

## Pre-operative fasting guidelines: an update

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Liberal pre-operative fasting routines have been implemented in most countries. In general, clear fluids are allowed up to 2 h before anaesthesia, and light meals up to 6 h. The same recommendations apply for children and pregnant women not in labour. In children <6 months, most recommendations now allow breast- or formula milk feeding up to 4 h before anaesthesia. Recently, the concept of pre-operative oral nutrition using a special carbohydrate-rich beverage has also gained support and been shown not to increase gastric fluid volume or acidity. Based on the available literature, our Task Force has produced new consensus-based Scandinavian guidelines for pre-operative fasting. What is still not clear is to what extent the new liberal fasting routines should apply to patients with functional dyspepsia or systematic diseases such as diabetes mellitus. Other still controversial areas include the need for

and effect of fasting in emergency patients, women in labour and in association with procedures done under 'deep sedation'. We think more research on the effect of various fasting regimes in subpopulations of patients is needed before we can move one step further towards completely evidence-based pre-operative fasting guidelines.

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**A**NAESTHESIA-RELATED pulmonary aspiration leading to respiratory failure (Aspiration Pneumonitis; Mendelson's syndrome) has been described in both elective and emergency surgical patients (1–7). With the hope of reducing the risk of this complication, rigid fasting routines before surgery have been enforced (8). However, the scientific basis for these rigid fasting routines in elective patients has been challenged and found to be non-existent (9–11). Based on this new information, several national anaesthesia societies now have accepted more liberal fasting rules for clear fluids (water, clear juices, coffee, tea) (12–17). Intake of solids in the morning of elective surgery is still not recommended.

To what extent pre-operative fasting is of any importance in emergency cases is still a matter of uncertainty with variation in clinical practice. Further, it is also not clear to what extent specific patient populations with suspected or proven delayed gastric emptying need to be exempt from

the new fasting guidelines (16, 17). Recently, a new method for pre-operative optimization of the elective patient, oral nutrition with carbohydrates (16, 18, 19), has been introduced, but so far has not been widely implemented into clinical practice.

This review aims to give an update on pre-operative fasting and gastric content as a risk factor of pulmonary aspiration. We will focus on the development and experience with the new and more liberal clinical practice guidelines, but also present still controversial areas worth further research.

### Anaesthesia-related pulmonary aspiration: risk factors

#### Gastric emptying

The volume of the adult ventricle is approximately 1500 ml. The ventricle can be divided into two functional parts, i.e. the proximal and the distal part (20). The proximal part consists of the fundus, cardia and the upper part of the corpus, and acts as a reservoir

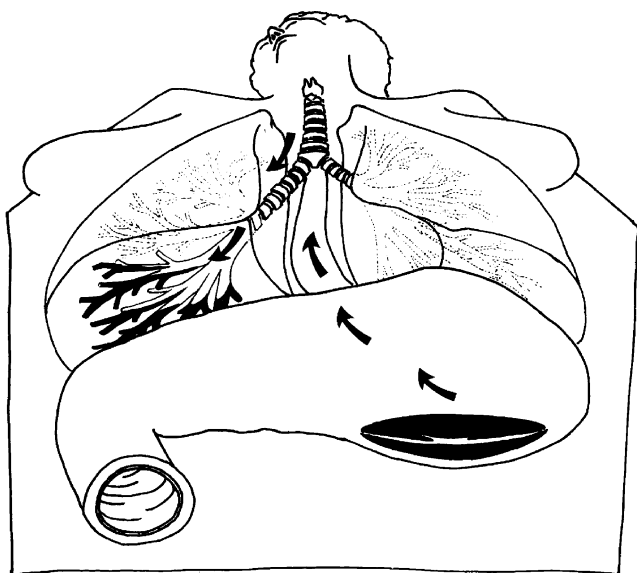


Fig. 1. The anatomical relationship between the gastro-oesophageal part of the digestive system and the upper airways and the lungs makes pulmonary aspiration likely during regurgitation or vomiting when the patient is anaesthetised. Previously published in the Doctoral Thesis 'Anaesthesia and gastric content. New methods and trends' (1995) by Eldar Soreide. Permission granted.

for ingested food regulating the intra-gastric pressure (adaptive relaxation) and the speed of gastric emptying. The distal part (Fig. 1) of the ventricle includes the lower part of the corpus, antrum and pylorus. The contractions of the distal part of the ventricle mix the larger solid food particles with gastric fluid. Only particles small enough (i.e. less than 1 mm) are allowed to pass via the pylorus to the duodenum.

In a normal situation, the gastric emptying of fluids is influenced by the pressure gradient between the stomach and the duodenum, and the volume, caloric density, pH and osmolality of the gastric fluid (20, 21). In otherwise healthy patients, gastric fluid content is not increased in the immediate pre-operative period despite the theoretical negative impact of anxiety on gastric emptying (22, 23). Gastric emptying of water and other inert, non-caloric fluids follows an extremely fast exponential curve with a mean half-time of 10 min (20, 21) (Fig. 2). Initially, glucose-loaded fluids empty a little slower, but after 90 min this difference is negligible (20, 21, 23).

In contrast, the gastric emptying curve for solids is linear (20, 21) (Fig. 2). Gastric emptying of solid food starts approximately 1 h after a meal. Within 2 h, approximately 50% of the solid food ingested is passed to the duodenum. The gastric emptying of solids is independent of the amount of food ingested but dependent on the caloric density of the meal.

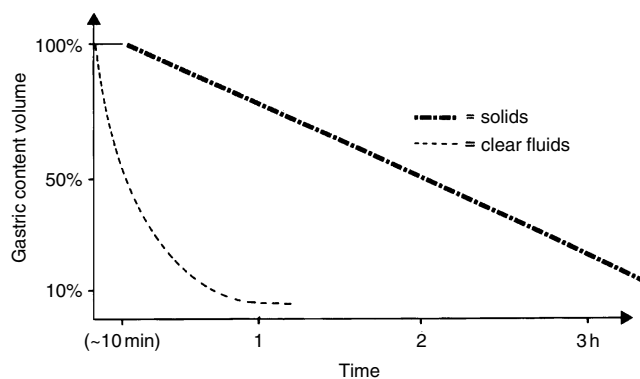


Fig. 2. The gastric emptying of solids (thick dotted line) and clear fluids (thin line). Previously published in the Doctoral Thesis 'Anaesthesia and gastric content. New methods and trends' (1995) by Eldar Soreide. Permission granted.

Gastric emptying is slower in females than in males and slower in the elderly. In order to secure emptying of solids, longer fasting is needed (24).

In neonates and infants, clear fluids also follow first order kinetics and emptying of solids in a linear manner (25). Gastric emptying of human milk in mature neonates and infants is not complete after 2 h and at least 3 h seems to be required (26). The optimal fasting period for human milk has not been established but it is more than 2 h and less than 5 h. Pre-mature babies have a somewhat slower rate of gastric emptying, and cow's milk empties slower than human milk (26). Gastric emptying time for formulas vary with the content of the formula. One should be aware of the fact that there is a rather large variation in the composition of formula food between different regions/countries. Most paediatric anaesthesiologists now use the same 2-h limit for clear fluids as in adults, and recommend 4- to 6-h fasting after breast- and formula milk with the lower limit applied in children less than 6 months (25).

Delayed gastric emptying is found in numerous situations, and may be divided by aetiology into alterations in normal physiology, state of disease and intake of external agents, either drugs or substances for abuse. Pain and opioids are well-known reasons for delayed gastric emptying (20, 24). Some systemic diseases are known to slow down the gastric emptying; among them most notably diabetes mellitus (27). Diabetes does affect gastric emptying much more for solids than for fluids (20, 27). Local gastrointestinal stasis (tumour or obstruction) may have the same effect.

Gastric emptying times for solids are delayed in smokers, but not with nicotine patch use (28, 29). Habitual smokers have a small but statistical significant increase in gastric fluid volumes when

compared with non-smokers, even when refraining from smoking (30). To what extent smoking affects gastric fluid emptying and volume is still controversial, but overall there seems to be good reasons for avoiding smoking immediately before anaesthesia (24, 30, 31). Recreational abuse of cannabinoids (32) and high doses of alcohol (33) also inhibit gastric emptying. Functional dyspepsia (34–36) is associated with a delay in gastric emptying. Obese patients seem to have a similar gastric emptying to non-obese patients, and pre-operative fluid intake does not increase gastric content (37). Studies on the impact of female hormones on gastric emptying have shown variable results (20, 24). Pregnant females seem to have a normal gastric emptying rate, except for the first trimester, where a hormonal cause for slowing has been suggested (38). When in labour, gastric emptying will be slowed down and stay slow for at least 2 h afterwards (39).

Metoclopramide may improve gastric emptying in these patients but cannot assure emptying of the stomach content (24, 40). The same goes for patients with pain or on opiate medication.

#### *Gastric content and gastro-oesophageal reflux*

The volume and acidity of the gastric content are a result of gastric secretion, oral intake and gastric emptying (20, 24). For passive regurgitation and pulmonary aspiration to occur during anaesthesia, a certain gastric volume needs to be present. Studies (41) indicate that more than 200 ml is needed in an adult patient. In otherwise healthy elective patients much lower gastric fluid volumes in the range of 10–30 ml are found (9–11, 42). In a few patients, higher volumes up to 200 ml may be found, irrespectively of intake of clear fluids or not. These outliers probably represent patients with an undetected gastric disorder such as functional dyspepsia (34–36). In patients with gastro-oesophageal reflux or if active vomiting occurs, even smaller gastric volumes may be propelled up and into the trachea (2, 7, 43) (Fig. 1).

#### *Patient and anaesthetic factors*

Airway management problems frequently precipitate pulmonary aspiration (3–7). Air blown into the stomach and bucking and coughing due to light anaesthesia may all cause gastro-oesophageal reflux episodes. Obese patients, patients with known gastro-oesophageal reflux disease and patients with difficult airways are particular prone to pulmonary aspirations, independent of their gastric content. Kruger et al. (7) found such patient factors together with poor judgement in choice and performance of

anaesthetic method to be the most important factors predisposing clinical significant pulmonary aspiration, and not violations of fasting precautions. This certainly put our historic overemphasis on gastric content into perspective. It is important to differentiate between what happens when airway manipulation during a light stage of anaesthesia induces active vomiting or gastro-oesophageal reflux episodes independently of the volume of gastric content, and the situation with a distended stomach pouch and anaesthesia that causes the oesophageal sphincters to relax and passive flow (regurgitation) of gastric content into the upper airways and pulmonary aspiration (2). The anaesthetist is probably as an important factor as the gastric content.

### **New guidelines for pre-operative fasting**

#### *Clinically controlled studies and meta-analysis*

Numerous controlled studies and meta-analysis have concluded that in otherwise healthy adults scheduled for elective surgery, oral intake of water and other clear fluids (tea, coffee, soda water, apple and pulp-free orange juice) up to 2 h before induction of anaesthesia does not increase gastric fluid volume or acidity (9–11, 15, 44). The studies were performed in both male and females adults (the study was in adults), and in different countries (44). Hence, according to the evidence-based medicine classification (45), the present scientific evidence allows a Level 1 recommendation for more liberal fasting routines for clear fluids.

#### *National and anaesthesia society guidelines*

Based on the new data, most national anaesthesiology societies now recommend no more than 2-h fasting for clear fluids (water, tea, coffee, pulp-free fruit juices) in elective patients, both adults and children and including pregnant women not in labour (12–17). Importantly, this does not apply to milk, any other fat-containing fluids, or solids. No complications associated with the new and more liberal fasting guidelines have been reported (44, 46). To provide sufficient safety margins, the fasting period after intake of solids should not be less than 6 h (47, 48). Further, although shown to affect gastric content not all national societies guidelines include information on the use of chewing gum, tobacco and pre-operative medications in the immediate pre-operative period. Chewing gum and tobacco use both increase gastric content, but to what extent the increase is of any clinical significance is very uncertain (30). Still, we think their

use should be discouraged in the immediate pre-operative period (14).

Oral benzodiazepines are commonly used for pre-medication. Up to 150 ml of water together with oral medication up to 1 h before induction of anaesthesia is perfectly safe in adults (42). Based on the prolonged gastric emptying seen with the use of opiates, it is reasonable to stop fluid intake 1 h before the use of opiate premedication (49).

### *New Scandinavian guidelines*

Our Task Force aimed at making one combined but not too detailed practice guideline for pre-operative fasting for all the Scandinavian countries. We concluded that based on the current knowledge, a general recommendation of 2-h fasting for clear fluids and 6 h for solids in otherwise healthy elective patient is appropriate (Table 1). This guideline is non-controversial and valid both for children > 1 years, adults and pregnant women not in labour. Similar to others, we define clear fluids as water, coffee, tea, pulp-free juice and soft drinks, but also included the pre-operative carbohydrate drink intended for pre-operative nutrition (Nutricia Preop<sup>®</sup>, Numico, The Netherlands) (16, 19, 23). The restrictions for solids include soups, yoghurt, sour milk or milk-containing drinks. We felt that our Scandinavian consensus-based clinical practice guidelines should not go into more detail but leave this to the national societies. Instead, we also decided to include topics still controversial or topics where more research is needed.

## **Controversial topics and topics for future research**

### *Patient groups exempt from the liberal fasting guidelines*

While the new, liberal fasting guidelines can be safely used for the majority of elective patients, it

is important to emphasise that pre-operative fasting is still strictly recommended for all emergency surgery cases. The delayed gastric emptying in emergency cases may be due to both the effect of pain per se, the opioids given or gastrointestinal obstruction (2, 24). Hence, fasting such patients will never make them 'fasted and elective'. The same applies to pregnant women in labour (50).

There are also elective patients where a significant delayed gastric emptying must be suspected. These include patients with gastrointestinal obstruction of any form, or cancer in the upper gastrointestinal tract. When it comes to choice of anaesthetic technique, patients with a known hiatus hernia have a greater risk of regurgitation and should be handled as 'at risk of regurgitation'. However, there is no clear evidence of slower gastric emptying or greater residual gastric volumes in these patients (16, 17).

There is a high prevalence of delayed gastric emptying and gastro-paresis in patients with upper gastrointestinal symptoms, which is not influenced by the presence of organic disease(34–36). Hence, such patients should probably be fasted after intake of solids for more than 6 h. How long, however, is not known. Although the effect on gastric emptying of fluids probably is much less, more controlled trials are needed in these patients (44).

In patients with systemic disease, the extent of gastric slowing may be highly variable depending on the severity of the disease (20, 27). Most investigations have been carried out in diabetes mellitus where the gastric slowing is due to polyneuropathy in the innervations of the gastrointestinal system with advanced disease. To what extent diabetic patients should be nil per mouth after midnight to secure gastric content in the normal range is still not known. Diabetes and other medical conditions do affect gastric emptying much more for solids than for fluids (20, 24, 27). Probably, a 2-h fasting period for clear fluids is also enough in patients with

Table 1

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Scandinavian guidelines for pre-operative fasting in elective patients.

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Patients (adults as well as children) may drink clear fluids up to 2 h prior to general or regional anaesthesia

Patient should not take solid food 6 h prior to induction of anaesthesia

Breast-feeding should be stopped 4 h prior to induction of anaesthesia. The same applies to formula milk

Adults may drink up to 150 ml of water with pre-operative oral medication up to 1 h before induction of anaesthesia, and children up to 75 ml.

Use of chewing gum and any form of tobacco should be discouraged during the last 2 h prior to induction of anaesthesia

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These guidelines also apply to elective Caesarean sections. Clear fluids are defined as non-particulate fluids without fat, for example, water, clear fruit juice, tea or coffee.

Both cow's milk and powdered milk are treated as solid food.

Patients with known or suspected delay in gastric emptying (diabetes mellitus, upper gastrointestinal pathology and symptoms) should be assessed on an individual basis.

systemic diseases. More studies, however, are needed before a scientific validated answer can be given. In the mean time, we think it is wise to err on the conservative side when it comes to fasting after intake of solids in these patients.

Women going into labour have very prolonged gastric emptying times (39) and have an increased incidence of pulmonary aspirations compared with other patient groups (6). Despite this fact, most maternity wards encourage oral intake during labour (50). This may sound counter-productive for us as anesthesiologists, but to obstetricians, midwives and the women themselves, the small risk of an emergency Caesarean-section under general anaesthesia may not be a valid argument to impose unphysiological starvation during a natural process with a large need for calories (50). A trade-off that midwives and obstetricians may accept is to allow fluids but no solids during labour. Anaesthesiologists are not in the position to decide the fasting guidelines for women in labour. We need more data on the actual practice and possible adverse effects in Scandinavian maternity systems before we can move forward on this topic.

#### *Sedation and need for pre-sedation fasting*

An increasing number of surgical procedures are done with 'light, conscious or deep sedation' in various combinations with local and regional anaesthesia. Should these patients be included in the pre-operative fasting guidelines? Sedation and analgesics tend to impair airway reflexes in proportion to the degree of sedation/analgesia achieved (51, 52). The available literature does not provide sufficient evidence to conclude that pre-procedure fasting results in a decreased incidence of adverse outcomes in patients undergoing either moderate or deep sedation. However, the American Society of Anesthesiologists recommends that patients undergoing sedation/analgesia for elective procedures should have the same restrictions as patients undergoing general anaesthesia (52). These guidelines are arbitrary and based upon consensus opinion.

In emergency situations, the potential for pulmonary aspiration of gastric contents must be considered. Green et al. (51) found that pulmonary aspiration during emergency department procedural sedation and analgesia had not been reported in medical literature. Therefore, there is little evidence to support specific fasting periods.

Steeds and Mather (53) surveyed the policy of pre-operative fasting in connection with eye surgery under regional anaesthesia. Fifty per cent of the

respondents felt that fasting was not necessary and mentioned hypoglycaemia, faint, thirst, nausea, headache, and dizziness as complications to prolonged starvation. Maltby and Hamilton (54) found no case of pulmonary aspiration in 30 000 patients undergoing cataract surgery done under regional anaesthesia. Only 1% needed sedation. Since 1984, they have allowed breakfast before the procedure. Still, they cautioned against heavy sedation and conversion of regional block into general anaesthesia. Most eye surgery can be done with local anaesthesia only. It looks like pre-operative fasting ensures very little extra patient safety, and at the expense of patient comfort. Post-operative emesis which is detrimental after ophthalmic surgery might be reduced by shorter pre-operative fast. It seems like the key points are to make the ophthalmologists aware of the potential danger of heavy sedation and non-fasting and to make local guidelines that take into account the type of surgery, type of local and regional anaesthesia, the need for sedation and the possibility of having to convert a failed regional anaesthetic to a general one. We feel that more data on the current sedation practice in elective and emergency cases in Scandinavia are needed before we can produce specific recommendations on pre-procedural fasting in these situations.

#### *Pre-operative fasting vs. oral nutrition*

The metabolic implications of prolonged starvation vs. shorter fasting times are also important (18). Studies have indicated that the availability of carbohydrates and the metabolic setting of the fed state are important factors which improve post-operative recovery (16). The main objective of pre-operative carbohydrate treatment is to cause a change in metabolism that normally takes place when someone takes their breakfast. This will elicit an endogenous insulin release that turns off the overnight fasting state of the metabolism. A carbohydrate-rich (12.5%) clear beverage containing mainly polymers of carbohydrates to minimize the osmotic load and thus reduce the gastric emptying time has been tested (23). Both in healthy volunteers and in pre-operative patients 400 ml passed the stomach within 90 min. Studies in more than 250 patients have shown that the median residual gastric volume is only approximately 20 ml (16, 18). A small fraction of the patients had gastric volumes above 120 ml, the highest being 200 ml. When the 400-ml dose was divided into 2 × 200 ml, the last intake 2 h before the gastroscopy, the highest volume

found was 120 ml, with the averages approximately 35 ml.

Studies have found that this carbohydrate-rich pre-operative beverage both improves subjective well-being compared with a placebo (water) and may positively affect the post-operative recovery (16, 19). From a patient safety point of view, it is important to notice that intake of up to 400 ml of the beverage does not produce negative effects on the gastric content compared with a similar intake of water (16, 24). The effect of oral fluid intake on peri-operative urine output should also be included in future studies (42).

## Conclusions

Free intake of clear fluids, including a specially designed beverage for oral carbohydrate nutrition, up until 2 h prior to anaesthesia for elective surgery is safe and improves subjective well-being. The new Scandinavian guidelines emphasize that the minimum fasting time after intake of solids should still be 6 h. Fasting in emergency patients cannot secure gastric emptying and should not delay surgical interventions. More studies are needed on pre-operative fasting and gastric content in patients with systemic disease, such as diabetes mellitus and patients with upper gastrointestinal symptoms. Overall, the choice of anaesthetic technique and airway management seems to be as important as adherence to any fasting guidelines when it comes to reducing the chance of pulmonary aspiration.

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