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The Use of Jejunal Tube Feeding in Children: A Position Paper by the Gastroenterology and Nutrition Committees of the European Society for Paediatric Gastroenterology, Hepatology and Nutrition 2019

Short Title: The Use of Jejunal Tube Feeding in Children: A Position Paper by the Gastroenterology and Nutrition Committees of ESPGHAN 2019

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Abbreviations:

EN: enteral nutrition

GJT: gastrojejunal tube or gastrojejunostomy tube

GER(D): gastroesophageal reflux (disease)

HEN: home enteral nutrition

JT: jejunal tube

JTF: jejunal tube feeding

LoE: level of evidence

MCT: medium chain triglycerides

MDT: multidisciplinary team

NGT: nasogastric tube

NI: neurological impairment

NJT: nasojejunal tube

PEE: percutaneous endoscopic enterostomy

PEG: percutaneous endoscopic gastrostomy

PEG-J: percutaneous endoscopic gastro-jejunostomy

PEJ: percutaneous endoscopic jejunostomy

PICU: Paediatric Intensive Care Unit

PN: parenteral nutrition

PPI: proton pump inhibitor

RCT: randomised controlled trial

SBS: short bowel syndrome

SoR: strength of recommendation

Abstract

Objectives: Jejunal tube feeding (JTF) is increasingly becoming the standard of care for children where gastric tube feeding is insufficient to achieve caloric needs. Given a lack of a systematic approach to the care of JTF in paediatric patients, the aim of this position paper is to provide expert guidance regarding the indications for its use and practical considerations to optimise its utility and safety.

Methods: A group of members of the Gastroenterology and Nutrition Committees of the European Society of Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) and of invited experts in the field was formed in September 2016 to produce this clinical guide. Seventeen clinical questions treating indications and contraindications, investigations prior to placement, techniques of placement, suitable feeds and feeding regimen, weaning from JTF, complications, long-term care, and ethical considerations were addressed.

A systematic literature search was performed from 1982 to November 2018 using Pubmed, the MEDLINE and Cochrane Database of Systematic Reviews. Grading of Recommendations, Assessment, Development, and Evaluation was applied to evaluate the outcomes.

During a consensus meeting, all recommendations were discussed and finalized. In the absence of evidence from randomized controlled trials, recommendations reflect the expert opinion of the authors.

Results: A total of 33 recommendations were voted on using the nominal voting technique.

Conclusions: JTF is a safe and effective means of enteral feeding when gastric feeding is insufficient to meet caloric needs or is not possible. The decision to place a jejunal tube has to be made by close cooperation of a multidisciplinary team (MDT) providing active follow-up and care.

Keywords: children; care; clinical guide; contraindications; ethical considerations; Feeding; indications; investigations; jejunal tube; jejunal tube feeding; multidisciplinary team; placement; recommendations; weaning

What is known:

- Jejunal tube feeding (JTF) is increasingly becoming the standard of care for children where gastric tube feeding is insufficient to achieve caloric needs.
- There is a lack of expert guidance regarding the indications and practical considerations to optimise its utility and safety in clinical practice.

What is new:

- JTF is a safe and effective means of enteral feeding when gastric feeding is insufficient to meet caloric needs.
- The decision to place a jejunal tube has to be made by a multidisciplinary team (MDT), working in close cooperation and providing active follow-up and care.

Introduction

Jejunal tube feeding (JTF) is defined as postpyloric feeding through a feeding tube with its tip placed at least 40 cm distally to ligament of Treitz. JTF bypasses the stomach when gastric feeding is not tolerated or associated with unacceptable complications including significant gastroesophageal reflux disease (GERD).

There is growing evidence suggesting the increased use of JTF in children (1-3) with a number of recent recommendations suggesting that feeding by jejunal tube (JT) is a valid option in infants or children who fail intra-gastric feeding (4-9). In parallel, a number of these and other papers also report on the safety, efficacy and limitations associated with it (10-12). Retrospective studies show that gastrojejunal tube feeding is a safe method to improve nutritional status; however, because of the frequent need for tube maintenance and replacement leading to increased morbidity, gastrojejunal tube feeding is rather a transitory alternative to e.g. surgical Roux-en-Y jejunostomy or antireflux surgery (10-12).

To our knowledge, there is little clear guidance as to the indications for the use of JTF or practical aspects related to its utility in clinical management. This paper seeks to address some of these issues.

A number of factors should be considered, however, before placement of a JT, or indeed a gastrojejunal tube (GJT). The symptoms of feeding failure such as nausea, vomiting, gagging, retching, and volume intolerance may be caused by anatomical or, indeed, non-gastrointestinal problems, which will need to be dealt with before considering placement of a JT.

The management of a child awaiting a jejunal feeding tube should begin well before its insertion and involve a multidisciplinary team (MDT) of health care providers who are

familiar with, and have access to, a range of alternative strategies to the insertion of such a feeding tube. These may include feed or regimen changes, specific feeding therapy, speech and swallow assessments, and access to psychological support. The MDT should, arguably, include a pediatric gastroenterologist, nurse, psychologist, dietitian, and a speech and language therapist.

Adequate planning, including discussion of ethical issues, warrants that all parties have a clear understanding of the indication and rationale for placement of a JT. In addition, ongoing and future strategies to increase possible oral feeding and enable weaning off the JT should be discussed.

The aim of this European Society for Pediatric Gastroenterology, Hepatology, and Nutrition (ESPGHAN) position statement is to provide a comprehensive guide for health care professionals on the safe, effective, and appropriate use of jejunal feeding tubes in children and young adults.

Methodology

Under the auspices of ESPGHAN, a working group (WG) consisting of members from the GI and Nutrition Committees and experts in the field, including pediatric gastroenterologists, dietitians, a nurse and a pediatric surgeon, was formed in September 2016 to formulate current evidence-based clinical practice guidelines for JTF. A systematic literature search was carried out using Pubmed, the MEDLINE and Cochrane Database of Systematic Reviews from 1982 to November 2018 applying the terms ‘‘jejunal, postpyloric, transpyloric, jejunostomy, feeding, nutrition, food’’. References in these documents were also searched to ensure acquisition of relevant source data. Grading of Recommendations, Assessment, Development, and Evaluation was applied to evaluate the outcomes. Levels of evidence for

each statement were based on the grading of the literature. Using the GRADE system, the quality of evidence was graded as follows (13-18).

1. High: Further research is unlikely to change our confidence in the estimate of effect.
1. Moderate: Further research is likely to have impact on our confidence in the estimate of effect and may change the estimate.
2. Low: Further research is likely to have an impact on our confidence in the estimate of effect and likely to change the estimate.
3. Very low: Any estimate of effect is uncertain.

The strength of recommendations was defined as follows:

Strong: when the desirable effects of an intervention clearly outweigh the undesirable effects, or they clearly do not. It should be noted that the expert group can make strong recommendations based on lesser evidence when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh the harms. Strong recommendations are formulated as ‘‘the working group recommends (...).’’

Weak: when the trade-offs are less certain (either because of the low quality of evidence or because the evidence suggests that desirable and undesirable effects are closely balanced). Weak recommendations are formulated as ‘‘the working group suggests(...).’’

The ESPGHAN WG anonymously voted on each recommendation. A 9-point scale was used (1 strongly disagree to 9 fully agree), and votes are reported for each recommendation. It was decided in advance that consensus was reached if >75% of the WG members voted 6, 7, 8, or 9. Consensus was reached for all questions. In the absence of evidence from randomized controlled trials, the majority of recommendations reflect the expert opinion of the authors. The final draft of the clinical guideline was sent to all the committee members for approval in

December 2018, and then critically reviewed by a multidisciplinary panel of the GI and Nutrition committees and members of the council of ESPGHAN.

Q1: What are the indications for jejunal tube feeding?

1. The ESPGHAN expert group recommends jejunal feeding as the route of choice for providing enteral nutrition in children with failure of oral and intragastric feeds or gastric outlet obstruction.

Level of evidence (LoE): very low

Strength of recommendation (SoR): strong

Vote: 9,9,9,9,9,8,9,7,8,9,9,8,9,9,9 (100% agreement)

2. The ESPGHAN expert group recommends that transpyloric tube feeding be considered to provide EN when gastric feeding fails in critically ill children.

LoE: moderate

SoR: weak

Vote: 9,9,9,9,9,9,9,9,8,9,9,9,9,9,9 (100% agreement)

3. The ESPGHAN expert group recommends that a trial of JTF be considered in children with paediatric intestinal pseudo-obstruction who fail gastrostomy feeding.

LoE: moderate

SoR: strong

Vote: 9,8,7,9,9,8,9,7,8,9,9,9,9,9,9 (100% agreement)

Practical note

Especially if there is some evidence of propagative peristalsis JTF should be considered.

4. The ESPGHAN expert group recommends to consider JTF as an alternative to fundoplication and gastrostomy tube feeding in children with severe gastroesophageal reflux with risk of aspiration (e.g., neurological disability).

LoE: moderate

SoR: strong

Vote: 9,8,8,9,8,9,9,8,8,9,8,9,9,9,8 (100% agreement)

Practical note

Gastroesophageal reflux or risk for gastroesophageal reflux worsening is not a contraindication for jejunal tube feeding unless jejunal tube feeding worsens gastroesophageal reflux.

5. The ESPGHAN expert group recommends the use of JTF in children with acute pancreatitis only in cases in which oral or gastric feeding is not tolerated.

LoE: moderate

SoR: strong

Vote: 9,8,9,9,9,8,9,7,8,9,9,9,9,9,8 (100% agreement)

In general, the choice of the route of enteral feeding depends on several major criteria i.e. the duration of enteral nutrition support, the integrity and functioning of the upper gastrointestinal tract and the risk of aspiration. In 2010, the ESPGHAN Committee on Nutrition recommended that postpyloric feeding is indicated only in clinical conditions in which gastroparesis/ dysmotility, aspiration, gastric outlet obstruction, or previous gastric surgery precludes gastric feeding or when early postoperative feeding after major abdominal surgery is planned (6). The evidence to support these recommendations is not based on controlled studies.

Since 2010 some studies and guidelines were published concerning indications of jejunal and postpyloric feeding in different clinical situations.

Gastric dysmotility: critically ill children, preterm infants, chronic intestinal pseudo-obstruction, gastroparesis and short bowel syndrome.

Critically ill children

In accordance with the 2010 ESPGHAN recommendations, the ASPEN/ SCCM and ESPEN guidelines advise against routine use of postpyloric feeding in the adult critically ill patient unless the patient has a high risk for aspiration or gastric feeding intolerance (8). In critically ill children, the ASPEN guideline (2009) states that postpyloric feeding should be considered in patients at high risk of aspiration or in whom gastric feeding fails (9). Both international bodies recognized that there is limited research data available.

In a systematic review and meta-analysis looking at gastric *versus* post-pyloric feeding in critically ill adults moderate to low-quality evidence was found showing a lower rate of ventilator-associated pneumonia with post-pyloric feeding (19, 20) and low-quality evidence suggesting an increase in the amount of nutrition delivered to these participants (19). Since

no differences were found between gastric and post-pyloric feeding for objective outcome measures like mortality, duration of mechanical ventilation and complications, the finding of decreased ventilator associated pneumonia in postpyloric feeding may not be real (20).

In 2014, an international survey among 31 paediatric intensive care units (PICU) evaluating institutional nutrition practices showed that 13.2% of patients were post-pylorically fed, but only 9 units had detailed enteral nutrition (EN) algorithms (21). All recommended the use of postpyloric feeding where gastric feeding has failed and/or where concerns about pulmonary aspiration exist (21).

A meta-analysis from 2013 (22) comparing the use of postpyloric *versus* gastric feeding in adults and children in the ICU, including 17 trials (1 paediatric RCT with 30 patients) (23), showed that postpyloric feeding, overall, delivered significantly more nutrition than gastric feeding, with a weighted mean difference of 12%. The meta-analysis failed to demonstrate any benefits of postpyloric feeding with regards to new-onset pneumonia, mortality, and aspiration (22).

In a Cochrane review in 2016 regarding nutritional support in critically ill children no studies addressed JTF.

In conclusion, JTF can be a good option for providing EN when gastric feeding fails in critically ill patients. There is conflicting evidence about the prevention of complications and studies in critically ill children are lacking.

Preterm neonates

A Cochrane review on preterm infants updated in 2013 (24) with a total of 9 RCTs (359 premature infants, studies from 1975-1992) failed to show beneficial effect of transpyloric feeding on feed tolerance or in-hospital growth. This is discussed in detail in question 4.

Paediatric (chronic) intestinal pseudo-obstruction

In a prospective study of JTF in children with chronic intestinal pseudo-obstruction 18 children dependent on parenteral nutrition (PN) and failing gastric feeding were initiated on elemental feeding via surgical jejunostomy after performing antroduodenal manometry (25). Follow-up showed that 12 of these children (9 with and 3 without migrating motor complexes on manometry) tolerated JTF well and PN could be stopped. Although not specifically addressed, an ESPGHAN guideline from 2018 recommended that strategies such as JTF could be considered in patients with intestinal pseudo-obstruction (7).

Gastroparesis

Gastroparesis in children is most often idiopathic with other causes including, post viral and drug-related issues as well as occurring in association with comorbidities. It is characterized by delayed gastric emptying of solids and/or fluids without evidence of a mechanical gastric outlet obstruction. JTF may be indicated in the management of gastroparesis in cases when medical therapies fail and when nutritional intake is inadequate (26-28).

Short bowel syndrome

Jejunal feeding can be considered in children with short bowel syndrome (SBS) in case of severe GERD, or severe gastric or upper intestinal dysmotility when oral or gastric enteral feeding fails. The limiting factor, however, will be the fact that with jejunal feeding a substantial part of the small bowel will be bypassed, thereby impairing the process of intestinal adaptation and further decreasing the absorptive capacity that is already limited in SBS. Furthermore, the presence of a jejunal feeding tube may increase the risk of intestinal contamination with a change of the gut microbiome and subsequent small intestinal bacterial

overgrowth. However, if JTF is the only option using the enteral route, it can be considered to induce intestinal adaptation (29, 30).

Severe gastroesophageal reflux with risk of aspiration (e.g., neurological disability)

GERD and swallowing problems are common in children with neurological impairment (NI) and predispose to aspiration pneumonia, which is the most common cause of death in these children. They often require fundoplication and gastrostomy tube placement. Various studies have retrospectively looked at JTF as an alternative option for treatment of GERD, but RCTs and prospective studies are lacking.

The 2017 ESPGHAN guideline suggests the use of JTF where there is a risk of aspiration due to GERD (5).

A systematic review and meta-analysis specifically in children with NI, included retrospective studies of GJT *versus* fundoplication with gastrostomy in the management of severe GERD (31). Of these, 3 studies reporting 556 children (fundoplication with gastrostomy (n=431) and GJT (n=125)), showed no differences in rates of pneumonia (17% *versus* 19%) or mortality (13% *versus* 14%) (32-34). Furthermore, no statistically significant differences were found between the occurrence of major complications (fundoplication with gastrostomy (29%) compared to GJT (12%), (risk ratio = 1.70, 95% confidence interval 0.85–3.41, p = 0.14)) and minor complications (GJT (70%) *versus* fundoplication with gastrostomy (45%), risk ratio=0.38, 95% confidence interval 0.05–3.07, p=0.36). No studies reported on quality of life using validated measures. The authors concluded that because of very low quality of evidence, large comparative studies are needed to find out which approach is associated with the best quality-of-life outcomes.

A number of more recent retrospective studies looking at short and long-term outcomes of GJT feeding in children with NI and GERD have suggested that although major complications are comparable to fundoplication, GJT feeding is associated with reasonable amounts of morbidity (1-3, 35).

In a study on pathophysiology by Rosen et al. (35) in which transpyloric feeding as an alternative treatment of GER was evaluated, multichannel intraluminal impedance tracings showed that reflux events, although significantly less than previously reported in patients with significant GERD, were still present especially during feeding periods. Furthermore, patients continued to have the same amount of aspiration events and reflux related hospitalizations after start of transpyloric feeding.

A large retrospective study in children with NI and GER requiring gastrostomy tube feeding who either underwent initial GJT placement (n=163) or fundoplication (n=1178) showed that first-year post procedure reflux-related hospitalization rates, and odds of death were similar in both groups, whereas failure to thrive, repeat of initial intervention, and crossover intervention were more common in the GJT group (36). It was concluded that either intervention could reduce future aspiration risk; the choice can reflect non-reflux related complication risks, caregiver preference, and clinician recommendation.

Egnell et al. reported retrospectively on the clinical outcome and safety (2) of surgically placed jejunostomies in 33 children (of which 17 with NI). They concluded that these types of tubes could be effective and safe in selected children with GERD, feeding difficulties or recurrent pneumonia.

Gastric outlet obstruction

The use of JTF in case of upper gastrointestinal obstruction has been studied mostly in adults with gastric or pancreatic cancer and benign pancreatic diseases. Few studies have been

performed in children and prospective randomised controlled trials (RCTs) are lacking. A retrospective study in 120 children who had undergone surgery for duodenal and jejunal congenital obstructions (i.e. duodenal atresia, annular pancreas, jejunal atresia) showed that children in the early EN group with feeding through a NJT, had a better outcome compared to children in the control group on PN (37). The JTF group experienced a shorter time to tolerate oral feeding and a lower incidence of cholestasis and had a shorter post-operative hospital stay. Another retrospective study from the same research group showed that feeding through an NJT could safely be provided in neonates after partial gastrectomy (n=46) because of gastric perforation and led to fewer complications than total PN (38).

Acute pancreatitis

The use of JTF in patients with severe acute pancreatitis is mostly performed in adult patients. In children, no RCTs are available and no guidelines have been published regarding type or route of nutritional support in acute pancreatitis.

The NASPGHAN recently published a clinical report about the management of acute pancreatitis in the paediatric population with conclusions mostly based on adult literature. Recommendations include early enteral nutrition as tolerated, whether through oral, gastric, or jejunal route (39).

Q2: What alternatives can be tried before finally considering jejunal feeding?

6. The ESPGHAN expert group recommends a trial of continuous gastric feeding with a hydrolysed or elemental formula before postpyloric feeding is started.

LoE: high

SoR: strong

Vote: 9,7,9,9,9,5,9,6,8,7,7,7,9,7,7 (87% agreement)

7. The ESPGHAN expert group recommends to consider trialling at least one prokinetic drug to promote oral or gastric feeding before instituting jejunal feeding as they are widely used, but there is no published data.

LoE: moderate

SoR: strong

Vote: 9,7,9,7,8,8,9,6,8,6,7,8,9,3,8 (80% agreement)

Meyer et al. carried out a systematic review on the impact of feed protein type and degree of hydrolysis on gastric emptying in children. Although this was limited by considerable variability between the studies a number of studies reported better emptying by hydrolysed compared to whole protein (40).

After other aetiologies are excluded and before a drug trial, gastric feeding with a hydrolysed or elemental formula should be performed.

Although a number of pharmacological therapies are used to improve gastric emptying and feeding tolerance, published paediatric literature is scarce and only a few controlled trials exist, while none of them has addressed the issue of drug introduction *before* jejunal feeding. Nearly all the published studies were performed on premature infants with the goal of advancing EN as quickly as possible. Most studies were retrospective. A recent guideline on feeding premature infants did not even discuss drug therapy (41). Available agents include erythromycin, a macrolide antibiotic and non-peptide motilin agonist, as well as metoclopramide and domperidone, both dopamine D2 receptor antagonists.

Erythromycin

Intragastric or intravenous administration of a low dose (3-5 mg/kg/dose 3-4 times daily) of erythromycin induces a migrating motor complex. Although a number of studies in premature infants suggests improved feeding tolerance in subjects given erythromycin compared to control infants a 2008 Cochrane review concluded that there is insufficient evidence to recommend the use of erythromycin in low or high doses for preterm infants with or at risk of feeding intolerance (42).

A recent retrospective multicentre review of 1095 infants treated with erythromycin and 19001 infants treated with metoclopramide stated that "*the safety and efficacy of erythromycin in infants is incompletely characterized"* (43) but that there were fewer adverse events with erythromycin than with metoclopramide.

Although frequently quoted there is no published data suggesting that the use of erythromycin benefits a paediatric patient intolerant of gastric feeding except for small single centre studies in premature infants (44).

In adult studies erythromycin may be more effective than metoclopramide for gastroparesis (28) but this may not be true in children (27). Tachyphylaxis to the prokinetic effect of erythromycin develops within 4 weeks.

Metoclopramide

An RCT performed by Hyman et al. found that metoclopramide is not efficacious in premature and neonatal populations whose primary cause of gastroparesis is prematurity (45). Tube feedings that contained 0.2 mg/kg metoclopramide had no effect on promoting gastric motility in low birth weight neonates but may be helpful in reducing emesis due to its actions on the chemoreceptor trigger zone. The usefulness of metoclopramide in neonates may be due to the centrally acting antiemetic properties and not the prokinetic effect seen through

binding of the dopamine D2 receptor in the peripheral nervous system. Another study showed that 80% of paediatric patients with gastroparesis failed to respond to metoclopramide therapy (46).

Because of the risk of tardive dyskinesia, the US Food and Drug Administration issued a black box warning for metoclopramide in 2009. In 2013 the European Medicines Agency restricted usage to children over 1 year of age and for a duration no longer than 5 days. The suggested dose of metoclopramide is 0.4-0.8 mg/kg/d 30 minutes before feeding.

Domperidone

Domperidone is available in many European countries and in Canada, but not in the United States. In some countries it is available over the counter. It is considered less safe than erythromycin. In adults it is more effective than metoclopramide for gastroparesis (47). The only paediatric studies relate to its use for GER and as an antiemetic. In 2014 the European Medicines Agency restricted use to the treatment of nausea and vomiting. The suggested dose of domperidone is 0.1-0.3 mg/kg/dose 2-4 times daily 30 minutes before feeding.

Q3: What investigations should be carried out prior to jejunal tube feeding placement?

8. The ESPGHAN expert group recommends to consider performing a contrast meal and follow through study of the small intestine in all patients to ensure patency of the intestinal lumen and exclude a mechanical obstruction prior to jejunal feeding tube placement.

LoE: very low

SoR: strong

Vote: 9,9,9,7,9,9,9,5,8,7,8,8,9,9,7 (93% agreement)

9. The ESPGHAN expert group recommends to consider an upper GI endoscopy in all patients prior or concomitant to JTF placement.

LoE: moderate

SoR: strong

Vote: 9,8,9,8,9,8,8,9,8,9,8,9,9,7,9 (100% agreement)

Clearly in the lead up to jejunal tube placement in children there should be careful consideration of the rationale for using this route of feeding including the reasons for the failure of oral or gastric feeding as well as any contraindications for post-pyloric feeding. It is these considerations that essentially underlie what investigations should be carried out prior to post-pyloric tube placement. Several excellent guideline papers are available on the use of condition-specific investigations.

Of particular importance are investigations, largely imaging that provide information about the patency of the GI tract and presence of any mechanical problems as well as about previous GI tract surgery and risk of intestinal perforation (Table 1). In patients suspected of gastroparesis for example diagnostic evaluation may include an upper endoscopy to rule out mechanical causes, followed by a gastric-emptying scintigraphy for diagnosis. Other diagnostic alternatives that have been used include wireless capsule motility, antroduodenal manometry, and breath testing (48). Apart from these there is virtually no evidence from the available literature for the routine application of a battery of investigations prior to the placement of a post-pyloric (jejunal) feeding tube.

In theory, if not applied previously, a contrast follow through study of the small intestine should be carried out to ensure patency of the intestinal lumen and exclude a mechanical

obstruction or issue that may increase the risk of intestinal perforation or impaired viability (e.g. intestinal pneumatosis). There is some evidence to suggest other investigations may add diagnostic value in particular groups of patients.

Van Haren et al. carried out a retrospective observational case study on adult intensive care patients who underwent postpyloric feeding tube insertion under endoscopic guidance (49). They found significant endoscopic findings in almost 50% of the patients in whom endoscopic reports were available and suggested that endoscopic placement of postpyloric feeding tubes resulted in the identification of a significant number of patients with previously undiagnosed upper gastrointestinal tract abnormalities (49). Others have similarly shown that diagnostic upper endoscopy performed concomitantly with placement of the JT often reveals findings of clinical importance (50, 51).

Q4: What are the absolute and relative contraindications against jejunal tube feeding?

10. The ESPGHAN expert group recommends to avoid jejunal tube feeding in the presence of the following conditions: paralytic or mechanical ileus, intestinal obstruction, intestinal perforation, peritonitis, and necrotising enterocolitis (see Table 2: absolute contraindications).

LoE: very low

SoR: strong

Vote: 9,9,7,9,9,9,9,8,9,9,9,9,9,9,9 (100% agreement)

11. The ESPGHAN expert group recommends caution when considering JTF in patients with relative contraindications to transpyloric feeding: preterm infants, intestinal dysmotility,

toxic megacolon, gastrointestinal bleeding, high-output enteric fistula, intractable diarrhoea, immunocompromised children (see Table 2. relative contraindications).

LoE: moderate

SoR: strong

Vote: 9,9,9,9,9,9,9,9,8,9,9,8,9,9,8 (100% agreement)

12. The ESPGHAN expert group recommends not to use jejunal tube feeding in preterm infants (<37 weeks' gestation).

LoE: moderate

SoR: strong

Vote: 9,8,8,9,8,9,9,5,8,9,8,9,9,9,9 (93% agreement)

A systematic review of transpyloric *versus* gastric tube feeding for preterm infants (less than 37 weeks gestation) came to the conclusion that because of the lack of evidence of any benefit, and an increased risk for gastrointestinal disturbance and possibly of death the transpyloric route should not be routinely used for preterm infants who require enteral tube feeding (52). Especially preterm infants with intrauterine growth restriction are at a higher risk for adverse events. Most of the studies recruited very low birth weight infants (birth weight <1500 g) although in the majority only infants grown appropriately for gestational age were included (52).

Two additional systematic reviews as well as the most recent Cochrane review conclude that there is no evidence of any benefit for transpyloric feeding in preterm infants compared to gastric feeding (24, 53, 54). Additionally, a higher risk for gastrointestinal complications

(relative risk 1.45, 95% CI 1.05, 2.09), as well as a higher mortality rate (relative risk 2.46, 95% CI 1.36, 4.46) before discharge from the hospital was observed in preterm infants fed transpylorically. However, because of allocation bias in the included trials - sicker and less mature infants were allocated to JTF - the authors of the systematic review advise that these findings should be interpreted with caution (24). Nevertheless, the ESPGHAN committee on nutrition recommends to avoid postpyloric feeding in preterm infants (6). It has been suggested that early transpyloric feeding in preterm infants may prevent bronchopulmonary dysplasia, but this must be further tested in studies before it can be recommended (55).

Other conditions considered relative contraindications include intestinal dysmotility, toxic megacolon, peritonitis, gastrointestinal bleeding, high-output enteric fistula, and intractable diarrhoea (6). These are not deemed absolute contraindications as minimal quantities of nutrients in the gastrointestinal tract - so-called trophic feeding - have well recognized benefits by promoting intestinal perfusion, initiating release of enteral hormones and improving gut barrier function (56, 57). Severe vomiting might compromise the benefits of JTF or impair viability, also through tube displacement (6). JTF is not a contraindication in patients with evidence of GOR or risk for GOR worsening, e.g. in children with severe NI. Placing the tip of the JT beyond the ligament of Treitz prevents duodenogastric reflux and GOR and this is suitable for children who are not acceptable candidates for antireflux surgery or in whom fundoplication has failed (10). This is discussed in detail in Question 1.

If long-term enteral feeding is required the high frequency of complications as well as the need for frequent tube replacement due to obstruction or displacement could be a limitation to JTF (10-12). However, other authors have reported enteral feeding through surgically placed jejunostomy tubes to be relatively safe even for long periods up to 12 years (2).

As placement of nasoduodenal or nasojejunal tubes (NJT) may be difficult percutaneous endoscopic gastrostomy (PEG) or enterostomy (PEE) currently are the preferred routes of placement especially for long term EN (6). Here, contraindications for PEG and PEE need to be considered (6).

Other conditions might be considered as limitations for JTF because of higher rates of significant complications. In immunocompromised children or in case of an impaired gastric acid barrier, there may be a higher risk for sepsis from bacterial contamination of feeds which is relative common both at home and during hospitalization (58). As patients being JT fed have a nine times higher risk for developing *C. difficile*-associated diarrhoea as compared to matched controls, decision of JTF in immunocompromised individuals needs to be carefully considered (59).

However, JTF can be safely used in children on chronic ventilation or during weaning of mechanical ventilation as no higher risk for aspiration or mortality has been noticed (60, 61).

The presence of a ventriculoperitoneal shunt or a peritoneal dialysis catheter is not a contraindication to JTF as a PEG does not result in a higher incidence of shunt infections or mortality (62); however, it has been suggested that PEG insertion should be deferred at least one week after ventriculoperitoneal shunt insertion (62).

Q5: What are the techniques available for placement of a jejunal feeding tube?

The route of placement and type of device used for jejunal feeding should depend on the expected duration of jejunal feeding, namely NJT for predictably <1 month and per endoscopic or surgical gastro-jejunostomy or jejunostomy for more prolonged use; the availability of experience and collaboration locally (i.e. interventional radiology, surgery, and

endoscopy); the presence of a pre-existing gastrostomy; and the need of gastric decompression.

Nasojejunal Tube (NJT)

13. The ESPGHAN expert group recommends that the radiological placement of an NJT should follow established protocols and training of clinical staff in order to reduce radiation exposure of patients.

LoE: low

SoR: strong

Vote: 9,9,9,9,9,9,9,8,9,8,9,9,9,9,9 (100% agreement)

The ESPGHAN expert group suggests not to use prokinetic agents during naso-jejunal feeding tube placement.

LoE: moderate

SoR: weak

Vote: 9,7,8,9,9,8,8,5,8,9,8,9,9,7,8 (93% agreement)

Nasoenteric tubes are a good choice for short-term feeding but have many drawbacks for long-term management (recoil into the stomach, clogging, nasal pressure sores, and accidental removal). There are several kinds of nasoenteric tubes made from various materials (e.g. polyurethane and silicone), which have different diameters (3.5-12 French), with and without guide wires, and with and without weight at their tips. Nasogastric tubes (NGT) made of Polyvinyl Chloride (PVC) are relatively stiff and therefore more irritating long-term, and are used primarily for gastrointestinal decompression and should not be used for prolonged enteral feeding. Usually, a nasoenteric tube is inserted with a guide wire,

previously flushed with saline solution for easier post insertion wire removal, and a weighted tip is inserted into the stomach using the usual technique for NGT insertion. The child is placed in right lateral decubitus and the tube is pushed through the pylorus. The guide wire should be removed at the end of the procedure. Self-advancing jejunal feeding tubes have been reported to be used effectively to establish early EN in critically ill children (63). The use of a non-invasive electromagnetic device to place transpyloric feeding tubes has been suggested to be effective in children (64) although in another study it significantly increased the time of placement (65). Several studies showed that the insufflation of 10 ml/kg air in the stomach significantly improves the rate of success without increasing risks (66, 67). A recent meta-analysis of all the RCTs both in adults and children concluded that gastric air insufflation seems to be efficient (without reaching significance), while clinicians should no longer use prokinetic agents in paediatric patients or patients without impaired motility (66, 67). Bedside placement of a postpyloric tube can be safe and effective in infants including preterm and reduce infants' exposure to radiation in comparison to interventional radiology placement (68). Nasoenteric tubes may also be placed with the aid of fluoroscopy or endoscopy. Fluoroscopic techniques of nasoenteric tube placement require skilled radiological support and cause exposure to radiation. Protocols and training can reduce radiation exposure of patients and staff (69). The NJT can be placed endoscopically, either using a guidewire introduced through the working channel of the gastroscope or the drag technique in which a suture is tied to the end of a feeding tube and dragged with the endoscope snare or forceps from the stomach to the duodenum. This procedure is less successful because the feeding tube frequently moves back into the stomach when the endoscope is removed unless the tip of the tube is clipped in the duodenum (this is limited to older children due to the opening size of the clip). Irrespective of the technique used for NJT

placement, proper position of the nasoenteric feeding tube must be verified radiographically before feeding is initiated.

pH-guided jejunal tube placement

14. The ESPGHAN expert group recommends to use pH-guided jejunal feeding tube placement whenever possible as a safe, easy and cost-effective bedside method.

LoE: low

SoR: strong

Vote: 9,8,9,9,9,8,8,7,8,9,8,8,9,9,8 (100% agreement)

pH in the upper gastrointestinal tract typically varies according to the anatomical segment (oesophagus: pH 5 to 7, stomach: pH 1 to 3, duodenal bulb: pH 3 to 4 and small intestine: pH 7 to 8) (70). Therefore, pH-guided JT placement is a safe, easy and cost-effective bedside alternative to fluoroscopic, endoscopic or surgical placement in critically ill infants and small children (70, 71). This method can be easily taught to house staff or other health care personnel (70). As the pH-assisted technique offers immediate feedback on correct positioning enteral feeding can be initiated promptly (71). Displacements of jejunal feeding tubes can be easily checked with a pH monitor, and therefore, aspiration of jejunal secretions to check pH with paper is not needed (71). Radiological placement control should only be applied in case of borderline pH values or in patients treated with PPIs.

Radiology

Radiological methods can help in placing NJTs and are needed to confirm proper tube position. Jejunal feeding tubes can also be placed under radiological guidance via a previous gastrostomy site (72) or by direct jejunal puncture (73). A retrospective review comparing surgical jejunostomy against image-guided GJT placement through a pre-existing gastrostomy orifice concluded that image-guided GJT placement needed more frequent tube

replacement (4.6/year *versus* 1.5/year) ultimately leading to surgical jejunostomy conversion in 50% of the cases (74).

Endoscopy

A jejunostomy may be inserted with endoscopic assistance indirectly via a previously placed or a *de novo* gastrostomy (percutaneous endoscopic gastro-jejunostomy (PEG-J)) or directly without gastrostomy placement (percutaneous endoscopic jejunostomy (PEJ)).

For PEG-J placement, a feeding tube long enough to pass beyond the pylorus is inserted through an existing gastrostomy. The tip of the feeding tube is then grasped with the biopsy forceps of the endoscope and the tube is pushed into the duodenum as far as possible. Extra tubing length is left within the stomach to allow peristalsis to pull the tip of the feeding tube past the ligament of Treitz. Although this procedure is simple, its major disadvantage is the tendency of the feeding tube to recoil into the stomach during the withdrawal of the gastroscope; a clip can limit this risk fixing the external part of the tube to the duodenum/ jejunum (this is limited to older children due to the opening size of the clip). In addition, the feeding tube tends to dislodge from the outer gastrostomy. An alternative is to introduce a neonatoscope (diameter 5.3 mm) through the gastrostomy, pass the pylorus and go as far as possible beyond the Treitz angle. Then a guide wire is introduced through the operating channel of the endoscope, the scope is removed and the GJT is passed over the guide wire (12). One advantage of this technique is that it minimizes the need for sedation because it causes minor discomfort such as hiccups, pain around the stoma site, and abdominal distension from air insufflation. These can be overcome in most patients by providing play therapy and the presence of the parents during the procedure (75). One-step GJT insertion through a *de novo* gastrostomy is a recent technique using the push technique. The procedure is basically the same as the one-step percutaneous endoscopy button placement (76) where a

neonatoscope is introduced through the 16 French introducer and passed into the jejunum *via* the pylorus and a GJT is placed over the guide wire as described above (77).

If there is no pre-existing gastrostomy or if a gastrostomy (for exsufflation or administration of medication) is not needed, direct PEJ can be performed using a gastroscope or colonoscope placed into the proximal jejunum. The most common techniques include the insertion of a needle into the jejunal lumen at the site of the maximal transillumination and/ or a finger indentation marking of the jejunal loop that is closest to the abdominal wall. The needle should be snared tightly, fixing the small bowel against the abdominal wall. The plastic sheath with stylet should then be inserted adjacent to the needle and snared by a wire loop that has been removed from the needle. An insertion wire is then passed through the plastic sheath and grasped with a snare or a grasp forceps. The rest of the procedure is similar to the PEG's pull technique: the gastroscope with a wire is pulled out through the duodenum, stomach, oesophagus and mouth. The insertion wire is then secured to the loop at the end of the feeding tube with an internal jejunal bolster and the assembly is pulled through the mouth all the way to the jejunum. The tube is pulled through an incision in the abdominal wall, sufficiently tight to compress the jejunal wall against the anterior abdominal wall. Intrajejunal tube placement is then verified by a second endoscopy. Finally, a skin disk is secured to the outside portion of the feeding tube to ensure the creation of a tract between the skin and jejunal lumen. It is important to avoid excess tension when approximating the jejunum to the abdominal wall, to prevent pressure sores of the skin or the jejunal mucosa. Experience in children with this technique remains very limited (78). Recently a laparoscopic assisted PEJ technique has been reported in 16 children aged 2-17 years. All procedures were successful and the technique was safe as it provides sufficient visualization of the bowel loops intraabdominally (79).

Surgery

15. The ESPGHAN expert group recommends, where long term (gastro-) jejunal feeding is expected, to use strategies such as Roux-en-Y jejunostomy, Omega jejunostomy, and retubularization instead of direct surgical tube insertion.

LoE: low

SoR: strong

Vote: 9,9,7,9,9,9,9,9,8,8,9,8,9,9,9 (100% agreement)

Many different surgical techniques have been described for jejunal tube insertion. Open or laparoscopic surgery techniques are available and there are no data that demonstrate superiority in effectiveness and safety of any strategy, and the choice depends on the surgeon's experience and his preferences.

Direct surgical catheter jejunostomy placement is a well-known and standardized procedure. However, high surgical complication rates (40%) have been reported in a large series (2).

Laparoscopic side insertion of a small calibre tube (6-9 Fr) or Foley catheter into the proximal jejunal loop is a straight-forward technique (80). A subserous tube conduit prevents the risk of peristomal skin damage due to leakage and tube dislodgement.

Laparoscopic insertion of a GJT has been described in a large group of infants less than 10 kg with cardiac disease (81). There are no clear advantages of this strategy except for the reduction of gastric and bowel distension during the procedure.

In case of long term JTF, surgical strategies such as Roux-en-Y jejunostomy (82), Omega jejunostomy (83) or retubularization (84) facilitate insertion of the tube into a modified

jejunal tract improving management by the caregivers and also reduce peristomal leakage and skin damage.

Q6: Which complications are related to JTF and how should they be minimised and/ or managed?

The development of procedural protocols with regular quality controls and audits, and monitoring by a dedicated nutrition support team warrants to minimize complications. Although gastrojejunal tubes are a useful temporizing method to provide enteral access in children their high rate of mechanical failure limits their long-term use.

16. The ESPGHAN expert group recommends that the tip of the jejunal feeding tube be placed beyond the ligament of Treitz in order to prevent retrograde dislodgment of the tube into the stomach.

LoE: very low

SoR: strong

Vote: 9,9,9,9,9,9,9,8,9,9,9,9,9,9,9 (100% agreement)

There are three major categories of complications following JT placement: 1) mechanical (e.g. perforation, buried bumper syndrome); 2) gastrointestinal (e.g. diarrhoea); 3) infectious (e.g. aspiration pneumonia, tube site infection) (Table 3).

1. Mechanical and surgical complications (e.g. perforation, intussusception, and buried bumper)

NJT is mainly used for short-term post pyloric feeding (4-6 weeks). Its complications include foreign body sensation, obstruction, tendency to dislocate and easy voluntary removal, reflux esophagitis, aspiration, nasopharyngeal ulcers and epistaxis (59).

Placing the distal tube tip beyond the ligament of Treitz minimizes retrograde dislodgement of the jejunal extension tube. Endoscopically placed clips may secure the tube and prevent migration.

Peristomal leakage may be reduced by adequate stabilization of the external bolster by a dressing. If persistent leakage causes peristomal skin damage, barrier creams may be helpful, as well as local antibiotics. It is essential to prevent stoma enlargement. Sometimes a smaller tube may facilitate healing around the tube, as well as the temporary application of continuous low-pressure suction at the insertion site (i.e. negative-pressure wound therapy (VAC® therapy), Replogle tube).

Buried bumper syndrome may complicate the placement of a GJT, when there is excessive traction between the internal bumper and the stomach wall as e.g. in patients with important weight gain. There is a higher rate of buried bumper syndrome associated with PEG-J tubes compared to PEG tubes, possibly related to the jejunal extensions leading to difficulty in the usual maintenance regimen that all carers are taught after PEG/ PEG-J insertion (85). To prevent buried bumper syndrome, it is advisable to allow some space between the external bumper of the PEG tube and the skin in order to minimize the risk of pressure-induced necrosis and to mobilize and loosen the PEG from the outside at least every other day to avoid mucosal overgrowth of the inner bumper. To prevent this event, the size of the device must be reviewed periodically for weight gain and increased abdominal wall thickness (86).

Intestinal perforation may occur even much time after placement, mainly at a younger age (1) and in patients with comorbidities, i.e. shock or heart disease (87) (88). Intussusception has also been reported as a rare complication (73).

Peristomal infections occur more frequently shortly after first tube placement (PEG or PEJ), but may also complicate long lasting enteral feeding. Accurate hygiene measures of the stoma

and the use of antimicrobial wound dressings may help in prevention (86). Depending on clinical status, topical or systemic antibiotics may be required.

2. Gastrointestinal complications

Although GJT feeding usually improves nutritional status, its use may be associated with pulmonary aspiration, bilious aspirates, and diarrhoea (10). Diarrhoea is the most commonly reported gastrointestinal side effect in patients receiving JTF. The pathogenesis of diarrhoea in enterally-fed patients can be related to the enteral formula or the administration method. Prevention of diarrhoea includes the use of a closed feeding system (to limit bacterial contamination), continuous administration of feeding using a pump, and limiting the use of hyperosmolar feeds. Persistent vomiting and retching are described in almost 18% of a large series of children with GJ tube (1), but is probably more likely due to the underlying disease (severe GOR, antropyloric dysmotility, etc.). The frequency of gastrointestinal complications is higher in critically ill children (89) and patients with cyanotic heart disease, which in turn increases the risk of necrotising enterocolitis (NEC) (87, 88).

3. Infectious complications (e.g. aspiration pneumonia, tube site infection)

The combination of gastric decompression *via* PEG and simultaneous jejunal nutrition reduces tube feeding-related aspiration in many patients. Tube site complications including granulation, infection and leakage are frequent and benign complications. Leakage of bile acids at the level of a jejunostomy can be responsible for severe and painful skin lesions due to the caustic nature of the bile.

Q7: Immediately after placement when should feeding be commenced?

When should feeding be commenced?

17. The ESPGHAN expert group recommends to start jejunal feeding within 24 hours after placement of the jejunal feeding tube irrespective of patient age or condition except in complicated surgical situations such as e.g. adhesions.

LoE: moderate

SoR: strong

Vote: 9,8,9,9,9,9,9,9,9,9,9,5,9,9,9 (93% agreement)

Practical Note

Refeeding syndrome should be considered whenever nutritional support is instituted in malnourished children.

Previously, commencement of feeding was delayed until 12 to 24 hours after transabdominal gastrostomy placement in order to allow the gastrointestinal tract to return to normal function and to allow healing of the enteral opening. However, several prospective RCTs (90-93) have clearly demonstrated that feeding can be safely started a few hours after the procedure (59), or at least on the first operative day (94), even in early infancy (12).

Abdominal intervention or severe stress are not a contraindication for early feeding as small intestinal motility and absorptive functions have been demonstrated to remain intact, although gastric and colonic motility may be impaired for up to 2 to 5 days (95). Retrospective and prospective observational studies have shown that early transpyloric EN starting within the first 24 hours was well tolerated even in critically ill children without an increased rate of complications compared to late (after 24 hours, range 1–43 d) transpyloric EN (96). 74% of the patients achieved their estimated caloric requirements within 24 hours and the remaining patients within 48 hours after transpyloric tube placement (95). Moreover, the incidence of

abdominal distension was lower in the children receiving early transpyloric feeding (3.5%) than in those receiving nutrition at a later time (7.8%; $p<0.05$) (96).

Refeeding syndrome should be considered whenever nutritional support is instituted in malnourished children. It is characterized by electrolyte depletion, fluid shifts and glucose derangements upon reinstitution of nutrition in malnourished patients.

Q8: Which feeds are suitable for jejunal feeding and what are the nutritional considerations?

18. The ESPGHAN expert group recommends starting feeding with standard polymeric formula, and if this is not tolerated switching to a hydrolysed formula.

LoE: moderate

SoR: strong

Vote: 9,9,9,9,9,9,9,5,9,9,9,6,9,9,9 (87% agreement)

Practical Note

Elemental formula and other hyperosmolar feeds should be used with caution.

Thickened and fibre containing feeds should be used with caution due to risk of tube blockage.

19. The ESPGHAN expert group recommends to start with a hydrolysed formula containing MCT where JTF is used in pancreatic insufficiency or malabsorption.

LoE: low

SoR: strong

Vote: 9,8,9,9,9,9,8,8,8,7,8,8,9,9,9 (100% agreement)

20. The ESPGHAN expert group recommends to monitor serum levels of copper, zinc, selenium, and iron for nutritional deficiencies in all patients that receive long term JTF.

LoE: low

SoR: strong

Vote: 9,8,7,9,9,9,8,8,8,7,9,9,9,9,9 (100 % agreement)

Practical Note

Serum levels for copper, zinc, selenium and iron should be checked on a 6-monthly to 1-yearly basis.

21. The ESPGHAN expert group recommends not to dilute the formulas so as to minimise the risk of microbial contamination of the formula, secondary diarrhoea and malnutrition due to its low caloric content.

LoE: moderate

SoR: strong

Vote: 9,8,9,9,9,8,9,9,8,9,8,9,9,6,8 (93% agreement)

In children, postpyloric feeds have traditionally been hydrolysed and less viscous because of the narrow lumen of the transpyloric tubes, although polymeric feeds have also been tolerated [85](97). Evidence in the literature for a particular feed for JTF is however lacking. Physiologically, intraluminal pressure and motility can increase in postpyloric feeding in response to volume and osmolality of the feed. This in turn can cause side effects such as abdominal distension, vomiting, diarrhoea, and dumping syndrome. In postpyloric delivery of

feeds pancreatic secretion may vary according to the site and type of feeding. Placement of the tube more than 40 cm below the ligament of Treitz inhibits pancreatic secretion and this would therefore favour use of an elemental feed. However, O'Keefe et al. looked at the effect of polymeric *versus* an elemental feed on pancreatic secretion (98). The polymeric feed allowed an adequate pancreatic secretory response whereas pancreatic secretion was reduced by 50% with the elemental diet. They concluded that intraduodenal infusion allows complete assimilation of a polymeric enteral feed due to adequate pancreatic secretory response (98).

The underlying disease may also affect the choice of formula, i.e. for those with pancreatic insufficiency or malabsorption a semi-digested formula may be the feed of choice (99). However, the higher osmolality of elemental feeds may cause non-tolerance. The recommended osmolality for infants and children <4 years of age is <400 mOsm/kg and for older children it is <600 mOsm/kg (100).

It is not recommended to dilute the formulas as it may increase the risk for microbial contamination of the formula (101), secondary diarrhoea and malnourishment due to its low caloric content (102).

JTF causes an iatrogenic bypass of the upper gastrointestinal tract, which may lead to nutritional deficiencies. Copper is primarily absorbed in the stomach and therefore in those being jejunally fed there is an increased risk for copper deficiency. Jacobson et al. described three paediatric patients on exclusive jejunal feeds who developed cytopenia secondary to copper deficiency (103).

Children on exclusive jejunal feeds may be at risk for iron deficiency due to feeds bypassing the duodenum, which is the primary site for iron absorption. A small case series of six children fed *via* the jejunum showed significant reductions in serum iron (18.5 g/l *versus* 9.8 g/l, p=0.01) and transferrin levels (23.1% *versus* 13.7%, p=0.02) after a mean period of

11 months. There was no change in ferritin, haemoglobin and mean corpuscular volume showing the proximal jejunum may have the capacity to adapt to iron deficiency (104). A retrospective study by Skelton showed a 30% reduction in zinc, a 68% reduction in selenium and a 25% reduction in iron (105).

There is an increasing popularity amongst families to use blenderised diets in those children on long-term enteral feeds. Blenderised diets need to be given as bolus gravity feed, thereby excluding their use in continuous JTF.

Q9: What feeding regimen should be used for long-term jejunal feeding?

Mode and rates of delivery

22. The ESPGHAN expert group recommends to administer jejunal feeding continuously *via* a volumetric enteral pump at a rate tailored to the patient's tolerance.

LoE: low

SoR: strong

Vote: 9,9,9,9,7,9,9,8,9,9,8,8,9,9,8 (100% agreement)

There is no evidence indicating the exact rate of the EN delivery. Jejunal feeding should be provided continuously *via* volumetric enteral pump because bolus feeding or high infusion rate can cause diarrhoea, abdominal cramping, and dumping syndrome-like symptoms (99). Proposed increments are 1-5 ml/h every 24 hours for infants or 5-20 ml/h in older children every 4 hours until the target rate is reached (9, 107).

Suggested volume rates are presented in Table 4. Lower perfusion rates such as 0.5 ml/kg/h are proposed if there is a risk of gut ischaemia. Once the target rate has been achieved, the concentration of the formula can be increased to deliver the estimated nutrient needs.

Over time, continuous feeding can be cycled with mainly overnight continuous feeding at the highest tolerated rate. **Intermittent continuous feeding** is more physiological, allowing greater patient mobility and stimulating oral feeding as it evocates periods of hunger and satiety. Intermittent continuous feeding provides cyclical secretion of gastrointestinal hormones with a trophic effect on intestinal mucosa (108). Therefore, intermittent continuous feeding patterns would be recommended to use over continuous feeding whenever possible (6).

The rest of the caloric intake can be provided during the day either orally if the child tolerates oral or gastric intake, or *via* continuous JTF over several hours at the highest tolerated rate. The quantity of feeds per day should be determined by the child's energy requirements and the duration of fasting, which is maximally tolerated. However, JTs should be accessed several times per day even if not in use in order to maintain tube patency.

When full or partial postpyloric enteral feed cannot be achieved (e.g. by clinical instability, airway management, radiological and surgical procedures, and accidental feeding tube removal) (109) **trophic EN** is recommended as continuous infusion of small amounts of enteral feed. Different rates are proposed ranging from 0.5 to 25 ml/kg/day or 20 ml/h (102, 107). Trophic feeding maintains the intestinal barrier and the mucosal integrity and stimulates intestinal secretion of brush border enzymes, endogenous peptides, secretory immunoglobulin A and bile salts (56, 110). These local intestinal effects reduce systemic inflammation by helping to prevent translocation of bacteria or bacterial products across the intestinal epithelial barrier (111).

Q10: What else can the JT be used for?

Administration of medication

23. The ESPGHAN expert group recommends not to use the JTF for the administration of medication unless absolutely essential and/ or delivery into the stomach is not possible.

LoE: low

SoR strong

Vote: 9,9,9,9,7,9,9,7,8,9,8,7,9,9,9 (100% agreement)

Practical Note

Delivery of medication via the jejunal route may have unpredictable bioavailability of the active component, the absorption site of the drug, potential local adverse effects, and potential reaction with the feeding tube (possibility of tube clogging).

In the case of motility disorders or obstruction, gastric aspiration should be avoided or performed after a sufficient time interval if medication is administered *via* the gastric tube.

The jejunal feeding tube can be used for the administration of medications. However, information is lacking regarding the site of intestinal absorption of most medications (112) and drug information sheets usually do not provide information about safety for jejunal intake. Furthermore, in patients with a GJT frequent changes of administration route (gastric *versus* jejunal) make it difficult to achieve stable therapeutic drug levels (112). Therefore, clinicians have to closely monitor medical therapy in these children. In patients with motility disorders and obstructions, the gastric port of the GJT is sometimes used to aspirate gastric contents. In this case, administration of medication through the gastric or jejunal tube should be avoided or at least be performed after a sufficient interval, as the medication may be sucked before intestinal absorption (112).

As the JT is often both used for EN and medication, interactions between the food and medication are possible, but there is limited published data in children (112). Additional adverse drug reactions are possible. Many liquid formulations of medications have a high

osmolality, which can result in cramping, abdominal distension, vomiting, and diarrhoea (113). These symptoms are usually attributable to inactive ingredients and excipients in the drug formulation, such as e.g. polyethylene glycol (114) or sorbitol (115).

Alterations in drug absorption can lead to increased toxicity or treatment failure (112). Increased toxicity may occur due to a lack of degradation by stomach acid or decreased first-pass hepatic metabolism, leading to increased drug absorption and/ or greater systemic exposure (115, 116). On the other hand, treatment failure may be caused by decreased absorption time leading to impaired degradation of medication (112, 116). Furthermore, bypassing the stomach may reduce the absorption and degradation of pH-dependent drugs (116).

In a large literature review 70 medications had information available regarding gastrointestinal site of absorption (112) (Table 5).

For the majority of medications, there are no specific data on bioavailability or solubility after the drug (tablet or capsule) is crushed. Many compounds are water-insoluble, and sustained- or extended-release product formulations should not be crushed due to potential toxicity from the rapid release of large doses of the active component (116).

Ideally, to prevent jejunal feeding tube blockage, medications should be completely dissolved in water or applied as liquid formulations (59, 117). After administration flushing the tube with water helps to deliver the drug to the intestinal mucosa (118).

Gastric decompression and aspiration

24. The ESPGHAN expert group recommends to perform gastric decompression and aspiration in children being fed by jejunal feeding tube who have a high risk of

gastroesophageal reflux and pulmonary aspiration due to accumulation of gastric residue and abdominal distension.

LoE: low

SoR: strong

Vote: 9,8,9,9,9,9,9,8,8,9,8,6,9,9,9 (93% agreement).

Gastrojejunal feeding is a well-established feeding method to provide both postpyloric feeding and gastric decompression in patients with a high risk for GOR and pulmonary aspiration due to accumulation of gastric residue and abdominal distension (75, 89, 119). In children with an NJT or a surgical jejunostomy the presence of a gastric tube or a PEG may reduce the risk for GOR and pulmonary aspiration by facilitating gastric decompression.

"Downstream" JTF increases gastric acid secretions (89). Furthermore, there is retrograde movement of enteral feed and bile into the stomach due to abnormal gastrointestinal motility (89, 120). Increased gastric residue/ aspirates are considered as greater than 50% of the volume administered in the previous 4 hours (121). Increase in gastric residue leads to a higher risk of aspiration and also favours small intestinal bacterial overgrowth (121).

Aspiration of gastric residue can also help in deciding when to start and how to advance oral feeding when no biliary drainage exists in the nasogastric aspirate (37).

Special use in the case of suspected small intestinal bacterial overgrowth

The jejunal feeding tube offers a unique opportunity to aspirate intestinal fluid and evaluate for small intestinal bacterial overgrowth (SIBO) in the case of clinical suspicion (e.g. bloating, diarrhoea, growth failure) and/ or diagnostic indications (vitamin B12 deficiency, urinary organic acids profile). Ideally, aspiration of jejunal secretions for culture should be performed via a new jejunal tube to avoid culturing bacteria that have been colonising the

tube. The presence of a (polyethylene) JT itself has shown to alter the intestinal flora of the small intestine in very low birth weight preterm infants (122). There was an increased risk to develop NEC if the jejunum was heavily colonized with Gram-negative bacilli (122). Furthermore, increase in gastric residues favours small intestinal bacterial overgrowth (121).

Q11: What is needed for on-going care of post pyloric feeding?

25. The ESPGHAN expert group recommends to tailor the care and management of jejunal feeding devices according to the type of device used and route of insertion.

LoE: low

SoR: strong

Vote: 9,8,3,9,9,9,9,9,8,9,8,7,9,9,7 (93% agreement)

Nasojejunal tubes

NJTs should be measured prior to use to rule out displacement. The nasal passage should be clean and dry with good skin integrity. It should then be secured with appropriate tape to avoid re-passing.

To reduce the risk of pulmonary aspiration, the patient should ideally be nursed at a 30° angle or higher if possible.

Nasal Bridle Retaining System

Patients requiring NJ tube placement may benefit from a nasal bridle tube-retaining system. Nasoenteric feeding tubes can become dislodged due to patient non-compliance, transfers, or positional changes (123). Nasal bridles can provide a better, more reliable system to secure nasoenteric tubes.

Placement of a nasal bridle retaining system should only be carried out by health care professionals with specific training.

Contraindications for the insertion of a nasal bridle system include a grossly deviated nasal septum and persistent vomiting (124). Consideration for insertion includes nasal polyps, nasal deformity, a history of epistaxis, and ethnic/ cultural issues.

Routine care of surgically and endoscopically placed JT

Appropriate labelling should be used for PEG-J tubes distinguishing the gastric and jejunal lumina. Depending on the manufacturer some devices have a balloon-retaining bumper, which requires weekly water changes to make sure the balloon is always filled. GJTs are not to be rotated to avoid migration back into the stomach. Feeding extension sets are to be changed as per manufacturer's instructions. Minimal handling and an aseptic non-touch technique should always be applied to connect the administration set to the enteral feeding tube and feed receptacle (125). The exit site is cleaned and dried at least once a day. PEJ/ PEG-J tubes do not require routine aspiration but if the patient is showing signs of respiratory distress or vomiting then the pH of aspirate should be checked. A pH <5.5 may indicate that the tube has migrated to the stomach and the feed should be stopped and the tube checked with an X-Ray (126). If an aspirate were obtainable from the jejunum then a pH 6-8 would be expected (127).

Tube flushing

26. The ESPGHAN expert group recommends to flush the jejunal feeding tube with small amounts of warm water before and after administration of enteral nutrition and medication or when changing the bag or bottle in the case of continuous jejunal tube feeding.

LoE: very low

SoR: strong

Vote: 9,9,7,9,9,8,9,6,7,7,9,9,9,9,9 (93% agreement)

To maintain patency, the tube should be flushed whenever the feed is interrupted, before and after all feeds and medication administration (102) with 10–20 ml of sterile water 4–8 hourly (unless the child is fluid restricted). The water must be sterile.

All medications should be administered in liquid form, some liquid medications are known to be associated with tube blockages and so can be diluted before administering *via* the tube.

If giving 2 or more medications at the same time flushing is recommended in between to prevent precipitation/ clogging (settling of the medication) in the tubing.

Tube blockage

Mechanical complications are frequently reported (10-12); and often related to inadequate tube care by caregivers and nursing staff (59). Such events may be prevented by correct education on tube management with the goal to avoid frequent tube substitution. Several agents have been proposed for prevention and treatment of tube clogging, including pancreatic enzymes and carbonated beverages, but in vivo trials are still needed to establish their efficacy (128). Flushing may be more effective with warm water and small-volume syringes (1, 2 or 5 ml) in order to create higher pressure.

Site Management (Table 6)

Feed handling and preparation

In recent years, powdered infant formula contaminated with harmful bacteria has been associated with serious illness and death due to infection with bacteria such as *Cronobacter sakazakii* (129). Following this, recommendations on preparation of powdered infant formula have changed both for parents at home and in health care settings. The World Health Organization (WHO) guideline on "Safe Preparation, Storage and Handling of Powdered Infant Formula" (130) states that: "Powdered and decanted liquid feeds should only be used when there is no suitable alternative sterile feed available."

The handling of the enteral feed should be done in a clean environment using aseptic techniques by trained staff and if required the feed should be reconstituted with sterile or purified water heated to 70-80°C (102). A prolonged hanging time increases the risk for retrograde contamination and, therefore, the hanging time should not exceed beyond 24 hours (129, 131). Feed continuously administered should not be warmed.

Storage of feeds

27. The ESPGHAN expert group recommends to use a closed system for the preparation of the feed to avoid infection and error (e.g. correct feed, use before expiry date).

LoE: very low

SoR: strong

Vote: 9,7,8,9,9,9,9,8,8,9,9,8,9,9,9 (100% agreement)

The WHO recommends storage of feeds in a clean, dark place in its original box, between 15 and 25°C avoiding extreme temperatures, to avoid handling whenever possible (102, 130). Prepared feeds should not be frozen. The feed must always be connected to the administration set according to the manufacturer's instructions, and always with an aseptic

non-touch technique (132, 133). In bedded services the feeding system must always be labelled with the patient's name and the date and time the feed was set up (134). All opened containers of ingredients should be covered, labelled with an expiry date and stored in a clean secure location. Dry ingredients once opened should be used within 4 weeks of opening or as determined by the manufacturers' instructions if sooner. All opened or unused made-up liquid feeds must be discarded in accordance to the manufacturer's' instructions.

Q12: Who should be involved in the follow-up care?

29. The ESPGHAN expert group recommends to use a multidisciplinary team approach with well trained professionals for the follow-up and management of children requiring jejunal feeding.

LoE: low

SoR: strong

Vote: 9,9,9,9,9,9,9,8,9,9,9,9,9,9,9 (100% agreement)

Home enteral nutrition (HEN) is now widely supported and recognised as beneficial for the child's well-being and maintaining the family unit (135). Communication between hospital and community MDT (ideally consisting of a paediatric gastroenterologist, a dietician, a psychologist, an occupational therapist, and a speech therapist) involved in the child's care is therefore paramount between primary and secondary care settings in providing safe and effective care (136).

In hospital settings, education and training is provided to parents/ caregivers on preparation of feeds, management of feeding device and skin sites, pump training, administration of nutrition and medications. Various members of the MDT are involved throughout all stages of training (nurses, dietitian and medical doctors) (137). Communication and support to

families is paramount as it offers good understanding, provides safety and equips families with a competent feeling to take over care once discharged home (136).

The child's primary care giver follows up the child after JT insertion with the help of community nurses, dietitians and at times speech and language therapists. This provides a more holistic care approach making sure the child is thriving well as that the tube stoma tract is being well maintained. This shows that even in the community setting an MDT approach is also essential.

A number of hospital centres/ teams have developed tube feeding clinics to offer a holistic approach of care for these highly complex chronically ill children (138). These teams generally include a physician (usually a paediatric gastroenterologist), a dietitian, a nutrition nurse, a speech and language therapist and parents/ caregivers (132, 133).

Feeding clinics focus mainly on addressing, restoring and maintaining an adequate nutritional status of children to avoid nutritional depletion and to allow children to reach their potential growth and development. The timing of each child's feeding clinic review therefore varies depending on its nutritional status and general well-being.

Q15: How should you wean off jejunal tube feeding?

30. The ESPGHAN expert group recommends, in the absence of a standard approach such as a clinical guideline, to wean off JTF using a multidisciplinary team setting providing an on-going monitoring and support.

LoE: low

SoR: strong

Vote: 9,9,9,9,9,9,9,8,9,9,9,9,9,9,9 (100% agreement)

Practical note

If possible children on JTF should be re-trialled on oral or gastric feeds at intervals.

There is little guidance in the literature as to how to wean successfully off a JT (139, 140). As with all tube feeding when a tube is placed there should always be a discussion around transitioning back from tube to oral feeding where possible. The decision to begin weaning the child from JTF will depend on nutritional status, medical stability and oral aversion. Transition may take days to months and depending on the reason for the JTF a child may remain dependent on the JT for a long period of time. Feeding aversion may be a major issue and where possible some continuation of oral (if safe) feeding should be considered to limit this aversion.

Transition of JTF back to gastric/ oral feeding may be achieved by many methods and will depend on a centre's practice (141). The child may be admitted to hospital or a specialist centre for tube weaning or the child may remain at home with small changes made over a period of time. Interventions consist of psycho-education, supportive psychotherapy for parents including parent-child relationship work, behavioural interventions with mealtime structuring, nutritional and medical interventions, hunger provocation and treatment of oral sensory-motor difficulties (142). Where possible tube weaning should be done within the setting of an MDT comprising of a dietitian, specialist speech and language therapist, psychologist, occupational therapist and a paediatrician.

Q16: What are the ethical considerations?

31. The ESPGHAN expert group recommends to involve parents and/ or caregivers in each decision-making process and to ensure that informed consent is obtained.

LoE: moderate

SoR: strong

Vote: 9,8,8,9,9,9,9,8,9,9,9,9,9,9,8 (100% agreement)

32. The ESPGHAN expert group recommends to involve a professional ethicist to assist in decision-making in cases where the insertion of a jejunostomy poses ethical dilemmas.

LoE: very low

SoR: strong

Vote: 9,8,9,9,9,9,9,7,8,9,8,9,9,9,9 (100% agreement)

JTF is a therapeutic intervention aiming at reversing malnutrition and/ or maintaining nutritional status in children who cannot tolerate oral or gastrostomy feeds. Therefore, similar to other diagnostic or therapeutic interventions the decision on its initiation must be a result of consensus between the medical professionals and the parents/ caregivers. Obtaining informed and educated consent by the parents/ caregivers is an important ethical principle of every invasive intervention procedure including JTF.

The benefit of JTF is determined by the potential medical benefits but also by the perceived benefits by the child's parents/caregivers. Sometimes, the decision-making process regarding tube feeding for parents/caregivers is difficult and the process is delayed (143, 144). Multiple negative perceptions may coexist including feeling of failure, disruption of maternal nurturing and bonding, loss of normality and confirmation of the permanence of the disability. It is therefore important for the MDT to recognise these perceptions and to be involved in the discussions with the parents/ caregivers explaining benefits, risks, alternatives as well as the consequences of not receiving the proposed treatment. The parents/ caregivers should be given enough time to make their decision freely. The ethical principle of informed

consent is based on the understanding of the above perceptions by the health care professionals (145) who also need to develop effective, family-centred, patient appropriate adherence strategies.

Furthermore, in order to promote the best interest of the patient it is important to make every effort to guarantee maximum effectiveness of the intervention with minimum complications at reasonable costs. To achieve the above goals, the jejunal feeding tubes should be placed by experienced specialists and the jejunal feeding should be supervised by specifically trained professionals. Care coordination by an MDT including the families/caregivers, improves outcomes in patients receiving long-term enteral feeding while, specialized home enteral tube feeding programs significantly reduce morbidity and costs (146, 147). The ESPGHAN Committee on Nutrition recommends the implementation in hospitals of multidisciplinary nutritional care teams with expertise in all aspects of clinical nutrition care, funded by the health care system (138).

In conclusion, the decision to establish JTF must be based on the best clinical evidence and take into consideration the clinician's experience as well as the parents'/ caregivers' perceptions, concerns and expectations. Acknowledgement of benefits, risks, costs, and effects in the decision-making process provide the best approach for both health professionals and parents/ caregivers ultimately promoting the patient's optimal growth, health and quality of life.

Q17: Who is involved in the management at home/ in the community?

33. The ESPGHAN expert group recommends that in all patients on home enteral nutrition there is close cooperation between the home (parents/caregivers and community nursing team) and hospital multidisciplinary teams.

LoE: low

SoR: strong

Vote: 9,9,8,9,9,9,9,8,9,9,9,9,9,9,8 (100% agreement)

Home enteral nutrition (HEN) provides nutritional support to children with chronic diseases allowing them to be discharged earlier from hospitals (102). Only a minority of patients receive their feeding *via* jejunal approach (148), and general aspects of HEN may be applied to this subgroup. Data from a Spanish national paediatric registry on 952 patients on HEN show that the majority of patients are fed enterally due to neurological disease. The number of HEN patients has increased substantially over one decade. However, only 2.2% of patients in the registry are fed jejunally (102). There are no RCTs available on home/ community involvement in the care of patients with jejunal feeding.

When planning for discharge several important factors must be considered, namely stability of the patient's condition, adequate psychomotor skills and ability to understand and retain information. Adequate education and training, as well as supply of all necessary equipment required for HEN is essential. Referral to respective specialists (dietitian, general practitioner or general paediatrician, gastroenterologist etc.) able to prescribe the feeds in the outpatient setting needs to be ensured (6, 135, 148). In some countries commercial feeding companies can provide training for patients, caregivers, including e.g. 'out of hours' advice lines where patients and caregivers can obtain troubleshooting information (148). As community follow-up is often inadequate for patients discharged home on enteral tube feeding (136, 137, 148) and poor discharge information leads to predominantly negative experience of general paediatricians with enteral feeding (137), optimal communication at discharge between health-care professionals in secondary and primary care services and MDT needs to be established (6, 132, 133, 135, 148-150). Close cooperation should be established also

between the community and the hospital nutrition team, if available. The need for hospital nutrition teams has been stressed by the ESPGHAN Committee on Nutrition (138).

Essential information given to the parents or caregivers and possibly to children at discharge should include: reasons for home tube feeding and likely duration; safety aspects of care (tube placement, infection control, hand-washing, feed preparation); information on feeding equipment; social and practical implications; problem solving advice; the importance of maintaining oral stimulation; telephone contacts for hospital and community staff; and detailed information about how to obtain equipment and supplies (6, 135, 148) The use of an easy-to-manage, lightweight and portable enteral feeding pump is recommended for jejunal feeding and detailed instructions on the management of the pump should be given at discharge (6). Information on regular evaluation of the nutritional status as well as oral motor skills, swallowing and gastroesophageal function is essential in order to allow early taper of jejunal EN (6, 149).

ESPGHAN disclaimer:

ESPGHAN is not responsible for the practices of physicians and provides guidelines and position papers as indicators of best practice only. Diagnosis and treatment are at the discretion of physicians.

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TABLE 1. Investigations recommended prior to placement of post-pyloric feeding tube.

	Consider routinely in all patients prior to placement of post-pyloric feeding tube	**Consider on case-by-case basis to rule out underlying disorders (in parentheses) that may limit pre-pyloric feeding**
Investigation	Upper GI endoscopy (*upper GI abnormalities e.g. esophagitis, ulceration, lesions causing obstruction not picked up on contrast studies*) Contrast meal and follow-through (*mechanical obstruction*)	pH/impedance studies (*gastro-oesophageal reflux disease*) Gastric emptying (nuclear medicine/scintigraphic) studies (*gastroparesis*) Antroduodenal manometry (*paediatric intestinal pseudo-obstruction*)

TABLE 2. Absolute and relative contraindications to jejunal tube feeding.

Absolute Contraindications	Relative Contraindications
• paralytic ileus • mechanical ileus • intestinal obstruction • intestinal perforation • necrotising enterocolitis	• preterm infants • intestinal dysmotility • toxic megacolon • peritonitis • gastrointestinal bleeding • high-output enteric fistula • intractable diarrhoea • immunocompromised children

TABLE 3. Late complications of post pyloric feeding (excluding events related to JT placement): possible causes, prevention and treatment.

Mechanical complications	Possible causes	Prevention and treatment
NJT/ GJT obstruction/ clogging, knotting	- Thick enteral feeds - Medications - Bulking agents (i.e. resins) - Small lumen	- Water flushing after feeding and medications - Accurately dissolve medications before administration - Prefer liquid drug formulations - Mechanical cleaning with wires or special "declogging" brush devices - Tube substitution - Continuous infusion
NJT/ GJT displacement (retrograde dislodgment in the stomach)	- Initial positioning of the tube tip before the ligament of Treitz - Altered gastro-jejunal motility with no regular peristalsis	- Tube tip beyond the ligament of Treitz - Endoscopically placed clips - Tube replacement ("beneath the scope" or "over the wire technique")
Accidental NJT/ GJT tube removal	- Inadequate fixing - Excessive traction of the tube during feeding - Patient's poor compliance	- Appropriate fixing, specific fixing devices - Avoid traction during feeding - Patient/ caregiver education - Contention
Breakage, leakage, wear of the NJT/ GJT tube; rupture of the GJT balloon	- Excessive wear - Inadequate manipulation	- Tube substitution - Patient/ caregiver education
Peristomal leakage (and subsequent erosion, ulceration and necrosis of skin and mucosa)	- Infection/ bleeding at the GJT insertion site - Gastric hypersecretion - Excessive torsion of the tube - Excessive cleansing with hydrogen peroxide - Host factors for poor wound healing - Inadequate size of the device - Inadequate stabilization by the external bolster	- Reduction of risk factors (i.e. antisecretory therapy with PPIs) - Barrier creams containing zinc and skin protectants - Placement of a smaller diameter tube - Apply continuous low pressure suction (i.e. Replogle tube)

Buried bumper syndrome	- Excessive traction between the internal bumper and the stomach wall	- Appropriate size of the device (length according to abdominal wall thickness and weight gain)
Intestinal perforation, intussusception, intestinal obstruction	- Young age - Comorbidities (i.e. shock, heart disease)	
Infectious complications	**Possible causes**	**Prevention and treatment**
Infection at the GJT insertion site Peritonitis	- Improper wound dressing (i.e. occluding) - Excessive traction between the internal bumper and the stomach wall - Host factors (i.e. immunosuppression)	- Regular and appropriate skin and stomal care (i.e. antimicrobial wound dressings) - Proper size of the device (length according to abdominal wall thickness and weight gain) - Topical or systemic antibiotics
Infectious diarrhoea	- Inadequate manipulation and storage of feeding formula - Host factors (i.e. immunosuppression)	- Hygienic manipulation and storage of feeding formula
NEC	- Host factors (i.e. prematurity, shock) - Vasoactive drugs	Surgery and/ or medical treatment
Jejunoileitis	- Local vascular compromise - Bacterial overgrowth	Surgery and/or medical treatment
Nasopharyngeal and ear infections with NJT	- Partial upper airway obstruction by NJT	- Substitution of NJT with GJT in case of prolonged post pyloric feeding
Gastrointestinal complications	**Possible causes**	**Prevention and Treatment**
Diarrhoea	- Too rapid infusion rate - Too cold feed temperature - Hyperosmolar feedings - Fat malabsorption - Milk-protein intolerance - Lactose intolerance - Drugs	- Reduce/ control infusion rate - Increase to room temperature - Use isotonic feeding solution, initially dilute hyperosmolar feeding solutions - Low-fat or MCT-containing diet

		- Protein hydrolysate/ elemental formula - Low-lactose or lactose-free diet - Fibre/ probiotics
Persistent GERD	Underlying disease (i.e. neurological impairment, oesophageal atresia, prematurity, etc.)	
Respiratory complications	**Possible causes**	
Aspiration pneumonia	- NJT + supine position: combination of gravitational back-flow and presence of the tube across the gastric cardia - Neurological impairment - Persistent GERD	
Metabolic complications	**Possible causes**	
Refeeding syndrome	- Chronic/ severe malnutrition - Prolonged fasting	
Overhydration	- Excessive enteral + intravenous fluid intake	
Electrolyte disturbances	- Underlying metabolic diseases (i.e. diabetes mellitus and renal/ hepatic insufficiency)	
Hyper- and hypoglycaemia	- Dumping syndrome: high-volume, highly refined carbohydrate in the small bowel - Underlying metabolic diseases (i.e. diabetes mellitus and renal/ hepatic insufficiency)	
Vitamin and trace element deficiency	- Pre-existing condition or inadequate intake with feeding formula, side effects of medication (e.g. cholestyramin)	

GERD: gastroesophageal reflux disease; GJT: gastrojejunal tube or gastrojejunostomy tube; MCT: medium chain triglycerides; NEC: necrotising enterocolitis; NJT: nasojejunal tube; PPI: proton pump inhibitor

TABLE 4. Infusion rates based on Pedrón Giner [1] and NASPGHAN [2].

Age	**Initial phase rate**	**Advance rate**	**Suggested tolerated rate**
Preterm	0.5-2 ml/kg/h	0.2-1 ml/kg every 8 hours	4-8 ml/kg/h
Infant	1-2 ml/kg/h	1-2 ml/kg every 2-8 hours	5-6 ml/kg/h
1-6 years	1 ml/kg/h	1 ml/kg every 2-8 hours	1-5 ml/kg/h
≥ 7 years	25 ml/h	25 ml every 2-8 hours	100-150 ml/h

TABLE 5. Information on the absorption site of a list of medications according to McIntyre [3].

Drugs requiring acid for absorption	Aspirin Ferrous sulphate
Drugs that bind extensively to the tube	Cyclosporine Isotretinoin
Drugs with higher absorption rate when administered in the small bowel	Azathioprine Ciprofloxacin Fluconazole Pravastatin Zinc
Drugs with decreased absorption when administered in the small bowel	Allopurinol Baclofen Calcium Ferrous sulphate Gabapentin Lopinavir Ritonavir Sirolimus
Drugs not absorbed when administrated in the jejunum	Digoxin Erythromycin Folic acid Griseofulvin Metformin Mycophenolate Phenytoin Pravastatin

TABLE 6. Site management of jejunal tubes.

Stoma site appearance	Treatment/ Management
Healthy stoma	Stoma site should be clean and dry. It should be daily cleaned when bathing the child and dried thoroughly.
Redness to site	Assess patient, consider cellulitis/ collection. Consider tube size. If there is moisture consider foam dressings and barrier cream. Swab stoma and send to microbiology. Consider topical creams for inflammation.
Discharge to site Assess and document redness	Low to moderate exudate: thin foam dressing. High exudate: apply absorbent foam antimicrobial dressings. Apply barrier cream to protect skin. Assess tube and fit. Send swab for microbiology. Consider oral antibiotic.
Leakage from stoma site	Try venting the stomach to relieve pressure. Thoroughly clean and dry stoma site. Cover with non-adhesive foam dressings. If leakage persists and irritates the skin apply barrier creams to protect the skin and continue to cover with foam dressing.
Granulation Tissue (pink, moist tissue around stoma, easily bleeding) Causes: - friction (seat belts/ clothing) - tube pulled too tightly or excessive movement of device - bacterial colonisation of site causing inflammation	Prevent by securing tube with tape. Check if fixation device is in correct position and fits well. Avoid friction to the site. Foam dressings on small granulation. Topical ointments for up to 7 days for moderate granulation. Silver Dressings or silver nitrate for persistent granulation tissue (by experienced practitioner). In rare cases surgical therapy is sought for huge overgranulation that has failed medical management.