

Special article

# Consensus on paediatric enteral nutrition access: a document approved by SENPE/SEGHNP/ANECIPN/SECP

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## Abstract

Standardization of clinical procedures has become a desirable objective in contemporary medical practice. To this effect, the Spanish Society of Parenteral and Enteral Nutrition (SENPE) has endeavoured to create clinical practice guidelines and/or documents of consensus as well as quality standards in artificial nutrition. As a result, the SENPE's Standardization Team has put together the "Document of Consensus in Enteral Access for Paediatric

## DOCUMENTO DE CONSENSO SENPE/SEGHNP/ANECIPN/SECP SOBRE VÍAS DE ACCESO EN NUTRICIÓN ENTERAL PEDIÁTRICA

## Resumen

La estandarización de procedimientos clínicos se ha convertido en un objetivo deseable en la práctica médica actual. La Sociedad Española de Nutrición Parenteral y Enteral (SENPE) está haciendo un considerable esfuerzo para desarrollar guías clínicas y/o documentos de consenso así como marcadores de calidad en nutrición artificial. Como fruto de ese esfuerzo el Grupo de Estandarización de SENPE ha elaborado un Documento de Consenso sobre Vías de Acceso en Nutrición Enteral Pediátrica, avalado también por la Sociedad Española de Gastroenterología, Hepatología y Nutrición Pediátrica (SEGHNP), la Asociación Nacional de Enfermería de Cuidados Inten-

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Nutritional Support” supported by the Spanish Society of Pediatric Gastroenterology, Hepatology and Nutrition (SEGHNP), the National Association of Pediatric and Neonatal Intensive Care Nursery (ANECIPN), and the Spanish Society of Pediatric Surgery (SECP). The present publication is a reduced version of our work; the complete document will be published as a monographic issue. It analyzes enteral access options in the pediatric patient, reviews the levels of evidence and provides the team-members’ experience. Similarly, it details general and specific indications for pediatric enteral support, current techniques, care guidelines, methods of administration and complications of each enteral access. The data published by the American Society for Parenteral and Enteral Nutrition (ASPEN) and several European Societies has also been incorporated.

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Key words: *Enteral nutrition. Children. Newborn. Enteral access. Gastrostomy.*

### Abbreviation’s list

D-PEJ: Direct Percutaneous Endoscopic Jejunostomy.  
EN: Enteral nutrition.  
EVA: Ethylen-vinyl-acetate.  
GERD: Gastroesophageal reflux disease.  
NG: Naso-gastric.  
PEG: Percutaneous Endoscopic Gastrostomy.  
PEG-J: Percutaneous Endoscopic Gastrostomy Jejunostomy.  
PVC: Polyvinyl chloride.

Artificial nutritional support must be prescribed to paediatric patients whose requirements cannot be supplied entirely through oral intake of normal foods. The preservation, be it total or partial, of gastrointestinal function is a determining factor when choosing the nutritional support access route: Whenever possible, intake should be supplemented or replaced by oral enteral nutrition (EN) or tube and if this is impossible or insufficient, by parenteral nutrition.

The particularity of paediatric patients and their course of illness will influence treatment regimen. Children are constantly growing and maturing and generally demonstrate low tolerance to fasting. Therefore, if the illness is accompanied by reduced food intake, the risk of malnutrition increases.<sup>1</sup> The main indications for EN support are represented in table I.

### Route of access to the digestive tract and specific indications

These will be chosen depending on the underlying disease, which influences the treatment and the nutritional support provided.<sup>2,4</sup>

sivos Pediátricos y Neonatales (ANECIPN) y la Sociedad Española de Cirugía Pediátrica (SECP). Esta publicación es una síntesis del documento consensuado que ha incluido el estudio en profundidad del acceso enteral pediátrico, la revisión de los niveles de evidencia y la experiencia de los componentes del Grupo. Se han considerado también los datos publicados por la American Society for Parenteral and Enteral Nutrition (ASPEN) y por diversas sociedades europeas. El texto completo se publicará como un número monográfico. En este trabajo se detallan las indicaciones generales y específicas de la nutrición enteral pediátrica, las técnicas, los cuidados generales y específicos, el modo de administración y las complicaciones de las diversas vías de acceso.

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Palabras clave: *Nutrición enteral. Niños. Neonato. Vías de acceso. Gastrostomía.*

### 1. Nasoenteral tubes

*Indications:* These represent the access route of choice for short-term NE, less than 8-12 weeks. Also for prolonged NE, in patients for whom surgical procedures or anaesthetic for enterostomy placement are unadvisable, or in those children for whom the estimated time of tube application exceeds 12 weeks but is self-limiting.

*Contraindications:* When passage of a conventional tube through the nasal cavity or through the oesophagus is impossible and in children at high risk of misplacement or perforation.

*Advantages:* Easy placement and removal, immediate use on insertion, skin integrity maintained by taking advantage of the natural orifices.

*Disadvantages:* Easy to accidentally remove, accumulation of secretions in the lumen and the outer wall; prone position may cause injuries to passageway; inability to hide the tube.

a) *Gastric tube:* Intra-gastric access should be used whenever possible. Suitable gastric emptying is required. It can be placed via the nasal (nasogastric NG) or oral (oral-gastric) cavities; the latter should be used in neonates (to reduce nasal injury) and in children with choanal atresia.

b) *Jejunal catheter:* Recommended when there is risk of bronchopulmonary aspiration, such as cases of gastric ileus and gastroesophageal reflux disease (GERD), cases of oesophageal or gastric fistula and acute pancreatitis, in order to avoid stimulation of pan-

**Table I**  
*Indications for tube feeding in children*

<p><i>Ingestion and/or swallowing disorders</i></p>	<p><i>Orofacial anomalies</i></p> <ul style="list-style-type: none"> <li>– Cleft palate, Pierre-Robin syndrome, other orofacial development abnormalities</li> <li>– Injuries and orofacial tumours</li> </ul> <p><i>Cricopharyngeal dysphagia</i></p> <p><i>Oesophageal disorders</i></p> <ul style="list-style-type: none"> <li>– Oesophageal atresia or stenosis</li> <li>– Tracheo-oesophageal fistula</li> </ul> <p><i>Immature sucking reflex</i></p> <ul style="list-style-type: none"> <li>– Prematurity (&lt; 34 weeks)</li> </ul> <p><i>Newborn who do not meet their requirements orally</i></p> <ul style="list-style-type: none"> <li>– Preterm</li> <li>– Ventilated newborn</li> </ul> <p><i>Encephalopathy with psychomotor retardation</i></p> <p><i>Neuromuscular diseases</i></p> <ul style="list-style-type: none"> <li>– Werdnig-Hoffman disease</li> <li>– Guillain-Barré syndrome</li> <li>– Duchenne disease</li> </ul> <p><i>Patients in coma with/without mechanical ventilation</i></p> <p><i>Eating disorders</i></p> <ul style="list-style-type: none"> <li>– Anorexia nervosa</li> <li>– Other changes in eating behaviour</li> </ul>
<p><i>Digestion and absorption disorders</i></p>	<p><i>Surgical short bowel syndrome</i></p> <p><i>Severe or prolonged diarrhoea due to mixed-origin mucosal dysfunction</i></p> <ul style="list-style-type: none"> <li>– Malabsorption syndrome</li> <li>– Infections</li> <li>– Post chemotherapy, post irradiation enteritis</li> <li>– Graft versus host disease</li> </ul> <p><i>Serious tract motility disorders</i></p> <ul style="list-style-type: none"> <li>– Chronic idiopathic intestinal pseudo-obstruction</li> <li>– Extensive Hirschsprung disease</li> </ul> <p><i>Severe pancreatitis (jejunal infusion)</i></p> <p><i>Severe pancreatic insufficiency</i></p> <p><i>Hepatopathy/chronic cholestasis</i></p> <p><i>Intestinal/hepatic transplantation</i></p>
<p><i>Extraintestinal diseases with high requirements that cannot be reached for orally</i></p>	<p><i>Chronic kidney disease</i></p> <p><i>Congenital heart disease</i></p> <p><i>Severe respiratory disease</i></p> <ul style="list-style-type: none"> <li>– Cystic fibrosis</li> <li>– Bronchopulmonary dysplasia</li> <li>– Malformations of the thoracic cage</li> </ul> <p><i>Critically ill patients</i></p> <p><i>Cancer disease, Bone marrow transplant (BMT)</i></p> <p><i>Severely impaired skin integrity</i></p> <ul style="list-style-type: none"> <li>– Major burns</li> <li>– Severe epidermolysis bullosa</li> <li>– Severe ichthyosis</li> </ul> <p><i>Recurrent infections with/without immunodeficiency</i></p>
<p><i>Diseases in which the EN is an essential part of treatment</i></p>	<p><i>Metabolic diseases</i> (administration of formulas specific and/or for prolonged periods of fasting)</p> <p><i>Crohn's disease</i> (when indicated)</p>
<p><i>Other indications</i></p>	<p><i>Moderate-severe primary protein-caloric malnutrition</i></p> <p><i>Preoperative EN</i> in previously malnourished patients</p>

creatic secretion. After gastrointestinal surgery, early feeding is facilitated with rapid recovery of jejunal motility in critically ill patients, contributing to intestinal barrier-function maintenance and preventing bacterial translocation.

## 2. Gastrostomy

*Indications:* In cases of long duration invasive EN (> 8-12 weeks), provided that the stomach is not affected by primary disease and there are no upper gastrointestinal fistulas. The patient should display adequate gastroduodenal emptying. Gastrostomy types are the following:

a) *Percutaneous:* The recommended technique, either endoscopically (percutaneous endoscopic gastrostomy—PEG—) or radiologically. PEG is a simple and safe technique by which nutritional support can be instituted early in patients at risk.<sup>5</sup> Fluoroscopic insertion is recommended in severe oesophageal stenosis when surgical gastrostomy is not possible. In long-term NE gastrostomy, the gastrostomy tube can be replaced by a “button” after 2 to 3 months.

b) *Surgery:* Indicated in children requiring abdominal surgery, which is common in patients who also require gastrostomy, presenting severe GERD prone to surgical correction (fundoplication).<sup>6,7</sup> It is also recommended in the following cases: severe oesophageal injury; orofacial or pharyngeal trauma; when passage of the endoscope is impossible; in patients with severe scoliosis or kyphosis; in those with ascites; in ventriculo-peritoneal patients and in cases of abdominal surgery.<sup>5</sup> Surgery can be done by Stamm or laparoscopy. The *laparoscopic* technique is recommended in high-risk patients, who also require antireflux correction. Such cases usually concern children with myopathy.<sup>8</sup>

*Contraindications:* In circumstances where surgery can lead to serious complications (blood clotting disorders, heart failure or severe respiratory disorders...). Also surgery should be postponed in patients with intra-abdominal or anterior abdominal-wall infections.

*Advantages:* Provides safe and practical access, avoiding nasopharyngeal injuries resulting from carrying nasoenteral tubing long-term.<sup>5</sup> Tubing is hidden under clothing, thus body image is not marred to the same degree as in NG. Tube calibre is higher than in the nasoenteral tubing, therefore obstruction is unusual.

*Disadvantages:* For placement, children must be anesthetized. Fluoroscopic insertion require appropriate facilities and these imaging techniques cause high irradiation.<sup>9</sup>

*Jejunostomy:* Recommended when there is severe GERD or uncontrollable gastroparesis. Surgical placement in children is exceptional. It is considered when patients require jejunal feeding for more than 6 months, but is rarely used given the high number of surgical complications.<sup>10</sup>

## Techniques of access

### 1. Nasoenteral tubing<sup>2,4</sup>

Whenever possible, the child should be informed in order to obtain maximum cooperation and reduce anxiety aroused by the procedure. In case of NG tube placement, the nose-umbilicus distance is used as external reference. When naso- jejunal placement is required, 15-20 cm must be added to this distance. It is essential to verify the correct location.

a) *Gastric insertion:* The tube is inserted, after lubrication when necessary, via the more permeable nostril, with the patient sitting or inclined at 45-90° and the neck slightly flexed. The tube is pushed gently, and if the patient can assist he/she is asked to swallow or drink while the tube moves along, in order to facilitate passage through the oesophagus.

b) *Jejunal insertion:* Placement may be performed by normal gastrointestinal peristaltic action but this is laborious and is usually only successful in some cases. It can also be achieved through certain manoeuvres, administering air and postural changes (lying laterally on the right) or by endoscopy.

### 2. Gastrostomy

Shall be performed under general anaesthesia, in all cases. Antibiotic prophylaxis may be indicated.

a) *Percutaneous.* There are two main methods:<sup>4,5,11-13</sup>

- The Gauderer and Ponsky pull-through technique: After visualization of the oesophagus, cardia and gastric chamber, the stomach is pumped, a point is chosen on the greater curvature (between the navel and the lower part of costal margin), checking in the monitor image that slight pressure applied to the skin of the abdominal wall corresponds identically to the target area marked on the stomach, the abdominal wall and stomach are punctured, then a guidewire is inserted, held by the endoscopic snare or biopsy forceps. The endoscope-guidewire is pulled out through the mouth. The end of the feeding tube is attached to the guidewire, which is pulled from the abdominal wall. The tube is pulled down through the mouth, oesophagus and stomach. An incision of 3-4 mm

is made at the exit point to facilitate egress of the tube, endoscopically checking placement of the tube head. The outer tube is cut to the desired length and the device is secured.

- The Sacks-Vine push-pull technique, used in fluoroscopic placement: A NG tube is inserted by which the stomach is insufflated. A radiopaque object is placed in the epigastrium and by fluoroscopy the intraluminal object-gas distance is measured. The stomach is punctured in the left lateral side of the rectus muscle below the costal margin, checking the intragastric incision. Following, with the Seldinger technique, a guidewire is advanced through the lumen of the trocar and necessary dilators and, finally, the tube is passed over the guidewire. Its position is checked by infusing radiocontrast and the tube is secured.
- Recently, implementation by gastropexy has been described, which allows direct endoscopic placement of a button.

b) *Surgery*:<sup>14</sup> The *Stamm* technique is recommended for children of any age, due to its simplicity, effectiveness and the ease of removing the device when it is no longer useful, with subsequent spontaneous closure of the gastric and abdominal walls. After a small supra-umbilical midline laparotomy, a segment of the greater curvature is extracted, near the fundus, the anterior stomach wall is fastened to the abdominal wall with temporary sutures in the centre of which an incision (by needle and J-wire) is made.

The gastrostomy button or tube is inserted through a small cutaneous counter-incision, and guided into the stomach where it is attached to the abdominal wall. The skin is sutured. In almost all cases, a gastrostomy button is fitted to facilitate the child's autonomy.

Other techniques include minimally invasive procedures (mini-laparotomy and laparoscopy) with cutaneous infiltration of local anaesthetic into aponeurotic-muscle planes, thus the complications arising from this surgical technique have decreased significantly.

### 3. Jejunostomy

This modality involves inserting the tube into the jejunum via a surgical technique or through a PEG (gastrojejunostomy).<sup>15</sup> In the latter case, following the placement of a PEG (20 Fr or larger), a jejunostomy tube (9-12 Fr) is passed through it, which is guided endoscopically to the jejunum. Also jejunal placement can be fluoroscopically guided.<sup>7</sup>

### 4. Removal and replacement of gastrostomy

PEG tubes can be removed by traction and by endoscopy. Replacement can be accomplished by: 1)

low-profile button with internal balloon device or mushroom-shaped tip. The former are easy to replace. The balloon must simply be deflated and removed. Replacing mushroom-shaped devices is more laborious and painful. A snare is introduced through the button so the mushroom can be caught in the stomach and pulled out; 2) balloon gastrostomy tube, which is easy to place because the balloon only needs to be inflated and the tube attached to the abdominal wall.

## Material

EN delivery requires specific equipment, consisting of an infusion system comprising a container, a supply line, a nutrition pump and nasogastric, nasoenteral, gastrostomy or jejunostomy tubes and other accessories.<sup>2,16</sup>

### 1. Formula container

It is the container in which the formula to be administered is placed, regardless of its origin. They are made of PVC (polyvinyl chloride), EVA (ethylene-vinyl-acetate) or other materials.<sup>17</sup>

a) Original container. It is a ready-to-use container holding formula. This reduces the risk of contamination, saves money, can be properly identified and allows exact volumes to be administered. Containers can be made of glass, plastic, tin or Tetra Brick.

b) Empty flexi or semi-rigid container. It is generally recommended to use manufactured packaging whenever possible. Flexible and semi-rigid containers can be reused, although it is ideal and desirable to use them once only in 24 or 36 consecutive hours.

### 2. Supply Lines

They are usually made of flexible transparent PVC and there are for administration by both gravity flow or by pump. The proximal end is attached to the container or package and the distal end to the tube.<sup>17</sup> In addition, the system has a filter, drip chamber or a flow regulator.

### 3. Nutrition pump

Is a device that automatically controls the volume of formula that passes through the tube, allowing a continuous flow or as a bolus without oscillations.<sup>17</sup> There are three types: peristaltic, volumetric and syringe<sup>17</sup> (table II).

#### 4. ENTubes

a) *Nasoenteral tubes*. When selecting, it is recommended to take into consideration: the material used for manufacture, the length, size, use of snare/guide and harness, the type of connector, characteristics of the distal end, the existence of positioning markings and lubricant used.<sup>3,4,18,19</sup> (table III).

b) *Tubes for enterostomy*:

1. *Gastrostomy tube*.<sup>20</sup> made of polyurethane for medical use or silicone. Those available are (table IV):

- Surgical gastrostomy tube.
- Percutaneous gastrostomy tube (endoscopic —PEG—, or radiological):
  - For the pull-through technique (by traction or the Gauderer-Ponsky technique).
  - For the push-through technique (by pressure or the Sacks-Vine technique).

- For the direct puncture technique and gastrostomy.
- Gastrostomy replacement kits (either PEG or surgical).
  - Balloon catheter kit.
  - Low profile or button kit.

#### 2. Jejunostomy tube

Available: Jejunostomy surgical tubes, direct percutaneous jejunostomy (D-PEJ) and gastrojejunostomy tubes or transgastric jejunostomy (PEG-J) (table V).

#### 5. Other accessories

Quick-release and safety clamps; connectors of different sizes for replacement in case of breakage, devices for measuring the depth of the stoma; extension sets to connect the button to the delivery tube; delivery tubes; cleaning brushes; seals.

**Table II**  
*Enteral feeding pumps*

Company	Brand	Pump type	Ambulatory	Flow rates Increments (ml/h)	Flow rate accuracy	Size (cm) = Height x width x depth	Battery expected life	Weight
Abbott	Flexiflo Companion®	Volumetric	Yes	5-300 ml/h 1 ml	± 10%	Pump only 10.92 x 15.24 x 4.32 With battery charger 15.24 x 17.02 x 8.38	8 h (at 150 ml/h)	675 g Battery charger: 1,125 g
	Flexiflo Companion Clear Star®	Volumetric	Yes	1-300 ml/h 1 ml	± 10% ± 0,5 ml/h	Pump only 10.92 x 15.24 x 4.32 With battery charger 15.24 x 17.02 x 8.38	24 h	Pump: 600 g Battery charger: 700 g
	Flexiflo Quantum®	Volumetric Automatic flush feature	No	1-300 ml/h 1 ml Automatic flush: 25 ml of water/1 hour	± 10% ± 0,5 ml	20.96 x 19.05 x 15.24	8 h at 125 ml/h	3,270 g
	Flexiflo Patrol®	Peristaltic	No	1-300 ml/h 1 ml	± 10% ± 0,5 ml	21.59 x 16.51 x 12.19	8 h at 125 ml/h	3,000 g
Nestlé Nutrition	Compat® Standard	Peristaltic	No	1-295 ml 1 ml	± 10%	14 x 18 x 10	8 h at 100 ml/h	2,500 g
	Compat® Go	Peristaltic	Yes	1-600 ml/h 1 ml when < 100 ml 10 ml when > 100 ml	± 10%	12.8 x 11.4 x 4.3	24 h at 125 ml/h	480 g
Grifols	Nutriflow II®	Peristaltic	No	1-300 ml/h 1 ml	± 10%	17 x 26 x 14	10 h at 150 ml/h	2,750 g
	Nubo®	Peristaltic	Yes	1-400 ml/h 1 ml	± 10%	15.5 x 10.5 x 4.5	24 h at 125 ml/h	530 g
Nutricia	Flocare® Infinity	Peristaltic	Yes	1-4,000 ml/h 1 ml	± 5%	9.5 x 14 x 3.5	24 h at 125 ml/h	392 g
Covidien	Kangaroo ePump	Peristaltic	Yes	1-300 ml/h 1 ml	± 10%	16.8 x 16.3 x 11.7	15 h at 125 ml/h	1,100 g

**Table III**  
Nasoenteric feeding tubes for pediatric EN

Brand Company	Coflo® Grifols	Flexijlo® Abbott	Compat Soft® Nestlé Nutrition	Compat Stay-pip® Nestlé Nutrition	Flocare® Nutricia	Nasoenteric tube Bengmark Flocare® Nutricia	Freka® Freka Paed® Frexenis-Kabi	Vygon®
Material	Polyurethane	Polyurethane	Polyurethane	Polyurethane	Polyurethane	Polyurethane	Polyurethane/ Silicone	PVC/ Polyurethane/ Silicone
Radiopaque	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Connector	Luer type with Y connector and universal adaptor	Y connector with universal adaptor	Y connector with universal adaptor/ Luer-Lock (L-L)	Y connector with universal adaptor	Luer type/ Universal	Luer type/ Universal	L-L type, Universal and Luer in brand Freka® Universal in brand Freka-Paed®	Luer type/ Universal
Stylet (with/without)	With/without	With/without	With/without	With	With	With	With/without	Without
Weighted tip	Without	With/without	Without	Without	Without	Without (distal spiral)	Without	Without
Distal holes	Unique lateral eye	2 or 4 lateral eyes	Several	2	3	Several	2	2 or more
Fr sizes and Length (cm)	With stylet 5 fr/56 cm 6 fr/58, 56, 91 cm 8 fr/56, 91, 109, 140 cm 10 fr/91, 109, 140 cm 12 fr/109 cm Without stylet 12 fr/109 cm	With stylet and weighted tip 8 fr/91, 114 cm 12 fr/114 cm Without stylet or weighted tip 12 fr/91 cm	With stylet and Y connector with universal adaptor 8, 10 and 12 fr/120 cm Without stylet and L-L connector 5 fr/50 cm With stylet and L-L connector 7 fr/80 cm	Yeysnal 9 fr- Gastric 18 fr/150 cm	With stylet 6 fr/90, 110 cm 8 fr/110 cm 10 fr/110, 130 cm 12 fr/110 cm 14 fr/110 cm	8 fr/145 cm 10 fr/145 cm	Polyurethane L-L connector 8 fr/60, 120 cm 12 fr/120 cm Polyurethane universal connector 6.5 fr/50 cm 8 and 12 fr/120 cm Silicone L-L connector 7.6 fr/130 cm 13 fr/120 cm	PVC, L connector 4, 5, 6 y 7 fr/40 cm 8, 9 and 10 fr/50 cm 6, 8 and 10 fr/125 cm PVC, universal connector 12 fr/50 cm 12 and 14 fr/125 cm Polyurethane, L connector 6, 8, 10 and 12 fr/125 cm Silicone, L connector 6, 8 and 9 fr/125 cm Silicone universal connector 12 fr/125 cm
Lubricant	Yes	Yes	Yes	No	No	No	No	No
Reference markings	Cm each	At 50 and 76 cm	Cm each	No	20 cm each	10 cm each	10 cm each	According to brand

Fr: French (1 Fr=0.3 mm). PVC: Polyvinyl chloride.

**Table IV**  
Gastrostomy feeding tubes for pediatric EN

Company	Brand	G/PEG/B	Material	Connector	Internal retention system	Fr sizes and length (cm)	Placement technique	Endoscopic removal	Maximum suitable time for use
Abbott	Gastrostomy Flexiflo® tube	G	SIL	Y luer type	Balloon	16 and 20 Fr/16 cm	Surgery PEG substitution	No	NE
	Kit Inverta-PEG® Push technique	PEG	SIL	Y luer type	Balloon	16 and 20 Fr/16 cm	Percutaneous (push)	No	NE
	Kit Inverta-PEG® Pull technique	PEG	SIL	Y luer type	Balloon	20 Fr/16 cm	Percutaneous (pull)	No	NE
Nutricia	Floicare	PEG	PUR	Universal	Disc	10, 14 and 18 Fr/40 cm	Percutaneous (pull)	Yes	6 months
	Floicare	G	SIL	Universal	Balloon	10, 14, 16, 18 and 20 Fr/23 cm	PEG substitution	No	3 months
	Floicare cuBBY	B	SIL	For extension system	Balloon	12, 14, 16, 18, 20 and 24 Fr/(1,4-5 cm)	PEG substitution	No	3 months
Nestlé Nutrition	Compat® Niprot PEG	PEG	SIL	Universal and luer	Disc	22 Fr	Percutaneous	No	3 months
	Compat® PEG	PEG	PUR	Universal and luer	Disc	15 Fr	Percutaneous	Yes	3 months
	Compat® Gastrotube	G	SIL	Universal and luer	Balloon	22 Fr and 15 Fr	Surgery PEG substitution	No	3 months
Grifols	Mic-PEG	PEG	SIL	Y luer type and universal	Ring	14, 20 and 24 Fr	Percutaneous (pull)	No	4-6 months
	Mic G	G	SIL	Y luer type and universal	Balloon	12, 14, 16, 18, 20, 22, 24, 26, 28 and 30 Fr	Q.R, PD+G PEG substitution	No	4-6 months
	Mic B	G	SIL	Universal	Balloon	12, 14, 16, 18, 20, 22 and 24 Fr	Q.R, PD+G PEG substitution	No	4-6 months
	Mic Key	B	SIL	For extension system	Balloon	12, 14, 16, 18, 20 and 24 Fr/(0,8-4,5 cm)	PEG substitution R, PD+G	No	4-6 months
	Ponsky PEG	PEG	SIL	Y luer type and universal	Disc	16, 20 and 28 Fr (Pull) 20 and 28 Fr (Push)	Percutaneous (pull and push)	No	6-12 months
Bard	Ponsky-Gauderer PEG	PEG	SIL	Y luer type and universal	Disc	20 Fr	Percutaneous (pull and push)	Yes	6-12 months
	Fastrac PEG	PEG	SIL	Y luer type and universal	Disc	14, 16, 20 and 24 Fr (Pull) 20 and 24 Fr (Push)	Percutaneous (pull and push)	No	6-12 months
	Bard button	B	SIL	For extension system	Dome	18, 24 and 28 Fr/(1,2-4,4 cm)	PEG substitution	No	6-12 months
	Wizard Low Profile	B	SIL	For extension system	Balloon	16, 18, 20 and 24 Fr/(1,2-4,4 cm)	PEG substitution	No	6-12 months
	Ponsky	G	SIL	Y luer type and universal	Ring	16 and 20 Fr	PEG substitution	No	6-12 months
	Bard Tri-Funnel	G	SIL	Y luer type and universal	Balloon	12, 14, 16, 18, 20 and 24 Fr	PEG substitution	No	6-12 months
	Freka PEG	PEG	PUR	Y luer type and universal	Disc	9, 15 and 20 Fr	Percutaneous	No	NE
	Freka Gastroutbe	G	SIL	Universal	Balloon	15 Fr/13 cm	PEG substitution	No	NE
Fresenius-Kabi	Freka button	B	SIL	For extension system	Balloon	15 Fr/(1,1-4,5 cm)	PEG substitution	No	NE
	Freka Pexact	B	SIL	Universal	Balloon	15 Fr	PD+G	No	NE
	Entristar®	B	PUR	For extension system	Dome	12 Fr/1,2-5,0 cm 16 Fr/1,5-3,5 cm 20 Fr/1,5-5,0 cm	PEG substitution	No	5 years
Covidien	Entristar® PEG Initial	PEG	PUR	Y luer type and universal	Dome	16 and 20 Fr	Percutaneous (pull)	No	5 years

B: Button or low profile system; Fr: French (1 Fr = 0,3 mm); G: Gastrostomy tube; PEG: Percutaneous Endoscopic Gastrostomy tube; PD+G: direct puncture + gastrostomy; PUR: medical grade polyurethane; SIL: medical grade silicone; NE: not specified by the manufacturer.



**Table V**  
*Jejunostomy feeding tubes for pediatric EN*

Company	Brand	Type	Weighted tip	Material	Connector	Internal retention system (ml)	Fr sizes and Length (cm)	Placement technique	Maximum suitable time for use
Nutricia	Bengmark Flocare	PEG-J	No	PUR	Universal	No	8 Fr/90 cm	Through Flocare 18 Fr PEG (E)	6 weeks
	Jejunokath	Q	No	PUR	Universal	No	5 Fr and 8 Fr/50 cm	Q	3 months
Nestlé Nutrition	Compat J-line 9F	PEG-J	No	PUR	Y luer type and universal	No	9 Fr/120 cm	Through Compat® 15 Fr PEG (E)	30 days
	Compat® Jejunalcath 9 FR	Q	No	PUR	Luer-lock	No	9 Fr/70 cm	Q	30 days
Grifols	MIC Jejunostomia	Q	No	SIL	Luer/ Universal	No	14 Fr	Q	4-6 months
	Mic Tj	PEG-J	Yes	SIL	Universal	Balloon 20 ml	16 Fr/ 15, 22, 30 and 45 cm 18 Fr /22, 30 and 45 cm 22 Fr/ 45 cm	E, R, PD + G	4-6 months
	Mic Tj	Q	Yes	SIL	Universal	Balloon 20 ml	16, 18 and 22 Fr/ 45 cm	Q	4-6 months
	Mic-Key Tj	PEG-J + button	Yes	SIL	Universal	Balloon 20 ml	Buttons: 1 to 3, 5 cm length 16, 18 and 22 Fr/ 15, 22, 30, 45 cm	E, R, PD + G	4-6 months
Bard	Mic Gastroenteric	PEG-J	Yes	SIL	Universal	Balloon 5, 20 ml	16, 18, 20, 22, 24, 26, 28 and 30 Fr	E, Q	4-6 months
		PEG-J	Yes	SIL	Universal	No	9 and 12 Fr/68 and 89 cm	Through 20, 24 and 28 Fr PEG	6-12 months
Fresenius-Kabi	Freka Intestinal Tube	PEG-J	No	PUR	Universal Y	No	9 and 12 Fr	Through Freka® 15 (9 Fr) PEG FR or Freka® 20 (12 Fr) PEG FR	NE
	Freka® FCJ-SET	Q	No	PUR	Luer-lock	No	9 Fr/75 cm	Q	NE

Button: low profile system. E: Endoscopic. G: Gastrostomy tube. PEG-J: gastrostomy percutaneous endoscopic jejunostomy. PD+G: direct puncture + gastrostomy. PUR: medical grade polyurethane. SIL: medical grade silicone. Q: Surgical. R: Radiological (echo or fluoroscopy). NE: not specified by the manufacturer.

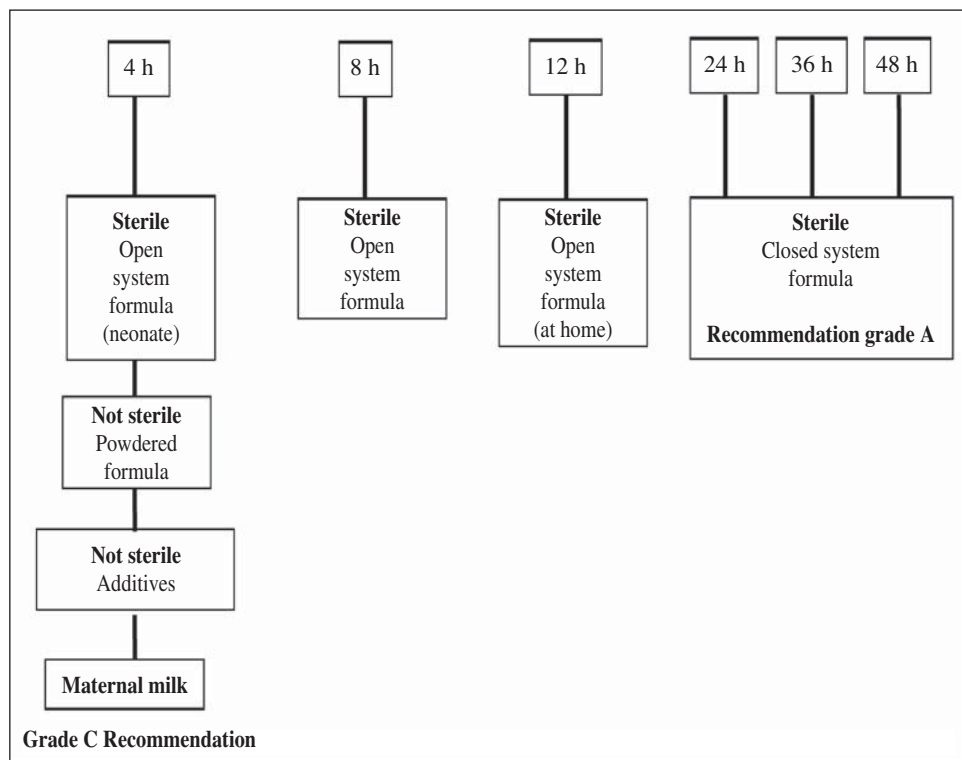


Fig. 1.—Recommended time intervals for changing the formulas for paediatric EN. (Source: Bankhead R et al<sup>1</sup>).

## Care of the enteral nutrition routes

### 1. Care common to all EN access

a) *Hand hygiene*: the most effective method for prevention and control of infection. The caregiver or the patient should wash their hands under running water, with liquid soap and dry them with disposable paper towels, when preparing the EN or when handling any part of the equipment. At the hospital it is advisable to use, in addition, disposable gloves (grade A recommendation) during administration.<sup>15</sup>

b) *Position of patient during feeding*. Patient should be sitting at an angle of 30° to 45° during feeding (grade A recommendation)<sup>15</sup> and from between at least half and hour<sup>21</sup> and one hour later, except for jejunum feeding.

c) *Oral hygiene*. Although there is no intake via the mouth, oral hygiene must be maintained by: brushing with fluoride toothpaste twice daily (evidence level 1B, grade B recommendation)<sup>22</sup> or with a gauze and a mouth-wash or mouth rinse daily a solution of 0.05% fluorine. Tooth paste should be spat out and it is preferable not to mouth-rinse with water (evidence level 1B). Consumption of food, drink or medicines rich in refined sugars should also be avoided (grade B recommendation).

d) *Administering water*. In hospital or in a nursing-home sterile water should be used for irrigation

before and after administration of EN or medications<sup>15</sup> while at home the kind of water depends on the patient and his/her home environment. If there is an increased risk of infection or gastrointestinal barrier disruption, sterile water should be used as the bactericidal effect of gastric barrier is lost (grade C recommendation).<sup>21</sup>

e) *Care of the EN formula*. It should be stored in a clean, dark place, between 15-25 °C, avoiding extreme temperatures (grade B recommendation). It is preferable to avoid handling, thus it is recommended, whenever possible, to choose ready-to-use products rather than powdered formulas to reconstitute (grade A recommendation).<sup>15</sup> In event of handling, it should be done in a clean environment, using aseptic techniques and trained staff (grade A recommendation) and reconstitute with sterile water or purified water (grade B recommendation). The recommendations regarding the time intervals for changing the formulas are shown in figure 1.

f) *Prevention of tube clogging*. The appropriate dimension must be chosen for the size of the child, taking into account the viscosity of the product to be infused and the interactions between the pharmaceutical formulations and NE.<sup>21,23</sup> The tubes should be rinsed with warm water with a 20 ml syringe, or larger, before and after food infusion, if the administration is intermittent, or when changing the bag or bottle (every 4 hours)<sup>15</sup> if it is continuous. Also before and after each

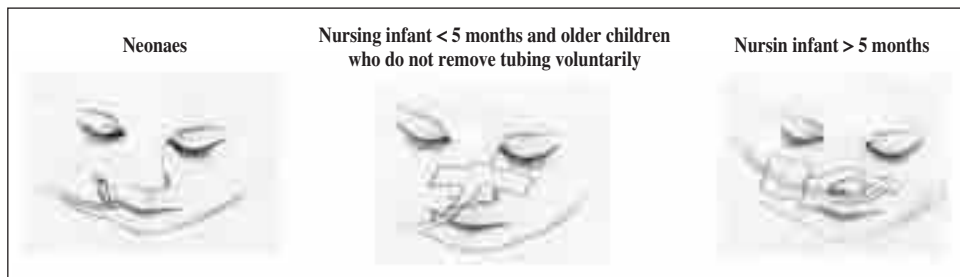


Fig. 2.—SNG attachment modes.

medication (grade C recommendation)<sup>21</sup> and, although unused, once or twice a day.

## 2. Care of NG tube

Silicone or polyurethane NG tubes are flexible and can be used for up to 4-6 weeks (grade C recommendation).<sup>21</sup> PVC tubes need to be replaced every 3-4 days. Once installed, do not insert wires or guides, or make sudden or repeated aspirates.

a) *Attaching the tube* to avoid accidental displacement/removal. You should alternate nostrils, using hypoallergenic gauze or Steri-strips®, change the area of skin where it is attached and keep the skin and nasal passages hydrated and with high levels of hygiene. The method used to secure the tube depends on the child's age and mobility (fig. 2).

b) *Monitoring tube position.* In terms of effectiveness, checking gastric pH (below 5.5) is the closest method to radiological verification,<sup>24</sup> which is the “gold standard” (the tip of the tube should be below D12). X-ray can be used if the child needs it for another reason or after tube placement or if pH monitoring is doubtful<sup>25</sup> (children receiving antacid or other medication that affects the acid pH or continuous or frequent NE) (table VI). No lung aspirate has been found with a pH below 6.

## 3. Care of gastrostomy tubes

a) *Gastrocutaneous fistula.* Accidental removal of the gastrostomy tube, within 3-4 weeks of placement, should be treated as an emergency because the gastrocutaneous fistula has not been formed and there is a high risk of peritonitis. If removal occurs after this time, the stoma may close within 1-2 hours; therefore a balloon catheter should be inserted as replacement or a Foley the same size as the old catheter, immediate referral to hospital.

The gastrostomy balloon may come out because the balloon has deflated or broken. In the event of deflation, if the family is trained to do so, the balloon can be reinserted and re-inflated. If broken, a new tube should

**Table VI**  
Circumstances in which check tube position is necessary (level of evidence IB, grade A recommendation)<sup>21,25</sup>

- After the initial placement.
- If migration is suspected, for example by a change in the length of the outer part of the tube (recommendation grade B)<sup>21</sup>.
- At least once daily if food administration is continuous or after a period of non-use.
- After an episode of coughing, vomiting or retching.
- After oropharyngeal aspiration.
- If there are signs of respiratory distress.
- If there is discomfort or food reflux in the oropharynx.
- When the patient is transferred to another hospital or another ward.

be fitted if available. Otherwise, the broken tube should be replaced, anchored with tape to prevent closure of the fistula before reaching the hospital.

Families and other caregivers must have an action plan and enough knowledge to deal with this complication during the fistula formation period. At this stage, a button or PEG should never be used at home without its position having been tested in the hospital previously.

b) *Stoma skin care.* It is essential to prevent infection, abrasions, wounds and granulomas. This is done by keeping the area clean, moisturized and without signs of maceration (avoids it getting wet). The skin of the stoma should be cleaned once a day or more often in the case of secretions (table VII).

c) *Monitor PEG position.* Perform daily on adjusting the PEG, check the graduated markings, check fastening systems are in place and that the external tube length remains constant. In case of doubt, the position will be confirmed by X-ray, ultrasound or by measuring gastric pH with a colorimetric test strip.

d) *Specific care of the gastrostomy button.* Balloon volume should be monitored if there are signs of deflation, and at least once a month under normal cir-

**Table VII**  
*Care of stoma after the complete formation of the gastrocutaneous fistula*

<i>Care up to 24 hours postinsertion</i>	<i>Care after 24 hours postinsertion</i>	<i>Care 3-4 weeks postinsertion</i>
<ul style="list-style-type: none"> <li>- Do not insert or remove the device before 8-12 hours, at which time the dressing, if used, should be removed.</li> <li>- Use aseptic technique (sterile solution and gloves) to clean the area up to seven days postinsertion.</li> <li>- Do not place another bandage unless there is large amount of exudate.</li> <li>- PEG can be used for food after 6 hours in children and 2 hours in adults (grade B recommendation)<sup>21</sup></li> </ul>	<ul style="list-style-type: none"> <li>- Keep the ostomy and the external silicone disk thoroughly clean and dry.</li> <li>- 24 hours after placement, turn the external disk 360° to prevent adhesion. Then turn daily. Do not place another bandage.</li> <li>- It is not advisable to use peri-stoma creams or powders because they can irritate skin and cause infections. Creams hinder external disk retention and can alter tube material.</li> </ul>	<ul style="list-style-type: none"> <li>- To maintain hygiene, the external fixation plate must be separated from the skin daily, then rotated 360° (grade C recommendation) and the tube moved anteroposteriorly.</li> <li>- As a general rule the disk should be kept 2 mm from the skin<sup>21</sup>.</li> <li>- Cleaning: should be performed with soap and running water. Afterwards, dry with disposable paper towels or a dryer. Is useful to inspect the skin and detect any abnormalities at that level. The patient can bathe by immersion (pool, beach or bath) or shower.</li> </ul>

cumstances because small amounts of water can evaporate. The button must be replaced biannually. Frequent breakage of the balloon or valve seals requires examination to check for the presence of yeast. Rupture may also be due to the use of inappropriate fluid (it should be filled with water). The cap should be closed after each administration of food or medication.

#### 4. Care after enterostomy tube removal

The most common complication after PEG removal is fistula persistence,<sup>26</sup> depending on the time it has been inserted. If duration was under 9-11 months, spontaneous closure is common.<sup>26,27</sup> On removing a PEG or gastrostomy button, it is sufficient to hold the orifice edges together with Steri-strips® to facilitate scar formation. If after 7-15 days it has not closed, the area can be cauterized with silver nitrate, re-align orifice edges with Steri-strips® and administer the patient antacids (antiH<sub>2</sub>).<sup>27</sup> If after 3-4 weeks of cauterization the orifice has not closed, it should be closed surgically or endoscopically, combined with cauterization and metal grips.<sup>28</sup>

### EN administration

#### 1. Infusion site

Gastric infusion is the most physiological because it enables large volumes of bolus to be administered. Post-pyloric infusion is recommended in patients with GERD and/or gastroparesis and patients at high risk of aspiration. It requires continuous infusion because the partial loss of the digestive and bactericidal processes of the stomach.

#### 2. Starting and monitoring EN

Nutrition will commence and proceed progressively depending on the child's nutritional status and gastrointestinal tolerance. To reduce the risk of aspiration during EN administration, the patient's head will be placed on a bed raised at an angle of 30-45 ° (evidence Level A).<sup>15</sup>

EN should be carefully monitored observing clinical (vomiting, reflux or aspiration, abdominal distension, abnormal volume and consistency of stool), anthropometric and analytical parameters and all aspects of correct tube positioning and possible complications. As for the control of gastric residue volume, there is no agreement on the need to monitor it; moreover, it can obstruct the tube. It seems advisable to do so in certain clinical situations: preterm newborns or critically ill patients.

In critically ill patients receiving continuous EN infusion, it should be conducted every four hours, interrupting nutrition, or changing the infusion rate if the volume is greater than or equal to infusion rate. In the intermittent regimen (bolus), it should be checked before each feed and nutrition discontinued or modified if the volume exceeds 50% of the infused volume in the previous feed<sup>15,29</sup> (evidence level C).

#### 3. Infusion regimen

This depends on several factors: the infusion site (stomach or jejunum), the type of patient (outpatient or hospitalised), feeding schedule (night or not), tolerance to food, the underlying disease (intolerance to fasting), and the presence of specific problems (vomiting, gastroparesis, dumping...).

a) *Continuous EN*: the formula is administered steadily throughout the day, either by gravity or pump.

**Table VIII**  
*Continuous and intermittent EN administration. Starting and progression*<sup>30,31</sup>

Age	Initial rate	Increase	Maximum
<i>Continuous EN</i>			
Preterm	0.5-2 ml/kg/h	0.2-1 ml/kg/h/8 h	4-8 ml/kg/h
0-1 year	1-2 ml/kg/h (10-20 ml/h)	1-2 ml/kg/h (5-10 ml/8 h)	5-6 ml/kg/h (20-55 ml/h)
2 to 6 years	2-3 ml/kg/h (20-30 ml/h)	1 ml/kg/h (10-15 ml/8 h)	4-5 ml/kg/h (70-90 ml/h)
7 to 14 years	1 ml/kg/h (30-40 ml/h)	0.5 ml/kg/h (15-20 ml/8 h)	3-4 ml/kg/h (110-130 ml/h)
> 14 years	30-60 ml/h	25-30 ml/8 h (0.4-0.5 ml/kg/h)	125-150 ml/h
<i>Intermittent EN</i>			
Preterm	1-5 ml/kg/2 h	0.5-2 ml/kg each feed or alternate feeds	120-175 ml/kg/day
0-1 year	10-15 ml/kg/feed (60-80 ml/4 h)	10-30 ml/feed (20-40 ml/4 h)	20-30 ml/kg/feed (80-240 ml/4 h)
2 to 6 years	5-10 ml/kg/feed (80-120 ml/4 h)	30-45 ml/feed (40-60 ml/4 h)	15-20 ml/kg/feed (280-375 ml/4-5 h)
7 to 14 years	3-5 ml/kg/feed (120-160/4 h)	60-90 ml/feed (60-80 ml/4 h)	10-20 ml/kg/feed (430-520 ml/4-5 h)
> 14 years	200 ml/4 h (3 ml/kg/feed)	100 ml/feed	500 ml/4- 5 h

It has the advantages of generating little gastric residue and allowing for more efficient energy balance than intermittent EN.<sup>10</sup> It is recommended<sup>2</sup> for post-pyloric nutrition, in patients with malabsorption or at risk of aspiration, when they do not tolerate intermittent feeding and in situations of high energy expenditure. Table VIII gives example infusion rates.

b) *Cyclical EN*: continuous infusion for periods of less than 24 hours (8-12 hours), usually overnight. Allows oral feeding *ad libitum* during the day.

c) *Intermittent EN*: volumes of formula are administered at regular intervals. This is the most physiological type of nutrition, allowing for greater patient mobility and stimulating oral feeding as it gives rise to periods of hunger and satiety. It is recommended for well-tolerated gastric feeding in non-critical patients, without risk of aspiration, and home nutrition whenever possible. Table VIII outlines a guide for starting and monitoring of intermittent EN.

d) *Trophic EN*: refers to the continuous infusion of small amounts of enteral product (0.5 to 25 ml/kg/day) in order to maintain the intestinal barrier and the mucosal integrity.<sup>30</sup>

#### 4. Infusion method

Infusion can be performed via: a) *infusion pump* which has the advantage of administering a constant volume, improving tolerance and reducing health-worker or family workload; b) *syringe*, which is used for intermittent feeding of bolus; and c) *gravity*, free fall from a syringe or drip systems. Its use is simple, but requires frequent monitoring to ensure that the desired amount passes through.

#### 5. Transition from EN

This represents a change in administration method, be it the place, infusion regimen or the type of formula, with the aim of optimizing feeding and lowering risks to the child. It should be done slowly and gradually, allowing the patient to adapt.

In general, the use of diluted formulas at the beginning of the EN is not necessary, and may even be counter-productive by increasing the risk of intolerance to microbial contamination of the formula<sup>15</sup> due to secondary diarrhoea, and undernourishment due to the administration of low-calorie diets.

The change from EN to oral feeding can be difficult, especially in children who have been intubated for a long time. It takes time and often patients respond to behavioural therapies. Oral intake should be maintained during the EN in all children who are able to swallow.

#### 6. Combined EN

Under certain circumstances it is necessary to combine EN, in one or more of its forms, and parenteral nutrition, which requires rigorous monitoring.<sup>31</sup>

### Complications of enteral access in children

All healthcare staff dealing with the insertion and maintenance of enteral access should be familiar with possible complications.<sup>32</sup>

#### 1. Complications of nasoenteral tubes

*Misplacement*: the tube is in a wrong position (e.g., larynx or trachea) or when in the gut it is not securely

fixed (for example, the distal end of the catheter is in the oesophagus, which can cause oesophageal perforation, pneumothorax by perforation or aspiration pneumonia).

– *Tube clogging* is a common complication for which preventive action must be carried out by rinsing and proper use of formulas and medication. When detected, run warm water through it, and if this is not effective, replaced with a new one. You can also try unblocking (provided there are no contraindications for the patient) with papain (Coca-Cola®) or pancreatic ferments.<sup>33</sup>

– *Injuries caused by prone position or friction in the tubal route*: nasal cartilage erosions, oesophagitis, erosive gastritis, less common with tubes made of soft materials.

– *Tube migration from its initial position or accidental removal* is the most common cause of interrupting scheduled enteral feeding.<sup>34</sup>

– *Breakage and nasal obstruction, otitis media, sinusitis* due to prolonged use of tubing.

– *Erroneous intravenous administration of EN*: extremely serious complications, which can be prevented by the use of devices that are impossible to connect.

## 2. Complications of gastrostomy

The same as in all other techniques, they are more common in malnourished patients or complex clinical situations.

a) *Placement related*: The most common and/or serious are:

– *Peristoma skin infection*, usually limited to the skin and subcutaneous tissue. After culture collection, treatment should be given with antiseptics and topical antibiotics preferably in solution (wash or drops).<sup>35</sup>

– *Pneumoperitoneum and paralytic ileus*, which usually get better spontaneously.

– *Separation of the peritoneum from the stomach wall* occurs when the gastrocutaneous fistula has not fully formed and gastrostomy bumpers are loosened or removed accidentally. If not detected early this leads to peritonitis.

– *Colocutaneous or gastrocolic fistula* occurs if the colon gets in between the abdominal wall and stomach when PEG is performed. Clinical signs, which start immediately or after the substitution of the initial tubes, take the form of intestinal obstruction or severe diarrhoea on infusing food directly into the colon. Treatment involves tube removal and leaving the fistula to close, sometimes requiring surgery.<sup>36</sup>

b) *Maintenance related*

– *Erosive dermatitis, loss of gastric contents, clogging or accidental removal of the gastrostomy tube* (avoidable with appropriate care).

– *Granulated tissue formation*: granuloma often treated with silver nitrate.

– *Buried bumper syndrome*: when the external bumper of the gastrostomy is too close to the abdominal wall, it pulls the inner bumper, which may become buried in the gastric wall. Abdominal pain occurs, mainly with infusion tube movement and the passing of nutrition and fluids through it. This syndrome requires immediate interruption of feeding and tube replacement.<sup>37</sup> If in doubt, gastroscopy should be performed.

c) *Related to extraction*. When the tube has been in position for a long time, which increases the stiffness of the material, and the internal bumper stays behind in the stomach, the disc may press on both cardia and in the cricopharyngeal area. The bumper should be removed with the patient relaxed and sedated.<sup>38</sup>

– *Persistence of the gastrocutaneous fistula*. After the definitive withdrawal of the gastrostomy tube, in most cases the hole closes fully within a week with external compression. In 25% of cases (usually those of longer placement duration) the fistula can remain open for more than one month and closure requires surgery.<sup>28</sup>

d) *Early replacement of the gastrostomy tube with low-profile button*. Early replacement (under 2 months) may cause gastrostomy tube migration and secondary peritonitis. Many medical teams prefer checking it endoscopically before its replacement.<sup>39</sup>

## 3. Jejunostomy complications

Jejunostomy catheters are rarely used in children and therefore there is a low incidence of complications,<sup>40</sup> which may include infection of the surgical wound, intraperitoneal infusion leakage, duodenal fluid egress with subsequent skin burn, accidental tube removal, obstruction of the tube or the small intestine and intestinal necrosis.

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