Ultrasound assessment of gastric contents in the perioperative period: why is this not part of our daily practice?

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In 1946, Mendelson\textsuperscript{1} showed that pulmonary complications and death could arise in pregnant women because of aspiration of gastric contents. Since then, prevention of aspiration of gastric contents has contributed significantly to a decrease in maternal deaths. Aspiration of gastric contents also impacts other areas of anaesthetic practice, particularly emergency surgery. Warner and colleagues\textsuperscript{2} demonstrated in a large series from the Mayo Clinic that no aspiration occurred in pregnant or post-partum women (probably because of the routine use of prophylactic measures), while both its occurrence and severity were significant in emergency procedures. An important risk factor for aspiration is gastric volume, determined in large part by gastric emptying. Unfortunately, measuring gastric volume over time is not easy, and scintigraphy has...
remained the gold standard technique for many years. However, because of cost, radiation exposure, and the need for specific equipment, this technique has remained largely restricted to research purposes. Ultrasound has progressively emerged as a useful replacement because it is cheap and can be performed at the bedside. After years of uncertainty recent studies provide sufficient evidence of accuracy and reproducibility. Clearly, ultrasound assessment cannot provide complete information about gastric function and status (i.e. pH), but it can deliver important and useful information, such as gastric volume. It also allows identification of particles that could increase risk if aspiration occurs. In the article by Okabe and colleagues in this issue of the *BJA*, important new information about the mechanisms driving gastric emptying is presented.

Hillyard and colleagues have recently challenged the traditional view that milk is slow to evacuate from the stomach. The study by Okabe and colleagues is important in showing that the greater the caloric content, the slower is gastric emptying. The authors do not speculate on what physiological sensor detects calorie content, but several mechanisms have been suggested. Gastric emptying is modulated by local mechanical factors and gastric wall stress, but neurohumoral mechanisms are also implicated. For example, when a lipid emulsion is infused directly into the duodenum, gastric motility decreases and appetite is suppressed. Filling the intestine with food or drink triggers a neurohumoral response mediated by the vagus nerve, the myenteric plexus, and the release of small bowel peptide hormones (e.g. CCK, glucagon-like peptide-1), which affect gastrointestinal function and slow gastric emptying. A similar mechanism is involved when nutrients enter the distal part of the small intestine (called the ‘ileal brake’). This latter effect partially explains the different (and slower) gastric emptying during the late post-prandial period. According to Kwiatek and colleagues, gastric emptying half-life increases by 18 min for each additional 100 kcal load. This estimate is largely consistent with the study of Okabe and colleagues’ (their Fig. 4) in which gastric emptying half-life was close to 30 and 50 min for the 220 and 330 kcal fluids, respectively. The nutrient content is less important than the caloric load, but there is a complex interaction between calorie load, gastric volume, and time. For example, during the early period of gastric emptying, volume is more important, and a ‘bolus’ of gastric content is rapidly evacuated into the duodenum, whatever its caloric load. Sensory mechanisms that sense gastric volume and its chemical content (calories) then modulate gastric emptying. This would explain the relationship of gastric volume to time: an initial rapid steep decrease subsequently flattening out when neurohumoral mechanisms take effect.

The study by Okabe and colleagues also confirms that viscosity and osmolality play lesser roles compared with caloric content, although this has been challenged. Milk per se is not slow to evacuate, but it is rather its fat-related caloric content that determines the slower rate of gastric emptying. A small volume of whole milk or a larger volume of skimmed milk poses a similar risk. For example, whole cow’s milk (fat content 4%) contains around 650 kcal litre⁻¹, whereas the same volumes of skimmed and semi-skimmed milk contain 340 and 460 kcal, respectively. The effect might be linked at least partially to the size of lipid droplets, smaller lipid droplets leading to more intense inhibition, possibly due to a greater contact surface area between the intestine and the nutrient. Milk cannot be used as a generic term, but requires precise definition as to what can (or cannot) be drunk. Simple explanations should be given to the patient, possibly with practical examples to facilitate understanding. This new information could have impact on professional recommendations if our willingness to be more patient-centred is predominant. Some patients like to have a milk-based drink in the morning before surgery. However, explaining subtle differences and providing precise limits for each type of milky drink would not be easy. As milk can curdle in the acid stomach environment, it can then act more like a solid, thus delaying gastric emptying. Gastric ultrasound can be of use as visualization of very small particles is possible with current ultrasound machines.

Studies such as those by Okabe and colleagues show that our research agenda is far from complete. Owing to the simplicity and non-invasive nature of ultrasound gastric volume assessment, this easy-to-learn technique can help in at least two ways. First, as discussed above, additional studies on gastric physiology could be done to refine and extend our knowledge, including both general mechanisms of gastric emptying and the various physiological situations (solid food, pregnancy, post-partum, children, sleep, etc.) that might be useful in anaesthetic practice. Ultrasound assessment of the stomach could also be useful in routine clinical practice. Fasting guidelines exist, but unfortunately, we often face situations in which they are unhelpful. For instance, the ability of diabetic patients to eliminate gastric contents is said to be delayed because of autonomic gastroparesis. Up to 50% of diabetic patients have altered gastric emptying and the predictive value of clinical symptoms is low. Interestingly, in most cases, the delay is modest and in some patients, gastric emptying is accelerated. Therefore, how do we determine which diabetic patients have significant gastroparesis and which are at risk on an individual basis? Studies performed in anaesthesia (i.e. after several hours of fasting) do not demonstrate with certainty the best course of action. Some show that solid particles remain in the stomach after a normal fasting period, but clinical practice does not suggest an increased risk. Similarly, morbidly obese patients are a cause of concern for the anaesthetist. Delayed gastric emptying has traditionally been an important preoperative factor to consider even in elective surgery, but more recent studies have shown that obese patients usually have a normal preoperative gastric volume. Of particular concern are patients who have previously undergone anti-obesity surgery and now require another procedure months or years later. One feels that these patients are at risk, but this may not always be the case. The anaesthetic literature would suggest these patients are at increased risk, but is unhelpful in individual situations.

Using rapid sequence induction for all the aforementioned ‘grey area’ situations or for all urgent surgical procedures
requiring general anaesthesia is one potential strategy. This procedure does however place the patient at risk of complications and is therefore difficult to promote universally. So what then are the options? The use of ultrasound to assess gastric contents may well be the way ahead. Measurement of antral cross-sectional area is easy to learn: ~30 examinations are required to ensure competence. It is more than likely that the complex formula currently used to estimate gastric volumes from antral cross-sectional area measurement will soon be available as a mobile phone application to facilitate interpretation of readings taken from portable ultrasound devices. As ultrasound becomes more widely used, the competence and understanding of this modality will naturally increase. All of the above suggests that routine ultrasound measurement of gastric contents will become part of our practice each time, there is any doubt as to residual gastric volume and the optimum strategy to avoid aspiration. Perlis and colleagues described a simple clinical score to classify patients with regard to their gastric content and predict their risk of aspiration. This study was performed in fasted patients before scheduled surgery, but the use of ultrasound in patients undergoing emergency surgery would certainly help to determine individual risk and subsequent prophylactic strategy. Recently, Bouvet and colleagues showed that after induction of general anaesthesia and before tracheal intubation, positive pressure ventilation applied with 15 cm H₂O achieved adequate ventilation, while ultrasound more often detected gastric insufflation than did auscultation. In the intensive care unit, ultrasound has been used to confirm nasogastric tube placement and has also been shown to provide accurate antral area measurements.

Ultrasound assessment of gastric content and volume has some limitations. Although antral area is visible in a very large proportion of subjects after fluid ingestion, it can be difficult to distinguish when the stomach is empty (leaving doubt between possible technical failure or a genuinely empty stomach). Placing the patient in the right lateral decubitus position is often helpful. After solid food ingestion, air can limit the ability to see the posterior wall and thereby decrease each time, there is any doubt as to residual gastric volume measurement of gastric contents will become part of our practice. As ultrasound becomes more widely used, the competence and understanding of this modality will naturally increase. All of the above suggests that routine ultrasound measurement of gastric contents will become part of our practice each time, there is any doubt as to residual gastric volume and the optimum strategy to avoid aspiration. Perlis and colleagues described a simple clinical score to classify patients with regard to their gastric content and predict their risk of aspiration. This study was performed in fasted patients before scheduled surgery, but the use of ultrasound in patients undergoing emergency surgery would certainly help to determine individual risk and subsequent prophylactic strategy. Recently, Bouvet and colleagues showed that after induction of general anaesthesia and before tracheal intubation, positive pressure ventilation applied with 15 cm H₂O achieved adequate ventilation, while ultrasound more often detected gastric insufflation than did auscultation. In the intensive care unit, ultrasound has been used to confirm nasogastric tube placement and has also been shown to provide accurate antral area measurements.

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Fibrinogen concentrates for post-partum haemorrhage? Do not miss the most relevant population!

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Post-partum haemorrhage (PPH) is an emotional clinical event leading to high morbidity and mortality in obstetrics. Among others, delayed availability of blood products has been identified as contributing to adverse outcomes. To reduce the requirements of transfusion, several new approaches have been suggested during PPH.1 Administration of fibrinogen concentrates for prevention or treatment of bleeding is increasingly being supported, even if evidence-based data are still lacking.2 3 Fibrinogen has been shown to be the first coagulation factor to decrease to critical levels in actively bleeding patients.4 The decrease is correlated with the volume of blood loss.5 The trigger level for supplementation has been increased in recent guidelines on severe bleeding.3 6 Clot strength increases with fibrinogen level over a wide range of values, from 0 to 9.5 g litre⁻¹.7 An in vitro model has suggested a plasma level as high as 2.5 g litre⁻¹ to optimise coagulation altered by a dilution coagulopathy.8 At term, parturients already exhibits a higher level of fibrinogen compared with non-pregnant women.9 During PPH, a fibrinogen level <2 g litre⁻¹ has been shown to predict progression to more severe bleeding or the need for a haemostatic intervention, 10 although even higher levels have been suggested.11 Anecdotal uncontrolled reports in obstetrics have suggested an improved haemostasis associated with administration of fibrinogen concentrates.12–14

Wikkelsø and colleagues15 have conducted a multicentre randomised placebo-controlled clinical trial in an attempt to evaluate the benefit of fibrinogen concentrates infusion in