

REVIEW ARTICLE

Ultrasound assessment of gastric content and volume

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Editor's key points

- The authors review the literature regarding the use of ultrasound to estimate gastric volume and, thus, aspiration risk.
- Suggestions for clinical usage are provided.

Pulmonary aspiration of gastric content is a serious anaesthetic complication that can lead to significant morbidity and mortality. Aspiration risk assessment is usually based on fasting times. However, fasting guidelines do not apply to urgent or emergent situations and to patients with certain co-morbidities. Gastric content and volume assessment is a new point-of-care ultrasound application that can help determine aspiration risk. This systematic review summarizes the current literature on bedside ultrasound assessment of gastric content and volume relevant to anaesthesia practice. Seventeen articles were identified using predetermined criteria. Studies were classified into those describing the sonographic characteristics of different types of gastric content (empty, clear fluid, solid), and those describing methods for quantitative assessment of gastric volume. A possible algorithm for the clinical application of this new tool is proposed, and areas that require further research are highlighted.

Keywords: antrum; gastric content; pulmonary aspiration; ultrasound

Perioperative aspiration of gastric contents is a rare but serious complication of anaesthesia. The overall incidence in a mixed surgical population ranges between <0.1% and 19% depending on patient and surgical factors and it has not changed in the last few decades.^{1–5} Aspiration pneumonia is associated with significant morbidity, including prolonged mechanical ventilation,⁶ and carries a risk of mortality as great as 5%. Pulmonary aspiration is involved in up to 9% of all anaesthesia-related deaths.^{7,8} One of the main risk factors for aspiration is the presence of gastric content. The critical volume threshold of gastric fluid that by itself increases aspiration risk is controversial, but healthy, fasted patients frequently have residual gastric volumes (GVs) of up to 1.5 ml kg⁻¹ without significant aspiration risk.^{9–13} Sedation and general anaesthesia depress or impede the physiological mechanisms that protect against aspiration (the tone of the lower oesophageal sphincter and upper airway reflexes).^{14,15} Since restriction of fluid and food intake before general anaesthesia is vital for patient safety, anaesthesiology societies have developed guidelines for preoperative fasting.^{16,17} For example, current guidelines by the ASA recommend a minimum of 2 h of fasting for clear fluids, 6 h after a light meal (toast and clear fluids), and 8 h after a full meal with high calorie or fat content.¹⁷ However, these guidelines apply only to healthy patients for elective surgery and are not reliable in patients with coexisting diseases that affect gastric emptying or volume, patients in whom airway management might be difficult or in emergency situations.¹⁷ This systematic review summarizes the current state of knowledge on the use of

bedside ultrasound to evaluate gastric content and volume as they relate to aspiration risk assessment from the perspective of the clinical anaesthesiologist.

Methods

The recommendations and checklist of the PRISMA statement (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) were followed to conduct and report this review.¹⁸

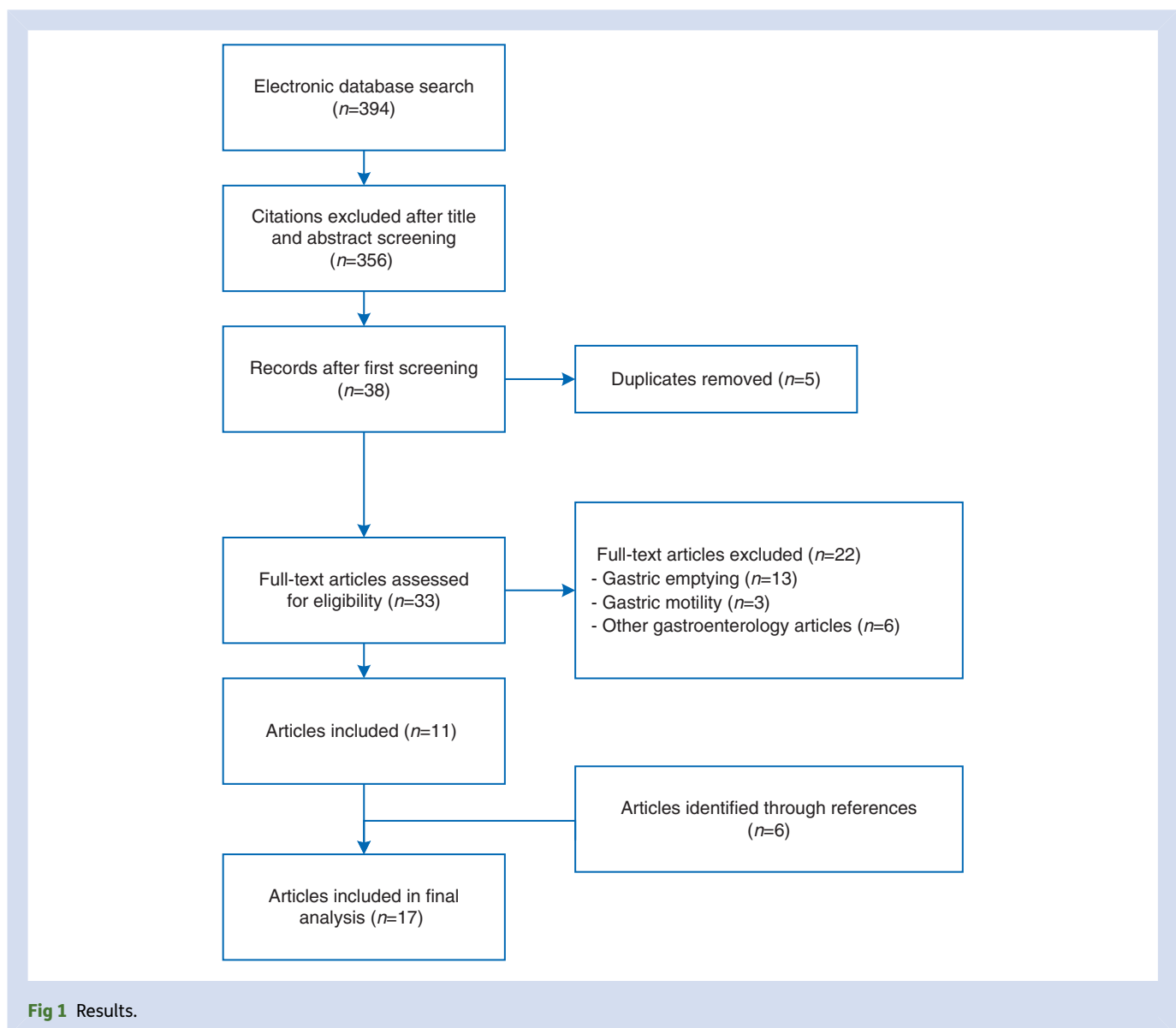
The National Library of Medicine's PubMed, OVID Medline, and EMBASE databases were searched since their date of inception to February 2013 using the following Medical Subject Headings: *gastric ultrasonography* or *gastric ultrasound* or *gastric sonography* and *stomach* or *antrum* were used. The search was restricted to English language articles and human subjects. Two independent reviewers read all citations. Prospective or retrospective experimental studies of portable 2D ultrasonography on human subjects, case series, or observational studies were selected for inclusion if they addressed one or two of the following questions: (i) Can ultrasound determine the nature of gastric content (empty, clear fluid, or thick fluid/solid)?, (ii) Can ultrasound estimate the volume of gastric fluid?, or both. Commentaries, abstracts, letters to the editor, case reports, editorials, and meeting proceedings were excluded. Discrepancies were settled by discussion and consensus. Selected articles underwent full-text review and references were screened for further articles not identified by the searches.

The following data were extracted from each included study: publication year, country of origin, study design, number of subjects and patient characteristics, gastric sections studied (antrum, body, fundus), scanning position, and plane. For quantitative studies, details of mathematical models were extracted (reference standard, correlation coefficient).

Results

Three hundred and ninety-four citations were identified (Fig. 1). Based on title and abstract, 356 were excluded as not meeting inclusion criteria, and five were duplicates. Thirty-three articles were retrieved for full-text review. Of these, 22 publications were excluded (13 studied gastric emptying, three studied gastric motility, and six were on other gastroenterology applications not directly related to aspiration risk assessment). Six additional articles were identified from reference lists. Seventeen

articles were included in this review. Eight articles dealt with qualitative assessment (Table 1), seven articles dealt with quantitative assessment (Table 2), and two additional studies were included in both categories. Of the included studies, 41% ($n=7$) were published before 2000, 18% ($n=3$) between 2000 and 2009, and the remaining 41% ($n=7$) in or after 2010. The majority of the studies originated in North America (47%, $n=8$) and Europe (41%, $n=7$), whereas 12% ($n=2$) were from Japan. A total of 533 subjects were included in the qualitative studies and 542 subjects in the quantitative studies. Study populations consisted of healthy volunteers ($n=267$), pregnant patients ($n=73$), newborns ($n=32$), other paediatric patients ($n=16$), elective adult surgical subjects ($n=467$), upper gastric endoscopy ($n=140$), or intensive care patients ($n=80$). The antrum was evaluated in 82% of the studies, the fundus in 23%, and the gastric body in 35%. Two studies did not specify which section of the stomach was evaluated.



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