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Preoperative fasting in children. The evolution of recommendations and guidelines, and the underlying evidence

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ABSTRACT

This review discusses the evolution of preoperative fasting guidelines and examines the incidence of pulmonary aspiration of gastric contents and suggested treatments.

Nine guidelines developed by professional societies and published in peer-reviewed journals since 1994 were identified. The recommendations on preoperative fasting for various categories have undergone only small adaptations in the following three decades in pediatric anesthesia.

We found twelve published studies of the incidence of pulmonary aspiration, which ranges from 0.6 to 12 in 10,000 anesthetics in children. However, this variation reflects differences in the definition of aspiration as well as differences in study design. The main risk factors identified are emergency surgery, ASA physical status, and patient age. Several additional risk factors have been suggested, including non-compliance to fasting guidelines.

The duration of clear fluid fasting is not associated with an increased risk of pulmonary aspiration which may be reflected in future guideline updates in pediatric anesthesia.

1. Preoperative fasting guidelines from past to present

The notion of preoperative fasting is as old as anesthesia itself. Case reports of asphyxiation due to vomiting were available during the 19th century with Sir Joseph Lister publishing the first recommendation for preoperative fasting in 1883. Lister identified remains of solid food in the stomach as a major risk for aspiration but also intuitively acknowledged the negative effects of prolonged fasting. A cup of beef tea about 2 h before the administration of chloroform anesthesia was subsequently recommended. More elaborate regimens for limited intake of food and drink (rather than outright fasting) before anesthesia were described in the following decades. Maltby compiled a detailed history of the evolution of preoperative fasting recommendations in this journal, an article well worth re-reading [1]. After the Second World War, the recommended strict nil-per-os from midnight rule was gradually enforced and included both solids and liquids. It took, however, another half a century before formal guidelines from national and international societies were developed and published (Table 1).

The first consensus-based guideline on perioperative fasting guidelines was published by the Norwegian Society of Anaesthesiology [2]. This guideline included a recommended mandatory fasting period of 6 h after a light meal. Clear fluids were allowed until 2 h

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before anesthesia but also 150 mL of water 1 h before induction to enable oral premedication. The authors correctly predicted that an adoption by the American Society of Anesthesiologists (ASA) task force would enable international consensus. Indeed, the 1999 '*Practice Guidelines for Preoperative Fasting and the Use of Pharmacologic Agents to Reduce the Risk of Pulmonary Aspiration*' not only led to the adoption of the recommendations of the task force in the United States but also worldwide [3]. The guidelines included recommendations for preoperative fasting after a large meal of solids (8 h), a light meal (6 h), breast milk (4 h), and clear fluids (2 h), commonly abbreviated to the 6-4-2 rule.

For clinicians and their patients alike, this guideline was a significant improvement from the '*Fast from Midnight*' as it addressed the problem of starving breastfeeding infants and offered a solution to dehydration and thirst for children and adults. Very few significant changes to these core recommendations have been made since [4,5].

The Scandinavian Society of Anaesthesiology and Intensive Care Medicine (SSAI) also appointed a task force on pre-operative fasting guidelines and published almost identical recommendations in 2005 [6]. One important exception was the inclusion of infant formula in infants undergoing elective procedures under anesthesia. In 2009, the European Society of Anaesthesiology (ESAIC) published its first guideline on preoperative fasting in adults and children [7]. In addition to the basic 6-4-2 rule, the ESAIC guideline introduced the concept of encouraging intake of clear fluids at 2 h before anesthesia, and breast milk or formula at 4 h before anesthesia in infants <6 months of age. The recently published ESAIC guideline for preoperative fasting in children was the result of two years of work by a newly appointed ESAIC task force consisting of pediatric anesthesiologists from 11 countries [9]. It is the first fasting guideline that used current evidence-based medicine methodology, including the definition of a set of Population Intervention Comparison Outcome queries (PICO), a systematic literature review, evaluation of the quality of the evidence according to GRADE, followed by a consensus process including several Delphi meetings, with subsequent publication in a peer-reviewed journal. The major changes compared to previous guidelines were the recommendations to encourage children to drink clear fluids until 1 h before anesthesia induction, for infants to be breastfed until 3 h before induction, or fed infant formula until 4 h before induction. Furthermore, the guideline did not advise against centers continuing to implement the concept of a well-defined light breakfast 4 h before induction or clear fluids until the patient is called to the operating theater (0+). In the current shorthand for preoperative fasting regimens, the evidence-based recommendations were summarized as 6-4-3-1, including solid food fasting for at least 6 h as per other guidelines.

2. It is too confusing: the 'pro and con' of the 6-4-3-1

At first, the addition of 1 h of clear fluid seems hardly worth it. Does it make a difference if children drink 2 h or 1 h before anesthesia, and is it worth the risk to change a rule that has been considered '*safe*' for more than two decades? [11] Will '*aspiration pneumonitis become the next major focus of morbidity and mortality in pediatric anesthesia*'? [12].

We think not. Firstly, increased gastric content volume suggested as a secondary surrogate marker for aspiration risk is irrelevant as similar gastric residual volumes in healthy children allocated to 1 or 2-h clear fluid fasting (median/IQR of 0.43 (0.21-0-84) vs 0.46 (0.19–0.79 ml kg-1) have been observed [13]. Secondly, ingestion of clear fluids does not seem to cause aspiration, as discussed below.

What are the negative effects of prolonged fasting? Fasting overnight does very little harm to healthy older children and only leads to clinically insignificant changes in blood glucose and ketone bodies, blood pressure, or difficulties of intravenous insertion during anesthesia [9]. However, more vulnerable populations may show a higher risk of hypoglycemia of one in four at induction of anesthesia [14]. Most recently, a prospective Swiss multicenter audit of pulmonary aspiration following the implementation of the ESAIC guideline reported no increase in the incidence of gastric aspiration compared with previous national data [15].

An argument against the change has been that studies comparing 1 and 2-h clear fluid fast have failed to demonstrate any benefit as most children allocated to the 1-h rule were fasted more than 2 h anyway. However, the reduction to 1 h resulted in a reduction of mean fasting times of almost 50%, from around 6 h to around 3 h [16–18]. The incidence of fasting more than 6 h decreased from 33% to 6% [16]. Most clinicians realize that the modern fasting rule aims to prevent unnecessarily prolonged fasting. There is a difference in encouraging clear fluid intake rather than forcing healthy children to have a drink exactly 1 h before anesthesia.

The change of the clear fluid fasting rule from a minimum of 2 to 1 h before induction in children is thus an effective means to

Table 1
Preoperative fasting guidelines published by national or international societies. Professional societies: Norwegian Society of Anaesthesiology, ASA – American Society of Anaesthesiology, SSAI – Scandinavian Society of Anaesthesiology and Intensive Care Medicine, CAS – Canadian Society of Anaesthesiology, ESAIC – European Society of Anaesthesiology and Intensive Care. Fasting rules in hours before induction; 0+ - fluids allowed until patient called to the OR).

First author	Society	Year	Country/Region	Solids heavy meal	Solids light meal	Infant formula	Breast milk	Clear Fluids
Raeder JC [2]	Norwegian S An	1995	Norway	None	6	NA	4	2
ASA TF [3]	ASA	1999	USA	8	6	NA	2	2
Soreide [6]	SSAI	2005	Scandinavia	None	6	4	4	2
Smith [7]	ESA	2009	Europe	None	6	4	4	2
ASA TF [4]	ASA	2011	USA	8	6	ND	4	2
ASA TF [5]	ASA	2017	USA	8	6	NR	4	2
Dobson [8]	CAS	2021	Canada	8	6		4	1
Frykholm [9]	ESAIC	2022	Europe	None	6/4	4	3	1/0+
ASA TF [10]	ASA	2023	USA	8	6		4	2

reduce mean fasting times with minimal effects on the residual gastric content volume. It has the potential to reduce the risk of hypoglycemia and metabolic effects in vulnerable populations and avoid discomfort and thirst in healthy children.

3. Quantifying the risk of pulmonary aspiration - a challenging task

Several studies of the incidence of pulmonary aspiration of gastric contents in children have been published; the incidence ranges from 0.6 to 12 in 10,000 (Table 2). No significant change over time can be observed. A problem with pooling data from the studies in Table 2 is the difference in design and differences in the definition of aspiration. Four of the audits were retrospective, four prospective using data from reported incidents or medical records, while three studies used case report forms (CRF) for all included procedures, i.e. both numerator and denominator data. The latter design is arguably the strongest, providing details about the severity of each incident, more accurate background data, and pre-defined risk factors. However, if available data from all the studies are analyzed in more detail we can distinguish four degrees of severity of outcome for aspiration incidents: 1) death, 2) intensive care/patient harm 3), escalation of care but not intensive care, and 4) transient symptoms such as desaturation or coughing.

First, pulmonary aspiration of gastric content in healthy children does not lead to mortality. Only 2 children have been reported over the past 50 years to have succumbed to pulmonary aspiration potentially contributing to their deaths [29]. Both cases had significant co-morbidity likely to have hastened their demise.

Second, patients that needed postoperative intensive care may have recovered without sequelae, but have come to harm. This is a hard outcome that has been recorded in most audits, ranging from 0.2 to 3 in 10,000. Interestingly, this outcome was one order of magnitude more common in the first audits from the 1990s compared to more recent audits.

Third, a less well-defined outcome is an escalation of care, including e.g. unplanned admission for in-patient care, supplemental oxygen beyond PACU, or treatment of aspiration with antibiotics. The reported or extracted incidence was 0.4–3 in 10,000.

Finally, transient symptoms such as intraoperative desaturation, coughing or perhaps only the need for suctioning of regurgitated gastric contents had an incidence of 0.6–10 in 10,000.

Thus the majority of aspiration incidents do not lead to patient harm. While aspiration of solid material into the airway may lead to acute asphyxia and death, clear fluids, regardless of acidity will not. Children are more likely to experience negative outcomes due to hypoxia caused by inadequate anesthesia technique and failure to oxygenate and ventilate. The real threat in children is hypoxia rather than aspiration. Future studies should differentiate between these four types of outcomes when reporting the incidence of pulmonary aspiration to facilitate comparisons between populations and to understand changes over time.

4. Real and perceived risk factors for aspiration

4.1. Risk factors identified in audits

Examining risk factors found in the large observational studies of the incidence of aspiration (Table 2), several conditions stand out.

Table 2
Incidence of pulmonary aspiration. Study design (P-prospective, R – retrospective, P (CRF) – prospective with a CRF for both numerator and denominator data. Fasting rule (e.g. 6-4-2 means 6 h fasting for solids, 4 h for breast milk, and 2 h for clear fluids). Events and published incidences are those reported or extracted from the articles. Outcome categories, number of reported cases and calculated incidence [Death – number of cases when aspiration contributed to death, ICU – number of cases (incidence) that required intensive care due to aspiration, Escalation of care – number of aspirations (incidence) leading to escalation of care, Transient – only transient symptoms, no treatment needed]. All incidence numbers are expressed as N:10,000).

First author/year	Design	Rule	N	Events	Published incidence	Death N	ICU N (Incidence)	Escalation of care N (Incidence)	Transient N (Incidence)
Borland [19] 1998	P	NA	50,880	52	10	0	15 (3)	23 (5)	37 (7)
Warner [20] 1999	P	NA	56,138	24	4	0	5 (1)	9 (2)	15 (3)
Murat [21] 2004	P	6-4-2	24,165	10	4	0	ND	ND	ND
Neelakanta [22] 2006	R	6-4-2	30,695	7	2	0	3 (1)	1 (0.3)	3 (1)
Walker [23] 2013	P	6-4-2	118,371	24	2	0	5 (0.4)	9 (0.8)	10 (0.8)
Andersson [24] 2015	R	6-4-0	10,015	3	2	0	0	3 (3)	14 (10)
Tan and Lee [25] 2016	R	6-4-2	102,425	22	2	0	2 (0.2)	7 (0.7)	13 (1)
Habre [26] 2017	P (CRF)	6-4-2	31,127	29	9	0	0	11 (0.4)	18 (0.6)
Eisler [27] 2018	R	6-4-2	47,272	26	6	0	1 (0.02)	18 (3)	8 (2)
Beck [28] 2020	P (CRF)	6-4-2/1/0	12,093	14	12	0	0	4 (3)	10 (8)
Pfaff [29] 2020	P	6-4-2	2,440,810	135	0.6	2	53 (0.2)	110 (0.4)	ND
Schmitz [15] 2023	P (CRF)	6-4-1	22,766	25	11	0	1 (0.4)	10 (4)	14 (6)

The largest study of the incidence and contributing factors to pulmonary aspiration is based on 2.6 million anesthetics recorded in the Wake Up Safe registry [29]. The authors reported 135 cases of aspiration which amounts to a very low incidence of 6:100,000. In their multivariate analysis, the most important risk factors were emergency surgery (OR 2.0 [1.2–3.5]) and high ASA status (ASA 3 (OR 5.0 [2.6–9.1]); ASA ≥4 (OR 5.5 [3.8–16.8])). When analyzing these 135 cases, the causes of aspiration included gastrointestinal comorbid conditions (19%), post-coughing event or laryngospasm (14%), nil per os (NPO) violation (11%), blood or secretions in the airway following or during the procedure (6%), and oral premedication reaction (3%). Borland and coworkers reported that pulmonary aspiration was twice as common in emergency surgery compared to elective (OR 2.086) [19]. Furthermore, age 6–11 y, i.v. induction and high ASA class were associated with an increased risk of aspiration. In a multicenter audit, difficult airway, gastrointestinal pathology, gastroesophageal reflux, obesity, esophageal disease, sepsis, renal failure, and preoperative opioids were identified as possibly contributing to the occurrence of regurgitation and aspiration, but the number of cases did not allow formal multivariate analysis [23].

Additional risk factors such as anxiety, increased intra-abdominal pressure, and inadequate or light anesthesia were also noted in some of the cases of aspiration.

4.2. Gastric fluid volume as a risk factor

Gastric fluid content has been cited as a risk factor for pulmonary aspiration based on a remark in a paper by Roberts and Shirley (1974) [30]. Gastric fluid (0.4 ml kg-1) with a pH of 1.26, directly instilled into the left bronchus via a tracheostomy in a single Rhesus monkey led to inflammation. Extrapolation from this single laboratory experiment resulted in the suggestion that pregnant women are at risk if gastric fluid content exceeds 25 ml. This 'fact' was uncritically accepted until 1998, when Schreiner pointed out that 30–60% of patients would be at increased risk of aspiration if the 0.4 ml kg^{-1} were to be valid in humans. In subsequent studies, the suggested 'critical gastric volume' increased from 0.4 ml kg^{-1} to 0.8 ml kg^{-1}, then further to 1.25 ml kg^{-1}, to presently the often quoted volume 1.5 ml kg^{-1} based on the method of measuring – laboratory, nasogastric suctioning and finally gastric ultrasound [30–32]. However, an ever more accurate determination of gastric fluid volume does not allow us to accurately predict the risk of pulmonary aspiration. The incidence of pulmonary aspiration is very low and experimental human studies of a dose-response relationship would be unethical. In addition, regurgitation of gastric content also depends on several other factors including lower esophageal sphincter pressure (varying among patients and according to the anesthetic drug administered), on the anesthesia team making sure that the anesthesia level is deep enough to avoid coughing and straining, on the occurrence of difficult airway, and finally the experience level of the anesthesiologist [26].

4.3. Malpractice claims

Another way of identifying events or factors leading to pulmonary aspiration is the analysis of medical malpractice claims. In 43 cases of periprocedural aspiration, the authors reported that the alleged cause was a failure to plan for intubation when there was a significant risk of aspiration [33]. Failure to place a nasogastric tube or perform rapid sequence induction was the second most common alleged cause (33%). The mean age of 60 was reported with only few if any children included. This may reflect the fact that aspiration may be more likely to result in morbidity in adults than in children. Identification of risk factors for aspiration and appropriate adaptation of the anesthesia plan are critical. This message is consistent with data from the NAP4 audit, in which failure to plan for intubation was a major risk factor for aspiration and subsequent poor outcome [34].

5. To treat or to observe: what do you do when the patient regurgitates and/or aspirates?

Aspiration of gastric content into the airway can lead to significant morbidity. However, with rapid recognition and management, gastric fluid can be effectively cleared from the airway and damage is avoided. This is evident from the results of many of the audits in

Table 3
Management of suspected or overt aspiration.

Signs and symptoms	Management
Coughing and bucking	Deepen anesthesia Check the airway for signs of regurgitation If signs of aspiration, consider intubation and suctioning ***Don't forget to oxygenate***
Obvious regurgitation of clear fluid	Turn the patient to a lateral position Suction the oropharynx If light anesthesia, give propofol 1 mg kg^{-1} If coughing or desaturation, suction ETT or LMA ***Don't forget to oxygenate***
Obvious regurgitation of solid gastric content	Suction of the oropharynx Intubate and suction the trachea ***Don't forget to oxygenate***
Consider chest x-ray after 2–4 h	Consider bronchoscopy for tracheobronchial suctioning Consider antibiotics

Table 2. Thus, most of the cases of either 'confirmed' or 'suspected aspiration' aspiration in Schmitz et al. and all of the 'suspected aspiration' in Andersson et al. developed only transient symptoms and did not require any additional treatment postoperatively [15,24].

Regurgitation of small amounts of clear fluid may go unrecognized unless the patient coughs and/or desaturates. However, when coughing or desaturation does occur, whether during induction, maintenance, or emergence, it is essential to maintain a high level of suspicion of possible regurgitation and to act promptly as outlined in Table 3.

Aspiration of solids is more likely to occur in well-known high-risk conditions such as achalasia, severe bowel obstruction with ileus, or patients who have recently had a meal. In the latter case, it goes without saying that the procedure should be postponed if possible (Table 4).

In most cases of regurgitation, if managed properly there will be no sequelae and the surgery can be performed as planned. However, if massive aspiration occurs at induction, leading to high oxygen and ventilation requirements, cancellation of the case should be considered in communication with the surgeon. Bronchoscopy for clearing the airway from gastric contents should be performed, and the patient transferred to the ICU for treatment of the pneumonitis and systemic inflammatory response syndrome that may follow. Antibiotics and steroids can be considered but are not universally accepted treatment of aspiration.

6. How do we optimize preoperative fasting times in daily clinical practice?

The new ESAIC guideline has the potential to reduce the incidence of prolonged fasting by changing the minimum fasting requirements for clear fluids and breast milk. However, merely changing the rules for preoperative fasting may not be enough. What other methods are effective to avoid unnecessary fasting? [35] Adequate information to parents and children in a multicultural environment can be a challenging task. Anesthesiologists with a pediatric practice are familiar with non-compliance to NPO rules, which is a common cause for the postponement of procedures in most pediatric centers. Incorrect instructions, educational level, or lack of understanding of fasting rules were associated with non-compliance [36,37]. But this is not only a logistic problem, it is also a safety issue. Replying anonymously to a questionnaire, 13.5% of parents had let their child breach the existing guidelines and the children were thus not adequately fasted at the time of surgery [37]. Furthermore, in the Wake Up Safe report, there were 12 non-emergency cases of aspiration in which NPO violation was a contributing factor [29]. Importantly, 9 (75%) of these cases resulted in patient harm.

In an observational study in a single center at which the 6-4-2 regimen was still implemented, the effects of systematic education of parents and hospital staff combined with measures to increase communication between operating theaters and wards were studied. Mean fasting times were reduced from 8.5 to 6 h and patient comfort was increased [38]. Information and education of ward staff, surgeons, and anesthesiologists were also part of two quality improvement projects to reduce real fasting times [17,18]. Interestingly, in both of these studies, the fasting times were not reduced significantly until the minimum clear fluid fasting time was changed to 1 h and children were encouraged to drink clear fluid on arrival to the hospital. There is a paucity of studies addressing the multicultural aspect of information about preoperative fasting. Infographics and video information are likely being used but have to our knowledge not been evaluated in peer-reviewed publications.

Using modern technology to provide information can be very effective. In one study, text messages were sent to the parents on the day before surgery reminding them of when to give their children something to drink. In the text message group, 92% of children were given clear fluids on the morning of surgery compared to 33% in the control group given only information at the preoperative visit [39]. The average fasting time for clear fluids was reduced from 8.7 h $\pm$ 4.8 h to 4.3 h $\pm$ 2.4 h. This strategy is effective also in adults [40].

7. The next step?

Whether reducing clear fluid fasting to 1 h will genuinely enhance the perioperative satisfaction of children and parents or impact the incidence of aspiration remains uncertain. A potential solution might lie in further simplifying clear fluid fasting instructions aiming to improve parental compliance and consequently bring about a successful and enduring shift in preoperative fasting times for children. Successful implementation of timed fasting relies on accurate knowledge of the anesthesia start time. Any adjustment to

Table 4
Management of children with a high risk of aspiration.

Gastroschisis/Omphalocele	Insert a nasogastric tube. Immediately before induction, turn the infant to semi-prone while suctioning through the nasogastric tube. Protect the bowels in the cele. Have a wide-bore suction catheter connected Experienced anesthesiologist performs the intubation, preferably with a videolaryngoscope. Expect regurgitation. Suction, and intubate the trachea expeditiously
Achalasia or Severe ileus in older children	Strict preoperative fasting at least from midnight If possible, consider asking the patient to vomit before induction Elevate the head part of the table Have a wide-bore suction catheter connected and running Perform RSI with rocuronium 1.2 mg kg^{-1} avoiding ventilation until intubation Experienced anesthesiologist performs the intubation Use a videolaryngoscope with an appropriate size Macintosh blade.

fasting guidelines is likely to falter without this critical information. However, the unpredictable nature of emergencies, surgical list rearrangement, and cancellations, particularly in busy units often result in prolonged fasting for both rescheduled and precautionarily fasted children. As outlined above, simultaneously striving for the "ideal" real fasting time and strict adherence to guidelines becomes challenging, even with an advanced multi-focus information program [17,18,38].

Addressing the lack of awareness regarding the advantages of preoperative hydration and dispelling unwarranted concerns about pulmonary aspiration presents challenges for the anesthesia, surgical, and nursing teams. We suggest that nursing staff, due to other responsibilities, may find it challenging to track the 1-h period and tend to err on the side of caution to avoid cancellations or delays.

While an anesthetist's prescription of oral fluids with specific parameters may be effective, it is notable that oral fluids are generally not actively prescribed or administered by anesthesiologists. An alternative approach, initially described by Andersson and co-workers, is combining a strict fasting from midnight for solids rule with active prescription of milk-based meals 4 h before anesthesia and allowing clear fluids until the child is called to the operating theater (6-4-0) [24]. It has been shown to simplify the process [16]. Introducing a "THINK DRINK" campaign wherein surgical patients receive a welcome drink of clear fluids upon admission on the day of arrival and are allowed unlimited sips (should he or she wish so) before the procedure, could significantly enhance staff compliance [18] and patient satisfaction, as recently demonstrated in a study in adults [41].

Hospitals dealing with pediatric anesthesia should tailor their fasting recommendations for clear fluids while prioritizing safety audits. Critical gastric aspiration events in pediatric anesthesia are rare, and regional, national, or international coordination for such audits is recommended. Even though a proposal for allowing clear fluids until called to theater might seem ahead of its time, generating evidence to support is feasible and may be delivered by upcoming studies.

8. Summary

To conclude, pulmonary aspiration of clear gastric content is rare in children and does usually not lead to complications. Only two children have been reported over the past 50 years to have died with aspiration contributing to death. Pulmonary aspiration leading to postoperative intensive care has become increasingly rare for the last 30 years, ranging from 0.2 to 3 in 10,000, with a decrease of one order of magnitude. A similar decrease was observed in the category of aspiration leading to escalation of care, including e.g. unplanned admission for in-patient care, supplemental oxygen beyond PACU, or treatment of aspiration with antibiotics. The reported incidence was 0.4–3 in 10,000. Finally, regurgitation with transient symptoms such as intraoperative desaturation, coughing or the need for suctioning of regurgitated gastric contents had an incidence of 0.6–10 in 10,000.

Preoperative fasting for solids is ever important, but clear fluids can be ingested closer to induction than previously thought. New fasting guidelines with the 1 h limit for clear fluid fasting appear to be safe and effective regarding the reduction of fasting times. Finally, despite following fasting guidelines, ensuring an empty stomach in a child coming to the operating room will always be uncertain, and the anesthesia team must be aware of the risk factors that are associated with aspiration (clear fluid fasting time does not seem to be one of them). Prompt recognition and management of regurgitation during anesthesia induction, maintenance, and emergence alike is essential to limit patient harm.

9. Research agenda

- Institutions should continue to audit their practice regarding fasting times and the incidence of aspiration.
- Randomized controlled trials of the incidence of pulmonary aspiration are not feasible due to the low incidence.
- Large multicenter audits (>100,000 cases) are needed when new guidelines are implemented.
- Audits should provide clear definitions of outcomes with different degrees of severity from minor regurgitation with transient symptoms, suspected or confirmed aspiration that leads to escalation of care, to confirmed aspiration that leads to postoperative intensive care, and finally, death.
- Gastric ultrasound can be used to increase knowledge of the safe limits of breast milk and infant formula feeding beyond the neonatal age. Randomized controlled trials are feasible.
- Multicenter studies of gastric ultrasound for clinical decision-making are needed to evaluate the technique for use in routine practice.

10. Practice points

- Pulmonary aspiration of gastric content in healthy children does not lead to mortality.
- Aspiration leading to escalation of care and/or intensive care has decreased by one order of magnitude in the last three decades.
- Aspiration of clear fluids ingested before anesthesia has not been associated with significant morbidity or mortality.
- Identifying patients with risk factors for aspiration with subsequent modifying of the airway management plan may be the most important way to avoid pulmonary aspiration.
- Prompt recognition and management of regurgitation during anesthesia induction, maintenance, and emergence alike are essential to limit patient harm.

CRediT authorship contribution statement

Peter Frykholm: Conceptualization, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Tom G.**

Hansen: Conceptualization, Writing – review & editing. **Thomas Engelhardt:** Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare no conflicts of interest.

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