers will independently extract data, followed by reconciliation. Pilot extraction will be conducted on a sample of studies to refine the form and ensure consistency. Extracted data will include:

? Bibliographic information: title, authors, year, country;

? Study characteristics: design, setting, sample, operator profession;

? PoCUS procedures aligned with I-AIM (17): Indication: clinical context for GRV assessment; Acquisition: patient positioning, transducer type, scanning windows, ultrasound settings; Interpretation: sonographic markers, grading scales, formulas; and decision-Making: use of findings to adjust care (e.g., feeding, fasting, aspiration risk);

? Other: training protocols, facilitators/barriers, guideline recommendations.

Results: A descriptive synthesis will be performed, with results organized thematically using the I-AIM framework (Indication, Acquisition, Interpretation, and decision-Making) (17). Quantitative data (e.g., frequencies of reported procedures) will be summarized in tables, while qualitative descriptors will undergo thematic content analysis. In addition to narrative and tabular presentations, visual representations such as conceptual diagrams, procedural flowcharts, and summary figures will be developed to illustrate variations, patterns, and gaps in practice.

Conclusions: this review is expected to make an important contribution to the field by identifying knowledge gaps, highlighting procedural inconsistencies, and supporting evidence-informed integration of PoCUS into clinical protocols for enteral nutrition management and aspiration risk reduction Clinical Trial: The full review protocol, including the search strategies and supporting documents, is publicly available on the Open Science Framework (OSF) at <https://osf.io/cq8s3>. Upon completion of the review, the extracted data, summary tables, and synthesis outputs will also be made openly accessible through the same platform. No primary data were collected for this study.

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Original Manuscript

Point-of-Care Ultrasound in the Assessment of Gastric Residual Volume: A Protocol of Scoping Review

Abstract

Background: Pulmonary aspiration of gastric contents is a serious clinical complication, especially in patients receiving enteral nutrition or undergoing anesthesia. Gastric residual volume (GRV) is a commonly used surrogate marker to identify delayed gastric emptying and enteral nutrition intolerance, which may increase aspiration risk. Traditional GRV measurement methods are invasive and lack standardization. Point-of-care ultrasound (PoCUS) has emerged as a promising, non-invasive, and bedside alternative. Despite its growing clinical use, there is no consolidated guidance on PoCUS procedures for GRV assessment in adult patients. This scoping review aims to map and synthesize the available evidence on procedural techniques, interpretation criteria, and decision-making applications related to PoCUS for GRV assessment.

Methods: This scoping review will follow the JBI Collaboration methodology and will be reported in accordance with PRISMA-ScR guidelines. The PCC mnemonic (Population, Concept, Context) guided the formulation of the research question. Systematic searches will be performed in MEDLINE, CINAHL, Embase, Scopus, Cochrane, and LILACS, along with grey literature sources. Eligible studies will include primary studies, reviews, and clinical guidelines focused on PoCUS for GRV assessment in adults (≥ 18 years). Two independent reviewers will conduct screening and data extraction. The synthesis will be structured using the I-AIM framework (Indication, Acquisition, Interpretation, Medical decision-making). Results will be summarized narratively, in tables, and through visual representations such as flowcharts and conceptual diagrams.

Results: A descriptive synthesis will be structured using the I-AIM framework (Indication, Acquisition, Interpretation, and decision-making). Quantitative data will be presented in tables, while qualitative findings will be analyzed thematically. Narrative, tabular, and visual formats—including diagrams, flowcharts, and summary figures—will be used to highlight variations, patterns, and gaps in practice.

Discussion: This review will identify and categorize the procedures, technical parameters, and clinical applications of PoCUS for GRV assessment in adult patients. By mapping existing evidence, the findings will contribute to future research, educational curricula, and the development of clinical guidelines for nurses. Additionally, the review will highlight methodological gaps and practice variations that may impact the safe and effective use of PoCUS in diverse healthcare settings.

Protocol registration: This protocol has been registered in the Open Science Framework (OSF): <https://osf.io/cq8s3>

Keywords: Point-of-care ultrasonography, Gastric residual volume, Scoping review

BACKGROUND

Pulmonary aspiration, defined as the entry of oropharyngeal or gastric contents into the lower airways (1), is a serious complication that can lead to aspiration pneumonia and other potentially fatal conditions (2–4). Elderly male patients, those with enteral feeding tubes, and those with neurological, gastrointestinal, or pulmonary disorders are at increased risk for this event (4–6). In anesthetic settings, gastric content aspiration is associated with high mortality rates and permanent injuries, especially when due to failures in implementing safe practices (7).

Previous studies have shown an aspiration incidence of 2 to 7 per 20,000 anesthetic procedures, reaching 0.5% in emergency surgeries performed in surgical centers, and rising to 2.7% in emergency procedures outside of surgical environments(8). Among patients receiving enteral nutrition, aspiration pneumonia is also common, with a prevalence ranging from 4% to 95% and

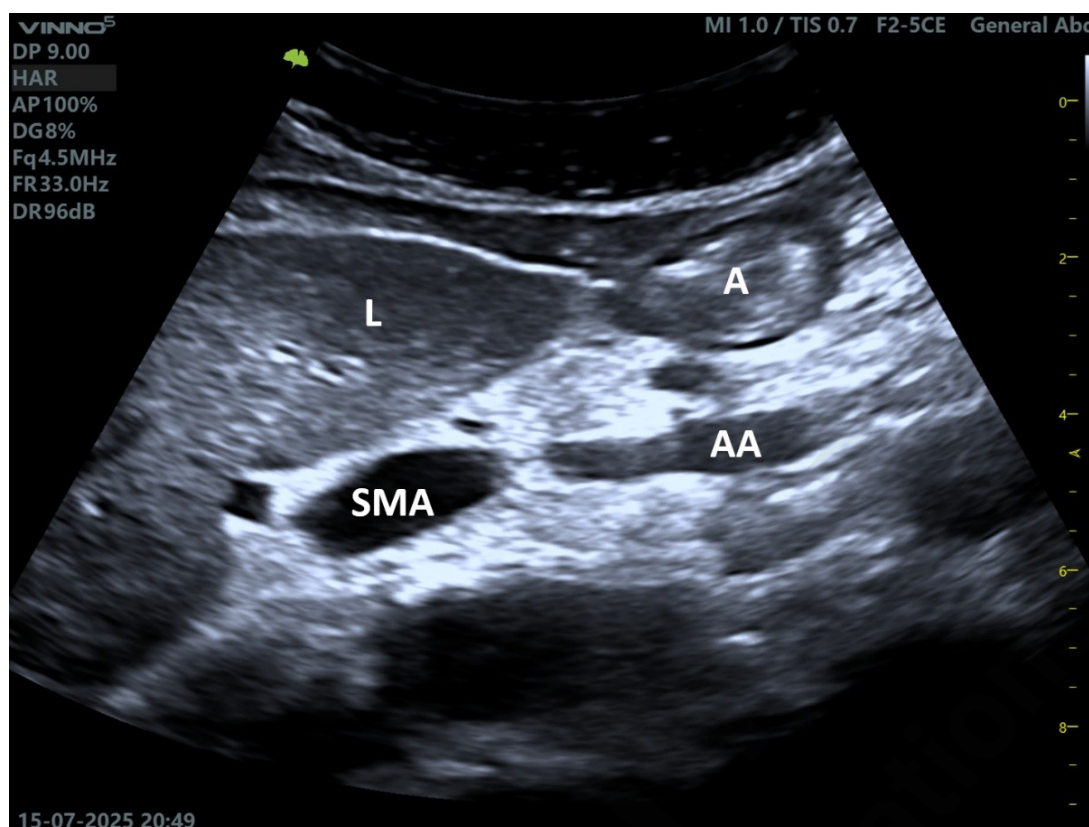
mortality rates between 17% and 62% (5).

One of the main risk factors for aspiration is elevated gastric residual volume (GRV), which indicates impaired gastrointestinal motility, intolerance to enteral nutrition, and delayed gastric emptying (5,9). These conditions contribute to reflux and vomiting, increasing the risk of pulmonary aspiration, especially in patients with a body mass index (BMI) over 30 and in those with type 2 diabetes mellitus undergoing anesthetic induction (5). Traditional GRV measurement involves active aspiration using a syringe or passive drainage by gravity. However, these techniques are limited by result variability and a lack of standardization (9,10).

In this context, point-of-care ultrasound (PoCUS) stands out as a promising alternative method for GRV assessment. PoCUS involves the use of portable ultrasound performed directly by the healthcare provider at the point of care for diagnostic or clinical monitoring purposes in real time. This is an objective, focused approach integrated into clinical reasoning, enabling faster and safer decision-making in acute and dynamic environments (11).

Regarding GRV estimation, PoCUS allows the evaluation of gastric contents by visualizing the gastric antrum in the transverse plane, usually with the patient in the right lateral decubitus position. This structure (Figure 1), located between the left liver lobe and the aorta or superior mesenteric artery, is measured and converted into an estimated volume using validated formulas such as the one proposed by Perlas and colleagues (12), offering a non-invasive and effective alternative to traditional methods. Moreover, this method aids in aspiration risk stratification and enhances the safety of enteral nutrition and preoperative fasting (5,9).

Figure 1 - PoCUS illustration of the gastric antrum



L: Liver. A: Antrum. SMA: Superior Mesenteric Artery. AA: Abdominal Aorta

A recent study showed that ultrasound performed by nurses in intensive care units for GRV assessment and nasogastric tube positioning correlates strongly with conventional methods, proving to be safe, simple, and effective (13). While most commonly used GRV thresholds for enteral nutrition interruption range from 200 to 250 mL (14), the current American Society for Parenteral and Enteral Nutrition (ASPEN) guidelines recommend suspending enteral nutrition in critically ill patients only when GRV exceeds 500 mL in the absence of other signs of intolerance (15). Meanwhile, the European Society for Clinical Nutrition and Metabolism (ESPEN) suggests delaying enteral nutrition administration in patients with GRV > 500 mL, without distinguishing between different patient populations (16).

Despite advances in the clinical use of PoCUS, significant gaps remain in the literature regarding specific techniques used to assess GRV in adults. A preliminary search in the PROSPERO, OSF, Web of Science, and Cochrane Library databases revealed no review protocols on this topic.

Moreover, no consolidated guidelines or standardized protocols currently support safe and effective PoCUS use for this purpose by nurses. Therefore, this scoping review was proposed to map and synthesize the available evidence on procedures used to assess GRV via PoCUS in adult patients. Specifically, the review aims to identify the clinical indications, image acquisition techniques, sonographic interpretation methods, and applications in medical decision-making related to GRV estimation using PoCUS across diverse clinical settings. Secondary objectives include:

- To classify the reported procedural techniques according to the I-AIM framework (Indication, Acquisition, Interpretation, Medical decision-making) (17).
- To identify gaps in the literature regarding standardization and training for PoCUS-based GRV assessment.
- To inform future guidelines and educational strategies for the safe and effective implementation of PoCUS in nursing and other healthcare professions.

METHODS/DESIGN

Protocol and registration

This scoping review will be conducted in accordance with the JBI Collaboration (18) and reported following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols – Extension for Scoping Reviews (PRISMA-ScR) (19).

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various clinical settings in which PoCUS is employed for this purpose. Accordingly, the central question guiding this scoping review is: What procedures are used in the application of PoCUS to assess gastric residual volume in adult patients across clinical care settings?

Eligibility Criteria

Eligible sources will include primary studies, reviews, and clinical guidelines that focus on the use of PoCUS for GRV assessment in adult patients (≥ 18 years). Exclusion criteria include: studies involving children or animals; abstracts, letters, expert opinion; protocols, trial registrations; studies not focused on the stomach (e.g., ultrasound of other organs); studies published in languages that do not use the Latin-Roman alphabet—modern Latin alphabet. No date or language restriction (except for script) will be applied.

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Material). Terms were refined using Boolean operators. The initial search was conducted in PubMed.

Frame 1. PCC framework applied to the research question and search terms

PCC elements	Description	Search terms employed
Population (P)	Adults and older adults (≥ 18 years)	(Adult* OR "Older adult*" OR Elderly OR "Aged" OR " ≥ 18 years")
Concept (C)	Assessment of gastric residual volume (GRV) using point-of-care ultrasound (PoCUS)	(Ultrasound OR Ultrasonography OR "Diagnostic Ultrasounds" OR "Ultrasound Imaging" OR "Bedside Test" OR "Bedside Testing" OR "Bedside Technology" OR "Bedside Technologies" OR "Point of Care" OR "Point-of-Care" OR "Point of Care Systems" OR "Point-of-Care Systems" OR "Point-of-Care System" OR "Point of Care System" OR "Point of Care Technology" OR "Point-of-Care Technology" OR "Point of Care Testing" OR POCUS OR "Point-of-care ultrasonography" OR "Point of care ultrasonography" OR "Point-Of-Care Ultrasound" OR "Point Of Care Ultrasound" OR Sonography OR Ultrasonic* OR ultraso* AND "Gastrointestinal Contents" OR "Gastric Residual Volume" OR "residual gastric volume" OR "gastric volume" OR "gastric content" OR "Gastric residuals" OR antrum OR "antral area") AND (assess* OR Evaluation OR avalia*)
Context (C)	Clinical settings where PoCUS is employed for GRV assessment	Perioperative care, intensive care, emergency, anesthesia, critical care

A search validation procedure was employed. A set of known key studies and guidelines relevant to the use of PoCUS for GRV assessment in adult patients was pre-identified by the review team based on prior knowledge and preliminary exploration of the literature. These studies will serve as benchmark references to validate the comprehensiveness and sensitivity of the search strategy. The initial search will be tested to ensure retrieval of these benchmark studies. If any of them are not retrieved, the search strategy will be refined accordingly by adjusting keywords, controlled vocabulary (e.g., MeSH, DeCS), and Boolean logic until all key studies are successfully captured.

For the purposes of this scoping review, PoCUS was defined as the use of portable ultrasound performed directly by a healthcare provider at the point of care, for real-time diagnostic or clinical monitoring purposes (21). Gastric residual volume is widely recognized as a surrogate parameter for

identifying gastrointestinal motility disorders, particularly delayed gastric emptying. Its measurement has traditionally been used in clinical practice as an indirect indicator of enteral nutrition intolerance and increased risk of complications such as pulmonary aspiration (22).

Screening and Selection Process of Included Studies

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Consultation with content experts in the fields of clinical nutrition, PoCUS, and nursing will be conducted to identify unpublished data, practice guidelines, or ongoing research that could contribute to the review will also be performed.

Data items and extraction process

A customized data charting form, adapted from the JBI template (23), will be used. Two reviewers will independently extract data, followed by reconciliation. Pilot extraction will be conducted on a sample of studies to refine the form and ensure consistency. Extracted data will include:

- Bibliographic information: title, authors, year, country;
- Study characteristics: design, setting, sample, operator profession;
- PoCUS procedures aligned with I-AIM (17): Indication: clinical context for GRV assessment;

Acquisition: patient positioning, transducer type, scanning windows, ultrasound settings;

Interpretation: sonographic markers, grading scales, formulas; and decision-Making: use of findings to adjust care (e.g., feeding, fasting, aspiration risk);

- Other: training protocols, facilitators/barriers, guideline recommendations.

Results

A descriptive synthesis will be performed, with results organized thematically using the I-AIM framework (Indication, Acquisition, Interpretation, and decision-Making) (17). Quantitative data (e.g., frequencies of reported procedures) will be summarized in tables, while qualitative descriptors will undergo thematic content analysis. In addition to narrative and tabular presentations, visual representations such as conceptual diagrams, procedural flowcharts, and summary figures will be developed to illustrate variations, patterns, and gaps in practice.

DISCUSSION

This scoping review protocol outlines a rigorous and structured approach to mapping the current landscape of procedures used in PoCUS for GRV assessment in adult patients. In addition to addressing a relevant clinical question, the study seeks to support the development of future training protocols and clinical guidelines to promote safe and standardized practices, particularly in settings where PoCUS is increasingly being adopted by nurses worldwide (24–26).

From a practical standpoint, the review team anticipates operational challenges related to the heterogeneity of the literature, especially in terminology, procedural details, and outcome reporting. Given the multidisciplinary nature of PoCUS use (e.g., by nurses, physicians, or allied health professionals), variability in how GRV assessment is described and conducted across studies may complicate data synthesis. To address this, the I-AIM framework (17) will be applied to guide the thematic categorization of data, and pilot testing of the data charting tool will help ensure

consistency across reviewers.

Another operational issue relates to the inclusion of grey literature and the need to search diverse sources beyond traditional databases. While essential for capturing guidelines and unpublished academic work, this process may be time-consuming and yield variable-quality materials. The team will apply structured screening criteria and maintain transparency in documenting inclusion decisions.

No formal quality appraisal will be conducted, in accordance with JBI Collaboration guidance for scoping reviews (18); however, the completeness of reporting and clarity of procedures will be noted during extraction to inform future methodological recommendations.

Finally, as this review will include studies from any country or clinical setting, the applicability of findings may be influenced by differences in healthcare infrastructure, professional training, and technological availability. These contextual factors will be considered in the synthesis and interpretation of results.

Despite these challenges, this review is expected to make an important contribution to the field by identifying knowledge gaps, highlighting procedural inconsistencies, and supporting evidence-informed integration of PoCUS into clinical protocols for enteral nutrition management and aspiration risk reduction

Availability of data and materials

The full review protocol, including the search strategies and supporting documents, is publicly available on the Open Science Framework (OSF) at <https://osf.io/cq8s3>. Upon completion of the review, the extracted data, summary tables, and synthesis outputs will also be made openly accessible through the same platform. No primary data were collected for this study.

Competing interests

The authors declare that they have no competing interests

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Supplementary Files

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Figures

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