Endoscopic management of enteral tubes in adult patients – Part 2: Peri- and post-procedural management. European Society of Gastrointestinal Endoscopy (ESGE) Guideline

Authors
Paraskevas Gkolfakis[1], Marianna Arvanitakis[1], Edward J. Despott[2], Asuncion Ballarin[1], Torsten Beyna[3], Kurt Boeykens[4], Peter Elbe[5,6], Ingrid Gisbertz[7], Alice Hoyois[1], Ofelia Mosteanu[8], David S. Sanders[9], Peter T. Schmidt[10,11], Stéphane M. Schneider[12], Jeanin E. van Hooft[13]

Institutions
1 Department of Gastroenterology, Hepatopancreatology, and Digestive Oncology, CUB Hôpital Erasme, Université Libre de Bruxelles, Brussels, Belgium
2 Royal Free Unit for Endoscopy and Centre for Gastroenterology, UCL Institute for Liver and Digestive Health, The Royal Free Hospital, London, United Kingdom
3 Department of Gastroenterology and Therapeutic Endoscopy, Evangelisches Krankenhaus Düsseldorf, Germany
4 Nutrition Support Team, AZ Nikolaas Hospital, Moerlandstraat 1, 9100, Sint-Niklaas, Belgium
5 Department of Upper Digestive Diseases, Karolinska University Hospital, Stockholm, Sweden
6 Division of Surgery, Department of Clinical Science, Intervention and Technology (CLINTEC), Karolinska Institutet, Stockholm, Sweden
7 Department of Gastroenterology, Bernhoven Hospital, Uden, the Netherlands
8 Department of Gastroenterology, Iuliu Hatieganu University of Medicine and Pharmacy, Cluj-Napoca, Romania
9 Academic Unit of Gastroenterology, Royal Hallamshire Hospital & University of Sheffield, United Kingdom
10 Department of Medicine (Solna), Karolinska Institutet, Stockholm, Sweden
11 Department of Medicine, Ersta Hospital, Stockholm, Sweden
12 Université Côte d'Azur, Centre Hospitalier Universitaire de Nice, Gastroentérologie et Nutrition, Nice, France
13 Department of Gastroenterology and Hepatology, Leiden University Medical Center, Leiden, The Netherlands

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Tables 1s – 3s
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Corresponding author
Paraskevas Gkolfakis, MD, Department of Gastroenterology, Hepatopancreatology and Digestive Oncology, Erasme University Hospital, Université Libre de Bruxelles, Route de Lennik 808, 1070 Brussels, Belgium
Paraskevas.Gkolfakis@erasme.ulb.ac.be

MAIN RECOMMENDATIONS

ESGE recommends the "pull" technique as the standard method for percutaneous endoscopic gastrostomy (PEG) placement.
Strong recommendation, low quality evidence.

ESGE recommends the direct percutaneous introducer ("push") technique for PEG placement in cases where the "pull" method is contraindicated, for example in severe esophageal stenosis or in patients with head and neck cancer (HNC) or esophageal cancer.
Strong recommendation, low quality evidence.

ESGE recommends the intravenous administration of a prophylactic single dose of a beta-lactam antibiotic (or appropriate alternative antibiotic, in the case of allergy) to decrease the risk of post-procedural wound infection.
Strong recommendation, moderate quality evidence.

ESGE recommends that inadvertent insertion of a nasogastric tube (NGT) into the respiratory tract should be considered a serious but avoidable adverse event (AE).
Strong recommendation, low quality evidence.

ESGE recommends that each institution should have a dedicated protocol to confirm correct positioning of NGTs placed "blindly" at the patient's bedside; this should include: radiography, pH testing of the aspirate, and end-tidal carbon dioxide monitoring, but not auscultation alone.
Strong recommendation, low quality evidence.

ESGE recommends confirmation of correct NGT placement by radiography in high-risk patients (intensive care unit [ICU] patients or those with altered consciousness or absent gag/cough reflex).
Strong recommendation, low quality evidence.

ESGE recommends that EN may be started within 3 – 4 hours after uncomplicated placement of a PEG or PEG-J.
Strong recommendation, high quality evidence.

ESGE recommends that daily tube mobilization (pushing inward) along with a loose position of the external PEG bumper (1 – 2 cm from the abdominal wall) could mitigate the risk of development of buried bumper syndrome.
Strong recommendation, low quality evidence.

SOURCE AND SCOPE

This is Part 2 of a two-part Guideline from the European Society of Gastrointestinal Endoscopy (ESGE) on the endoscopic management of enteral tubes. This part addresses peri- and post-procedural considerations, including adverse events, as well as modalities of treatment and prevention.

ABBREVIATIONS

AE	adverse event
BBS	buried bumper syndrome
CRP	C-reactive protein
CT	computed tomography
EN	enteral nutrition
ESGE	European Society of Gastrointestinal Endoscopy
$ETCO_2$	end-tidal carbon dioxide
ESPEN	European Society for Clinical Nutrition and Metabolism
D-PEJ	direct percutaneous endoscopic jejunostomy
GRADE	Grading of Recommendations Assessment, Development, and Evaluation
HNC	head and neck cancer
ICU	intensive care unit
NGT	nasogastric tube
NJT	naso-(duodeno)-jejunal tube
OR	odds ratio
PEG	percutaneous endoscopic gastrostomy
PEG-J	percutaneous endoscopic gastrostomy with jejunal extension
PG	percutaneous gastrostomy
RCT	randomized controlled trial

1 Introduction

Enteral tube feeding is one of the cornerstones of nutritional support since it allows the provision of enteral nutrition (EN) in patients who have a functionally normal digestive tract but cannot meet their nutritional requirements because of inadequate oral intake [1]. Enteral tube insertion is a major part of the daily activity of an endoscopic unit; in the UK alone, for example, up to 17 000 percutaneous endoscopic gastrostomies (PEGs) are placed annually [2]. Nevertheless, procedure-related morbidity and even mortality, remain an important concern, especially taking into consideration that the patient population involved is already frail [3]. Furthermore, there are still numerous controversies related to enteral tube insertion.

This evidence-based Guideline was commissioned by the European Society of Gastrointestinal Endoscopy (ESGE) and aims to address all major issues concerning endoscopic management of enteral tubes. This is the second of the two parts of the Guideline, and is dedicated to peri- and post-procedural considerations including adverse events (AEs) and their management. The first part, published as a separate manuscript [4] focused on definitions, enteral access and tube modalities, and preprocedural considerations, including preprocedural assessment and indications and contraindications for enteral tube insertion.

2 Methods

ESGE commissioned this Guideline (ESGE Guidelines Committee chair, J.v.H.) and appointed a guideline leader (M.A.), who in turn, invited the listed experts to participate in the project development. The topics and key questions were prepared by the coordinating team (M.A., P.G.) and then approved by the other members. The key topics consisted of preprocedural management (including indication/s), preprocedural assessment, periprocedural technical modalities, and post-procedural management (including AEs). The guideline development process included meetings and online discussions that took place from September 2019 to July 2020.

The authors performed a systematic literature search through PubMed/MEDLINE, the Cochrane Library, and Embase for papers published on this topic up to January 2020. The search focused on fully published randomized controlled trials (RCTs) and meta-analyses. Retrospective analyses and case series were also considered for inclusion if they addressed topics not covered in prospective studies. For important outcomes, papers were individually assessed using the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system for grading of evidence levels and recommendation strengths, as described in the ESGE guideline development policy [5]. Each author developed draft proposals which were each discussed and debated electronically, and eventually through a face-to-face meeting held in January 2020 in Brussels, Belgium. After agreement among the authors on a final version, the manuscript was reviewed by two experts selected by the ESGE Governing Board and then disseminated to all ESGE-affiliated societies and individual members. After agreement on a final version, the manuscript was submitted for publication to the journal *Endoscopy*. All authors agreed on the final revised manuscript.

This Guideline is issued in 2020 and will be considered for review and update in 2024 or earlier, if new and relevant evidence becomes available. Any updates to the Guideline in the interim will be noted on the ESGE website: http://www.esge.com/esge-guidelines.html.

3 Periprocedural management: endoscopic techniques for tube insertion

3.1 Nasojejunal tube (NJT) insertion

RECOMMENDATION

ESGE suggests placing an NJT for short-term jejunal access, either through the nostril with an ultrathin transnasal gastroscope and a guidewire, or through the mouth by inserting the NJT directly into the biopsy channel of a gastroscope followed by an oronasal transfer.

Weak recommendation, very low quality evidence.

NJTs can be placed endoscopically using either of two techniques, depending on the type of tube used. One technique requires endoscopic guidance only. Dedicated narrow-bore (8- or 10-Fr) NJTs can be inserted directly through the working channel of a gastroscope or pediatric colonoscope, and positioned beyond the ligament of Treitz [6]. The endoscope is then pulled back while advancing the NJT under direct endoscopic visualization during withdrawal of the endoscope so that tube coiling is avoided. An oronasal transfer is then required to pass the NJT through the nose.

Another technique ("over the wire") involves passage of an ultrathin transnasal gastroscope through either nostril. A guidewire is then inserted down the biopsy channel of the ultrathin gastroscope and under direct endoscopic and fluoroscopic guidance; this is then passed beyond the ligament of Treitz [6]. Once the guidewire is in the desired position, the endoscope is withdrawn, while simultaneously advancing the guidewire in a "one-to-one fashion," to maintain its distal position without looping or coiling. The stomach should be kept decompressed as the scope is initially passed and also during withdrawal, in order to minimize gastric volume. Finally, the NJT is threaded over the guidewire and advanced using a Seldinger technique, while putting slight tension on the guidewire, until it reaches the jejunum. Clipping of the tip of the NJT to the mucosa has been shown to reduce displacement [7].

3.2 PEG insertion

RECOMMENDATION

ESGE recommends the "pull" technique as the standard method for PEG placement.

Strong recommendation, low quality evidence.

RECOMMENDATION

ESGE recommends the direct percutaneous introducer ("push") technique for PEG placement in cases where the "pull" method is contraindicated, for example in severe esophageal stenosis or in patients with head and neck cancer (HNC) or esophageal cancer.

Strong recommendation, low quality evidence.

RECOMMENDATION

ESGE recommends percutaneous gastropexy of the anterior gastric wall to the anterior abdominal wall with T-fasteners or a dedicated suturing device prior to "push" PEG placement, in order to prevent deflection of the stomach and tube misplacement.

Strong recommendation, low quality evidence.

3.2.1 Overview

In principle, there are two major techniques for PEG tube placement: the peroral "pull" technique and the direct percutaneous "push" procedure. The success rate of PEG tube placement is as high as 99.5 % (range 76 % – 100 %). Reasons for failure include inadequate transillumination, complete oropharyngeal or esophageal obstruction, and previous gastric resections [8].

The "pull-string" or "pull" method introduced by Gauderer et al. in 1980 has established itself as the most widely accepted technique for PEG placement in clinical practice [9]. PEG placement using the "pull" method has replaced surgical gastrostomy [10, 11] since it is safer and more cost-effective, with lower procedure-related mortality (0.5 % – 2 %) and complication rates [12, 13].

The direct percutaneous technique, namely the "introducer" or "push" PEG, using a balloon-type tube placed transabdominally into the stomach, was first described by Russell et al. [14]

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for patients in whom the standard "pull" technique either cannot be used (e. g. because of presence of an esophageal stricture) or would involve an increased risk during passage of the internal bumper (e. g. risk of implantation metastasis in malignant diseases, mainly in primary squamous cell pharyngoesophageal cancer) [15]. The main problem initially associated with this technique was deflection of the stomach wall during puncture, combined with the risk of tube misplacement. However, its safety has since been improved through the use of an intragastrically positioned T-fastener to fix the stomach to the abdominal wall, under fluoroscopic or endoscopic guidance [16, 17]. A new, safe-introducer method has also become available recently. This allows the combination of a double gastropexy with a peel-away trocar-sheath introducer, to effectively secure the stomach wall to the anterior abdominal wall [18, 19].

Different types of enteral tubes are placed according to the type of insertion technique: enteral tubes with an internal bumper are used for the "pull" technique, whereas balloon-type tubes are used for the "push" technique.

3.2.2 General preparation [20]

- Patient fasting overnight (6 hours for solids and 2 hours for clear liquids, longer if there is impaired gastric motility)
- Antibiotic prophylaxis (single intravenous dose of a beta-lactam antibiotic, or suitable alternative in case of allergy, according to local policy; see Recommendation, section 3.4)
- PEG insertion is performed using a strict sterile/aseptic technique (skin disinfection, sterile surgical drapes, sterile gloves, sterile dressing, etc.)

3.2.3 Description of the "pull" technique [10, 21]

Two operators are required to insert a PEG tube: the endoscopist and the second operator who performs abdominal wall puncture and thread/wire traction. An upper gastrointestinal (GI) endoscopy is performed with the patient in the supine position. During endoscopy, the stomach is fully insufflated (ideally with carbon dioxide [CO_2]) in order to appose the stomach to the abdominal wall and displace any interposed viscera.

The desired puncture site (on the anterior gastric wall in the region of the distal corpus) is then identified by means of transillumination and finger indentation (by the second operator). The second operator then marks the skin over the chosen site, and after adequate skin cleansing and infiltration with local anesthetic, a green (21-G) seeker needle, attached to a 10-mL syringe (half-filled with 0.9 % saline) is inserted vertically through the skin and abdominal wall into the insufflated stomach. It is important for the second operator to maintain negative pressure on the syringe plunger as the needle is advanced, and to observe for any gas bubbles, which may be aspirated into the syringe (needle aspiration technique). Gas bubbles within the syringe that are seen earlier than when the needle is seen to puncture the gastric wall (on the endoscopic view) may indicate that an interposed viscus may have been punctured inadvertently and this should raise concern to seek an alternative site of puncture.

Once the seeker needle is safely in place, the second operator makes an appropriate incision over this puncture site, and the introducer trocar (and its overlying cannula/sheath) is then inserted under direct endoscopic visualization with constant endoscopic gaseous insufflation of the stomach. The dedicated thread/wire (found within the PEG kit) is then passed through the cannula/sheath and into the stomach by the second operator, where it is grasped by the endoscopist using a small endoscopic snare or grasping forceps. Once grasped securely, the thread/wire is then drawn out through the mouth together with the gastroscope by the endoscopist. The thread/wire loop is then secured tightly with a simple loop to the corresponding thread/wire loop provided at the external end of the PEG tube.

The second operator then applies continuous traction to the thread/wire through the abdominal wall puncture site, and the thread/wire-attached PEG tube is drawn down the esophagus and stomach and out through the puncture site until the internal fixation bumper apposes the anterior wall of the stomach. Provided that positioning of the PEG tube has been conducted without complications, the position of the internal bumper may be confirmed endoscopically, although this step is optional and not strictly necessary [22].

3.2.4 Description of the "introducer" or "push" technique (PEG with gastropexy) [18, 19]

Again, two operators are required for the "push" or "introducer" technique: the endoscopist and second operator. The procedure is done under strict aseptic/surgical conditions and local anesthesia. Percutaneous puncture of the stomach is performed through a previously determined area of the anterior gastric wall, by means of a dedicated double-lumen or T-fastener gastropexy device under direct endoscopic visualization.

The same steps as the "pull" technique described above are used to identify a safe and adequate puncture site with a seeker needle and attached syringe. With ongoing gaseous insufflation of the stomach by the endoscopist, after adequate skin cleansing and local anesthetic infiltration, the second operator places two or three gastropexies (in a triangular fashion) at a distance of 20 mm from one another. With maintenance of full gastric insufflation by the endoscopist, the second operator, securely fastens the gastropexies and makes a skin incision within the area between the gastropexies. The second operator then uses the dedicated trocar and overlying peel-away sheath for puncture of the abdominal wall and anterior gastric wall through the skin incision. This is done gently and under direct endoscopic visualization and with careful orientation of the trocar into the gastric lumen, in order to avoid inadvertent laceration/puncture of the posterior gastric wall. The metal trocar, is then removed, leaving the dedicated peel-away sheath in situ within the puncture tract.

A balloon-type PEG tube is then introduced through the sheath and once the tube balloon has been filled with sterile water under endoscopic visualization, the sheath is peeled away, leaving the tube and fastening external bumper in situ.

3.3 Percutaneous endoscopic gastrostomy with jejunal extension (PEG-J) and direct percutaneous endoscopic jejunostomy (D-PEJ) insertion

RECOMMENDATION

ESGE recommends placement of a jejunal feeding tube either through a PEG-J or D-PEJ in patients needing long-term EN and through a jejunal route. The choice between PEG-J and D-PEJ would depend on patient characteristics (anatomy, need for gastric aspiration, pre-existing PEG), as well as local expertise.

Strong recommendation, low quality evidence.

Long-term jejunal feeding can be achieved endoscopically through jejunal tube extensions passed through a PEG (PEG-J) or through direct percutaneous endoscopic jejunostomy (D-PEJ) [23, 24].

PEG-J placement beyond the ligament of Treitz can be carried out by pushing a jejunal extension feeding tube through a previously placed PEG using a "beneath the scope" [27] or "over the wire" tube technique, under fluoroscopic guidance [24, 28 – 31]. Extension jejunal tubes are limited to 9 Fr – 12 Fr in diameter, depending on the size of the previously placed PEG tube; they are approximately 60 cm in length. The extension tube may be grasped endoscopically with a forceps or a snare and dragged into the jejunum ("beneath the scope") or advanced over an endoscopically placed guidewire or stiffening catheter ("over the wire").

PEG-J tubes have an initial high success rate of up to 93 % [8, 20, 23, 24]. However, functional success is limited because of frequent retrograde migration of the jejunal extension tube into the stomach [32] and tube dysfunction caused by kinking or obstruction (as the jejunal tube maximum diameter is restricted to 12 Fr) [23, 24]. Endoscopically placed clips may secure the distal end of the tube to reduce the risk of retrograde migration [33]. Additionally, the initial PEG site should be near the antrum, to create a better angle of insertion and reduce the distance between the abdominal wall and the pylorus [6]. Finally, a nonrandomized, comparative study in patients with native gastric anatomy (56 patients with D-PEJ and 49 with a PEG-J) concluded that feeding tube patency lasted longer and fewer endoscopic re-interventions were required for patients with D-PEJ as compared with PEG-J [34].

D-PEJ placement is a modification of the "pull" PEG technique and is usually indicated for long-term jejunal EN [24, 35 – 38]. For endoscopic visualization a push enteroscopy is performed with a standard or, preferably, a pediatric colonoscope, or with a dedicated push enteroscope. Some reports have shown a higher success rate using single-balloon [39] or double-balloon enteroscopy [40].

Once jejunal transillumination and finger indentation are observed on the anterior abdominal wall (indicating the identification of a favorable superficial jejunal loop), this is used as an indicator of the scope's position within the jejunum. In an identical fashion to that described for the "pull" PEG insertion technique, described above, after adequate cleansing of the skin and using a strict aseptic technique, a green (21-G) seeker needle is used for infiltration of local anesthetic by the second operator. The seeker needle is then used to determine an optimal position prior to the trocar/needle pass. Grasping the tip of the seeker needle with a snare or a forceps helps to stabilize the jejunal segment and allows proper orientation for insertion of the larger trocar/needle alongside the indwelling seeker needle [41]. As described for the "pull" PEG insertion technique, a dedicated thread/wire is advanced through the plastic sheath by the second operator (after the trocar has been withdrawn). This thread/wire is then grasped by the awaiting endoscopist using a forceps or small snare, and the procedure is completed as described for the "pull"-type PEG placement. Though similar to PEG placement, D-PEJ is a considerably more challenging technique. In the two largest retrospective cohorts on D-PEJ outcome involving a total of 738 patients, successful placement was achieved in 68 % – 83 % [35, 38]; this may be higher if a double-balloon or single-balloon enteroscope is used [39].

The choice between a PEG-J and D-PEJ depends on local expertise, patient anatomy, pre-existing abdominal surgery, the presence of a pre-existing PEG, the need for concomitant gastric aspiration (favors the PEG-J), and the risk of retrograde migration of the jejunal extension (favors D-PEJ) [6].

3.4 Use of prophylactic antibiotic administration before insertion of a percutaneous tube (PEG/PEG-J/D-PEJ)

RECOMMENDATION

ESGE recommends the intravenous administration of a prophylactic single dose of a beta-lactam antibiotic (or appropriate alternative antibiotic, in the case of allergy) to decrease the risk of post-procedural wound infection.

Strong recommendation, moderate quality evidence.

A number of RCTs have highlighted the valuable role of pre-procedural antibiotic administration for reduction of peristomal infections [19, 42 – 54]. In the largest of these studies, which compared single-dose intravenous cefuroxime (750 mg) (n = 50) with placebo (n = 51) given 30 minutes before PEG placement, peristomal wound infection was significantly reduced during the first week in patients who had received the antibiotic as compared with the placebo group [48]. Pooled data from one meta-analysis including 10 RCTs (1059 patients), showed that prophylactic penicillin- or cephalosporin-based treatment decreases the risk of post-procedural wound infection [55]. The highest relative risk reduction was achieved with administration of penicillin rather than cephalosporin (13 % vs. 10 %, respectively) [55].

In the most recent Cochrane database systematic review of 12 studies (n = 1271 patients) comparing intravenous antibiotic administration prior to PEG insertion with placebo, no intervention, or simple skin antiseptic, a significant benefit for antibiotic

administration was detected (odds ratio [OR] 0.36, 95 %CI 0.26 – 0.50) [56]. The optimal timing of antibiotic administration has not been determined, but based on the methodology of these studies, intravenous administration 30 minutes before the procedure appears to be reasonable [57] (**Tables 1(a)s**, **1(b)s**, available online-only in **Supplementary material**). Nevertheless, in another RCT, a single 20-mL dose of an oral solution of co-trimoxazole deposited via the PEG catheter immediately after insertion has been shown to be at least as effective as preprocedural intravenous cefuroxime prophylaxis [43, 58]. This regimen can be proposed in patients with penicillin-related allergy. Finally, in patients who are already receiving antibiotics, no specific antibiotic prophylaxis is required [20].

Further to prophylactic antibiotic administration, the adherence to a full sterile, aseptic technique and avoidance of excessive pressure between the skin and the external bumper have also been shown to decrease the risk of wound infection [59].

3.5 Periprocedural adverse events (AEs)

RECOMMENDATION

ESGE recommends that periprocedural AEs related to endoscopic placement of any enteral tube should be considered to also carry the intrinsic risks relating to the sedation/general anesthesia used.

Strong recommendation, low quality evidence.

RECOMMENDATION

ESGE recommends that inadvertent insertion of an NGT into the respiratory tract should be considered a serious but avoidable AE.

Strong recommendation, low quality evidence.

RECOMMENDATION

ESGE recommends that visceral perforation, peritonitis, and bleeding should be considered as potential periprocedural AEs of PEG, PEG-J, or D-PEJ tube placement.

Strong recommendation, low quality evidence.

Periprocedural AEs are rare and rates should be of the order of < 0.5 % [20, 60], if strict contraindications are adhered to [20, 61, 62].

Sedation/general anesthesia. As with all other endoscopic procedures performed under sedation or general anesthesia, endoscopic placement of enteral tubes carries cardiovascular and pulmonary risks, which directly relate to the sedation/anesthetic itself [63]. These include risks of hemodynamic instability, dysrhythmias and aspiration pneumonitis. The rate of aspiration AEs occurring periprocedurally has been reported to be around 1 %, and risk factors for this include the supine position, type and dose of sedation used, neurologic impairment, and advanced age [20, 60].

NGT insertion is mostly performed "blindly" at the patient's bedside. AEs related to NGT insertion include epistaxis, coiling of the tube within the esophagus, and most importantly, inadvertent placement into the respiratory tract [64, 65]; this occurs infrequently but may potentially have fatal consequences. A retrospective study reported a 1.3 % incidence (n = 50) of misplacement in over 2000 NGT insertions in adults over a period of 4 years; mechanical ventilation and altered mental status appear to be risk factors [66].

NJTs are placed in the endoscopy suite, with or without fluoroscopy. The main periprocedural complications concerning NJTs relate to incorrect placement, tube kinking, and periprocedural dislodgment [7]. NJTs with a spiral end to facilitate bedside placement in patients with intact gastric motility are also available [67].

PEG, PEG-J, and D-PEJ tubes. Periprocedural AEs that are not related to sedation are rare (0.1 %), albeit potentially serious, and include: perforation of interposed viscera (including the colon, small bowel, liver, and spleen), peritonitis, and bleeding [20, 60, 62].

Although perforation of an interposed viscus is rare, transient subclinical pneumoperitoneum is a common finding following PEG insertion, occurring in up to 56 % of procedures and generally not of any clinical significance [68]. Conversely, full-blown peritonitis presents as abdominal pain, leucocytosis, ileus, and fever. It can result in significant morbidity if not identified and treated early [20].

Risk factors for bleeding include anticoagulation and previous anatomic alteration [20]. Immediate gastric bleeding after PEG placement is very rare (0.3 %) and is usually caused by injury of the left gastric or gastroepiploic arteries or one of their branches [69]. Severe intraperitoneal bleeding can also occur because of liver laceration and this presents as severe postprocedural hypotension with or without peritonitis [70]. PEG-J placement poses the additional risk of retrograde migration of the jejunal extension back into the stomach, and this may lengthen the duration of the procedure [60]. Finally, D-PEJs have a slightly higher rate of periprocedural AEs, reaching 2 %; these include bleeding and small-bowel perforation [35, 38].

3.6 Prevention and management of periprocedural AEs related to enteral tube placement

RECOMMENDATION

ESGE recommends careful preprocedural selection, preassessment, and optimization of any underlying patient comorbidities in order to reduce any sedation/general anesthetic risks. Should any sedation/general anesthetic periprocedural AEs arise, these should be managed using specific measures that address the event, with a low threshold to abandon or postpone the procedure.

Strong recommendation, low quality evidence.

RECOMMENDATION
ESGE recommends careful attention to safe procedure technique during PEG, PEG-J, or D-PEJ placement, in order to reduce the risk of inadvertent injury to any interposed viscera. In the case of any ongoing concern relating to incorrect placement/perforation, the patient's condition should be stabilized and there should be a low threshold to proceed to urgent, computed tomography (CT) scanning.
Strong recommendation, low quality evidence.

RECOMMENDATION
ESGE recommends close monitoring after PEG, PEG-J or D-PEJ tube placement, with due attention to unexplained tachycardia and hypotension. Should these occur, the patient should be resuscitated and transferred for urgent CT mesenteric angiography to rule out any intra-abdominal bleeding.
Strong recommendation, low quality evidence.

RECOMMENDATION
ESGE recommends that each institution have a dedicated protocol to confirm correct positioning of NGTs placed "blindly" at the patient's bedside, including radiography, pH testing of the aspirate, and end-tidal carbon dioxide monitoring, but not auscultation alone.
Strong recommendation, low quality evidence.

RECOMMENDATION
ESGE recommends confirmation of correct NGT placement by radiography in high-risk patients (intensive care unit [ICU] patients or those with altered consciousness or absent gag reflex).
Strong recommendation, low quality evidence.

Sedation- or general anesthesia-related AEs. In order to reduce any sedation- or general anesthesia-related risk, careful patient selection should be undertaken. This should include preassessment of the patient and optimization of their overall condition and underlying comorbidities, which may pose additional risks [63, 71]. The use of multidisciplinary nutrition support teams has been shown to be helpful with patient selection and choice of type of enteral access, and to help reduce overall AEs [72]. Moreover, the endoscopist can further minimize the risk by avoiding excessive sedation, aspirating the gastric contents before the procedure, suctioning previously insufflated gas after the procedure, and by performing the procedure in a time-efficient manner [20].

Should any sedation/general anesthesia-related AE occur, the procedure should be paused or abandoned, and specific measures to address the event should be undertaken. Cardiopulmonary resuscitation equipment and essential drugs (including reversal agents) should be readily available for immediate use [63].

NGT placement: periprocedural AEs In order to minimize the risk of inadvertent placement into the respiratory tract, a widely applied technique is to auscultate for sounds of airflow at the end of the tube or to place the tip into a glass of water to observe for bubbles. However, there is not always enough air movement to make this a safe strategy to adopt and other methods to confirm placement are therefore mandatory. Similarly, auscultation methods are not accurate enough to assess whether the tube is within the lung or the GI tract, with accuracy rates as low as 34.4 % [73]. The gold standard for confirming correct placement is chest radiography with visualization of the entire length of the tube according to previous guidelines, ranging from "always required" to "use when other methods fail" [64, 74 – 76].

Additional methods can be used to lower the number of radiographs needed to confirm correct positioning; these include pH sensors or end-tidal carbon dioxide ($ETCO_2$) monitoring [64]. An aspirate pH of ≤ 5.5 as well as the appearance of the fluid is also commonly used to confirm that the NGT is correctly positioned within the stomach [64, 75]. Nevertheless, in a prospective study including 97 and 106 samples taken during gastroscopy and bronchoscopy, respectively, the sensitivity for correctly identifying gastric samples at ≤ 5.5 was 68 % and the specificity was 79 % [77]. Although proton pump inhibitors do not seem to be associated with pH > 5, there was a considerable overlap between esophageal and gastric aspirates, therefore limiting the differentiation between correct gastric positioning and tube misplacement with retrograde coiling into the esophagus [78].

$ETCO_2$ monitoring using capnography or colorimetric capnometry has also been used to assess tube location [64]. A meta-analysis on 456 nasogastric tube insertions, mainly in an ICU setting with mechanically ventilated patients, revealed a sensitivity ranging from 0.88 to 1.00, and a specificity from 0.95 to 1.00 [79].

Finally, nose–earlobe–xiphoid distance is frequently used to estimate the insertion length of nasogastric tubes. Nevertheless, this method has been proven inaccurate, with underestimation of insertion length in more than 20 % of patients and overestimation of insertion length in 17.2 % of patients [80]. Underestimating the insertion length may lead to malpositioning of the tube in the distal esophagus and therefore increase the risk of reflux and pulmonary aspiration.

Marking the tube at the exit site from the nares can serve as an indicator of whether or not the tube has been partially removed, but this cannot exclude a retrograde migration of the tip into the esophagus [64].

NJT placement: periprocedural AEs. During endoscopic placement, every effort should be made to pass the tube beyond the ligament of Treitz, in order to reduce any risk of retrograde dislodgment back into the stomach. Functional patency

of the tube should also be checked after endoscopic placement by regular assessment of ease of tube-flushing; this allows immediate correct repositioning and avoidance of any persistent obstructive kinking of the tube.

PEG, PEG-J, and D-PEJ: periprocedural AEs. In order to reduce periprocedural risk in PEG, PEG-J, and D-PEJ placement, in addition to careful patient selection and review of any preprocedural cross-sectional imaging [81], certain technical periprocedural considerations described below, may also help [20, 60].

Perforation of an interposed viscus. Preventive maneuvers include: sufficient insufflation of the stomach to enhance its apposition to the abdominal wall; the achievement of good transillumination; external finger indentation (as viewed endoscopically); and the use of a green (21-G) seeker needle attached to a syringe half-filled with saline (the "safe track" technique) [20, 60, 62]. Prior to any attempt at insertion of the trocar, the seeker needle should be used, with negative pressure applied to the syringe plunger as the seeker needle is advanced through the skin. Any gas bubbles seen to appear within the syringe before endoscopic visualization of the seeker needle, may indicate interposition of another viscus (e. g. the colon or a small-bowel loop) and the targeted area of choice should be changed, or the procedure abandoned. In the case of any ongoing concern relating to incorrect placement/perforation, the patient's condition should be stabilized and there should be a low threshold to proceeding to urgent CT scanning and involvement of the surgical team [20].

Bleeding. Despite all precautions and appropriate technique, PEG, PEG-J, and D-PEJ placement all carry the risk of precipitating significant bleeding. This mainly relates to the use of the percutaneously inserted trocar/needle, which may inadvertently puncture large vessels within the abdominal wall, visceral surface/wall, or mesentery. Although cutaneous and intraluminal bleeding are immediately recognized and may be treated with external pressure or endotherapy, respectively, intraperitoneal major bleeding from other injured vessels may remain occult and strict vigilance regarding the patient's vital parameters is therefore required, for at least the first 2 hours post-procedure [3]. Particular attention should be paid to unexplained tachycardia and hypotension. Should these occur, the patient should be resuscitated and transferred for an urgent CT mesenteric angiogram to rule out any intra-abdominal hemorrhage.

3.7 Appropriate documentation of endoscopic insertion of enteral tubes

RECOMMENDATION
ESGE recommends appropriate documentation regarding endoscopically placed enteral tubes.
Strong recommendation, low quality evidence.

The procedure report should include the following elements, where applicable: indication for the procedure; type and dose of sedation/general anesthesia use; type of insertion technique; the number of attempts/trocar passes; type/gauge/brand of tube used; and serial number/batch of tube used (with the corresponding traceability sticker placed in the patient notes). There should also be documentation of antibiotic cover; type and dose of local anesthetic infiltrated into the skin or abdominal wall; and clear documentation of the internal bumper-to-skin distance, for reference.

4 Post-procedural management

4.1 Using the percutaneous enteral tube (PEG, PEG-J, D-PEJ) for the first time after endoscopic placement

RECOMMENDATION
ESGE recommends that EN may be started within 3 to 4 hours after uncomplicated placement of an PEG or PEG-J.
Strong recommendation, high quality evidence.

RECOMMENDATION
ESGE suggests that EN may be started within 24 hours after uncomplicated placement of a D-PEJ.
Weak recommendation, low quality evidence.

Two meta-analyses, including RCTs with 355 and 467 patients, respectively, showed no differences in terms of morbidity (local infections, diarrhea, bleeding, fever, gastroesophageal reflux, vomiting, stomatitis, leakage) or early mortality (<72 hours) when feeding was started within 3 to 4 hours from PEG placement as compared with delayed commencement of EN (>24 hours) [82, 83] (**Table 2s**). One meta-analysis revealed a statistically significant increase in gastric residual volume in the case of early feeding (OR 1.80, 95 %CI 1.02 – 3.19; P = 0.04), but without any clinical consequences [82]. Moreover, a prospective comparative study suggested that early feeding after PEG tube insertion could also help reduce inpatient stay [84]. Finally, in the two largest series of D-PEJ, the initiation of enteral feeding was reported to be within 4 to 24 hours after placement [35, 38].

4.2 Post-procedural AEs, mortality, and associated risk factors relating to percutaneous enteral tube (PEG/PEG-J/D-PEJ) insertion

RECOMMENDATION
ESGE recommends cautious preprocedural patient selection since patient characteristics are related to early and long-term PEG-associated mortality.
Strong recommendation, low quality evidence.

RECOMMENDATION
ESGE recommends considering patient age, the presence of stroke as an indication, and preprocedural nutritional and inflammatory status as risk factors for early and long-term PEG-related mortality.
Strong recommendation, low quality evidence.

Although PEG placement is considered a safe procedure if all recommended precautions are applied, post-procedural AEs may still occur. The AE incidence rate ranges from 4.8 % to 26.2 % [85 – 87], while early (30-day) and 1-year mortality are reported to be of the order of 1.8 % – 23.5 % [58, 85, 87 – 90] and 35 % – 55 % [85, 86, 90, 91], respectively. AEs are usually minor with major ones being reported in up to 2 % of cases [58].

In a retrospective study of more than 400 patients treated by either "pull" or "introducer or push" PEG, multivariate analysis revealed that underlying malignancy was a predictor of early (≤ 7 days) complications, while age ≥ 70 years and diabetes mellitus predicted late (> 7 days) post-procedural AEs [87]. In the same analysis thrombocytopenia (< 100 000/µL) and a high C-reactive protein (CRP) level (≥ 5 mg/dL) were associated with increased 30-day mortality rate, while patients suffering from other neurological diseases (apart from stroke) had lower 30-day mortality risk as compared with patients suffering from stroke or underlying malignancy [87]. Among the 20 patients who died within 30 days following PEG placement, pneumonia was the most frequently identified cause of death [87].

In a large retrospective study (n = 1625) low serum albumin (< 31.5 g/L) and increased CRP (> 21.5 mg/L) levels were associated with an increased 30-day mortality, with patients carrying both factors having an even shorter median survival [92]; similar results were also identified in a prospective, large cohort study [88]. Higher CRP levels were found to be the only independent risk factor for 30-day mortality in another study from Portugal (n = 157); the definitive cutoff value was a CRP level of ≥ 35.9 mg/dL [93].

As mentioned above, stroke patients appear to have worse survival and this was confirmed in another retrospective study of 500 patients [90]. In this cohort of patients with neurological disease, the median survival was shorter in patients who were suffering from stroke (11.4 vs. 27.1 months, $P = 0.014$). Moreover, in the subgroup of stroke patients, multivariate analysis identified preprocedural neutrophil percentage and late AE as negative independent prognostic factors, while prophylactic antibiotic usage and hyperlipidemia were found to be inversely correlated to mortality [90]. Similarly, in another cohort (n = 100), patients undergoing PEG placement because of underlying neurologic disease had a significantly higher 6-month mortality as compared with patients treated for underlying malignancy (60 % vs. 27.7 %, $P = 0.002$) [86].

In a recent study from Israel (n = 272) multivariate analysis identified older age, higher creatinine levels and elevated CRP-to-albumin ratio as significant predictors of short-term mortality after PEG placement [89]. Finally, in two further recent large studies, from Italy and Sweden (n = 950 and n = 495, respectively), age and lower body mass index (BMI) were identified as risk factors for mortality [58, 85] (**Table 3s**).

4.3 Post-procedural AEs related to enteral tube insertion

RECOMMENDATION
ESGE recommends considering wound infection, buried bumper syndrome, peristomal leakage, tube dislodgment, and fistula formation as the main post-procedural complications related to PEG/PEG-J/D-PEJ.
Strong recommendation, low quality evidence.

Several post-procedural PEG AEs have been described in detail elsewhere [4, 60, 62]. They include infection-related AEs, namely wound infection and necrotizing fasciitis; complications related to dysfunction of the enteral access tract, namely buried bumper syndrome (BBS); peristomal leakage; PEG site herniation; tube dislodgment; gastric outlet obstruction; and fistula formation.

4.3.1 Wound infection

RECOMMENDATION
ESGE recommends local antiseptic measures and daily dressing changes for minor (nonextending) wound infections and broad-spectrum antibiotics for more severe infections.
Strong recommendation, low quality evidence.

Infectious complications are considered to be the most common PEG-associated AEs [94, 95]. In the era of prophylactic antibiotic use, the incidence of infection has decreased significantly [58, 85], albeit this remains high, especially in developing countries [96]. Infections are usually mild and limited to the peristomal PEG site, but less frequently, more serious infectious complications including abscess formation and necrotizing fasciitis may occur [3]. In the case of local wound infection, the clinical examination reveals a painful PEG site with erythema, induration and potential purulent exudate with or without signs of systemic inflammation. Mild peristomal erythema is commonly found and should not be considered as an infection.

For mild wound infection, treatment consists of local antiseptic measures and regular dressing changes. Broad-spectrum antibiotics should be administered, either orally if the diagnosis is made early after PEG placement (within 3 – 5 days) or intravenously in cases of later diagnosis or in those with a more severe presentation (e. g. systemic sepsis); antibiotic therapy should be guided by sample culture and sensitivity results. Surgical intervention is reserved for severe complications, including abscesses, peritonitis, or necrotizing fasciitis; the last-mentioned is a rare but potentially fatal AE after PEG insertion,

that requires both antibiotic coverage and appropriate surgical debridement of the infected area [97, 98].

4.3.2 Buried bumper syndrome (BBS)

RECOMMENDATION

ESGE recommends that daily tube mobilization (pushing inward) along with a loose position of the external PEG bumper (1 – 2 cm from the abdominal wall) could mitigate the risk of buried bumper syndrome (BBS) development.
Strong recommendation, low quality evidence.

BBS refers to the migration of the internal PEG bumper along the PEG tract, ending up within the gastric or abdominal wall with consequent overgrowth of gastric mucosa over the bumper [99]. It occurs in 1 % – 4 % of cases [85, 100]. BBS is caused by excessive traction between the internal PEG bumper and the abdominal wall that results in local pressure necrosis and subsequent migration [101]. This traction is the result of excessive, usually long-term, PEG tightening post-placement; other associated, potentially contributory factors include obesity, weight gain, and chronic cough [102].

BBS is diagnosed clinically by visualization and palpation of the subcutaneously located bumper, and by endoscopic or CT demonstration of the migrated internal bumper. Pain at the PEG site, loss of tube patency, and leakage around the PEG site are other common findings in patients with BBS. BBS may lead to other complications such as bleeding, peritonitis, and abscess formation [100, 103].

In cases of incomplete BBS, where part of the internal bumper is still visible and the tube remains patent, the buried bumper can be effectively pushed back into the stomach by using a dilator [104] or the push – pull T technique [105, 106]. In cases of complete BBS, endoscopically guided application of electrosurgical incisions using a sphincterotome, a needle-knife, or recently developed dedicated devices can be used [104, 107 – 109]. For complicated extragastric cases [110] or when endoscopy fails to release the trapped bumper, surgery remains an option. If indicated, a new PEG should be placed a couple of weeks later, at a different site, in order to allow adequate healing of the previous tract. However, cases of simultaneous insertion of a new balloon-type tube have also been described [111, 112].

Initial (3 – 5 days after insertion) tighter fixing of the abdominal wall bolster and the internal bumper, aimed to prevent leakage, should be followed by a looser position of the external skin bumper with a 1 – 2 cm distance from the abdominal wall, in order to mitigate the risk of BBS [103]. Appropriate daily care, tube mobilization (pushing inward), and placement of a gauze pad under the external bolster could also reduce the risk of BBS development [59]. Rotation of the tube should be avoided in cases of PEG-J and D-PEJ in order to avoid jejunal extension dislodgment and jejunal volvulus, respectively [35, 36].

4.3.3 PEG site herniation

PEG site herniation is a rare complication associated with PEG placement [113 – 118]. It presents with ongoing leakage, bulging, or pain at the PEG site, either while the tube remains in situ or when it is removed. Choosing the optimal site for PEG placement and, if possible, avoiding the weakest points of the abdominal wall (e. g. the linea alba/midline) may reduce the risk of herniation. Appropriate surgical management of the hernia may be required.

4.3.4 Peristomal leakage

RECOMMENDATION

ESGE suggests that an effort to treat any underlying predisposing disease should be made in the case of peristomal leakage. Local treatment with absorbing agents, stoma adhesive powder, and zinc oxide may reduce local skin irritation.
Weak recommendation, low quality of evidence.

RECOMMENDATION

ESGE suggests, that in the case of persistent leakage, the PEG tube should be removed and a new PEG should be placed at a different site.
Weak recommendation, low quality of evidence.

Peristomal leakage of gastric content may occur in up to 2 % of cases following PEG placement [119]. Usually this appears early after PEG insertion but delayed leakage may also occur [94]. Different risk factors have been identified. Among them, local factors include skin infection, excessive cleaning with abrasive products, increased gastric acid secretion, gastroparesis, side torsion of the tube, BBS, increased tension between internal and external bumpers, and presence of granulomatous tissue within the tract. Systemic conditions such as diabetes mellitus, immunodeficiency, or severe malnutrition, which prevent adequate wound healing [95, 120], are also associated with peristomal leakage.

Optimal management of peristomal leakage includes treatment of any underlying predisposing disease and local treatment with absorbing agents. Antisecretory medication and prokinetics can also be used to reduce gastric acidity and stasis. The use of stoma adhesive powders or zinc oxide application has been proposed to reduce local skin irritation [20], while topical application of silver nitrate or argon plasma can be used in the case of a coexisting granuloma [62]. For persisting delayed peristomal leakage EN should be interrupted, and the tube should either be removed temporarily (24 to 48 hours) to permit partial closure, using a guidewire to secure tract patency, or there should be complete removal of the tube and replacement at another site of the abdominal wall, once the previous tract has healed completely [59, 120]. In the case of delayed gastric emptying despite prokinetics, a PEG-J or D-PEJ may be

considered. For balloon-type tubes with peristomal leakage, it should always be verified that the balloon is adequately inflated.

4.3.5 Tube dislodgment

RECOMMENDATION
ESGE recommends that in the case of early (<4 weeks) tube dislodgment, "blind" tube reinsertion should be avoided. The patient should be monitored clinically and broad-spectrum antibiotics should be administered in symptomatic patients. A new PEG should be placed once the initial tract has healed.
Strong recommendation, low quality evidence.

RECOMMENDATION
ESGE recommends that in the case of late (>4 weeks) tube dislodgment, a bedside balloon-type replacement tube, if available, can be immediately placed through the established tract. Otherwise, a Foley catheter can be used to maintain the tract as a temporary bridge to PEG tube replacement.
Strong recommendation, low quality evidence.

Tube dislodgment is considered to be a frequent PEG-associated AE. The incidence ranges from 13% to 29% [85, 121, 122]; apart from the association with major complications, tube dislodgment also results in significant healthcare costs [123].

In the vast majority of cases, tube dislodgment occurs towards the exterior of the abdominal wall, either by inappropriate manipulation of the tube or by accidental pulling, especially in patients with altered mental status or cognitive impairment.

Management of outer tube dislodgment depends on the time that it occurs, since the PEG tract is expected to mature within 4 weeks from placement [1]. Therefore, if dislodgment occurs after 4 weeks from initial placement, one can consider that the tract is mature and if a replacement balloon-type tube is available on site, this can be inserted through the pre-existing tract at the patient's bedside, without recourse to endoscopic visualization. If a replacement is not available and since the mature tract will start closing within the first 24 hours from tube dislodgment, the insertion of a temporary Foley catheter, in an attempt to keep the mature tract patent has been proposed [124, 125]. However, the use of Foley catheters has been associated with high complication rates [125] and the evidence to recommend their use is considered to be of low quality [126]. In the case that replacement tube position is uncertain, direct endoscopic verification or use of a water-soluble contrast facilitated "tubogram" should be used to confirm the position.

In the case of tube dislodgment within the first 4 weeks of its insertion, there is a risk of gastric content leakage and consequent peritonitis, since the stomach may separate from the abdominal wall. In that case, "blind" tube replacement should be avoided, since it could lead to tube malposition in the peritoneal cavity. The patient should be kept nil-by-mouth, and broad-spectrum antibiotics should be administered. An attempt to place a new PEG tube at a different site of the abdominal wall may be performed, once the initial tract has healed [124].

Infrequently, a patient may present with abdominal pain and vomiting, as the result of gastric outflow obstruction from a distally dislodged PEG tube, causing post-pyloric blockage by the internal bumper or balloon. Clinical suspicion of internal migration, usually raised by the inappropriate position of the external bumper, can be confirmed endoscopically or radiologically. This event can easily be reversed by simply pulling the PEG tube back (after deflating the balloon in the case of a balloon-type tube) and fixing its external bumper in the correct position [127].

Various methods have been proposed to prevent tube dislodgment; these include sophisticated tube designs such as low profile "button-type" tubes [128, 129]. In a recent RCT, balloon-tube dislodgment was significantly less frequent in a group of patients who underwent weekly measurement of the water volume within the balloon followed by tube replacement at 3-monthly intervals [130]. Cost concerns and tube-type selection would however hinder the general applicability of this strategy.

4.3.6 Gastrocolocutaneous fistula

This is a rare AE that occurs when the colon is accidentally punctured during PEG or D-PEJ placement. Its occurrence creates a fistulous tract through the gastric wall, colon, abdominal wall and finally the skin [131]. Its clinical appearance varies from asymptomatic to fecal leakage around the PEG site, frank perforation, or colonic obstruction. More often it usually becomes symptomatic once the initially placed tube is removed or replaced by another tube, the distal end of which is wrongly positioned within the transverse colon. In this case the patient presents with diarrhea once the enteral feeding is re-initiated [132]. Contrast-mediated radiographic imaging facilitates accurate diagnosis. The treatment of choice consists of PEG tube removal to allow the fistulous tract to heal. If this is unsuccessful, an endoscopic approach, using over-the-scope clips or full-thickness transmural sutures, or surgery (especially for persistent or complicated cases) have also been used [133 – 136].

4.3.7 Gastrocutaneous fistula, after PEG removal

RECOMMENDATION
ESGE recommends endoscopic modalities as the first-line management in the case of persisting gastrocutaneous fistula after PEG removal.
Strong recommendation, low quality evidence.

Healing of the gastrocutaneous tract usually starts within 24 hours of PEG removal and is often complete within a few days. In a limited number of cases it takes weeks for the tract to heal. However, in some cases the tract fails to heal and a gastrocutaneous fistula persists. Studies in children showed that a gastrocutaneous fistula developed in 1 out of 4 patients; longer PEG

duration was associated with a higher likelihood of fistula formation [137, 138].

The presence of a fistulous tract is easily recognized by presence of persistent or periodic leakage of gastric fluid from the previous PEG site on the skin of the abdominal wall. Currently, different endoscopic modalities, mainly consisting of the use of through-the-scope or over-the-scope clips, as well as application of argon plasma coagulation and endoscopy-assisted suturing, offer promising results and have obviated the need for surgical intervention in most cases [133, 139 – 145].

4.4 Post-placement instructions to carers for enteral tube maintenance

RECOMMENDATION

ESGE suggests daily care of the PEG/PEG-J/D-PEJ site using a sterile saline solution and dressing application for the first week after placement. Loosening of the internal bumper after 3 to 5 days is suggested, and mobilization of the tube should begin from 7 to 10 days after placement.

Weak recommendation, low quality evidence.

After the percutaneous tube placement, the skin and the position of the tube should be checked every day. The external fixator should be placed tightly, 0.5 cm above the skin, to prevent leakage during the first 3 to 5 days [146]. During the first week, the peristomal skin must be kept clean with a sterile saline solution, which is then dried. Before handling, manual hygiene and the use of gloves is important to prevent infection. A dressing may be applied to absorb any potential exudate, but it is not considered mandatory [147]. In that regard, a sterile "Y"-shaped dressing should be placed under the external site and the disc plate to reduce the tension applied. Any dressings must be changed regularly. Occlusive dressing use is not recommended, because of an increased risk of skin maceration. Glycerin hydrogel wound dressing can be used as an alternative, since it has been associated with significantly reduced rate of peristomal infections during the first 2 weeks post-PEG placement [148]; if used, this should be changed once per week.

At 3 to 5 days after insertion, the external bumper can be loosened by up to 1 cm. Only after 7 to 10 days should the tube be gently moved from 2 to 5 cm inward and outward in order to prevent future adhesion and BBS [146]. After this maneuver, the tube should be returned to and fixed in its initial position; the distance between the exit point of the tube and the abdominal wall should be marked with a permanent marker [146]. As already discussed in the cases of D-PEJ and PEG-J, any rotation of such tubes should be avoided [149], since this could lead to jejunal volvulus (D-PEJ) or displacement of the jejunal extension (PEG-J) [35, 36]. This is generalized to all percutaneous tubes in order to standardize the protocol of care independently of the type of enteral access used. After a gastropexy ("introducer" or "push" technique), the tube should be mobilized once the gastropexy tags have been removed (generally after 2 to 4 weeks).

After 7 to 10 days, the peristomal skin should be cleaned with soap and fresh tap water and then dried, twice a week. Patients are allowed to bathe, shower, and swim with a waterproof dressing thereafter [1].

4.5 Administration of medications through an enteral tube

RECOMMENDATION

ESGE suggests that the use of medication in liquid form is preferred; if crushed solid forms are administered through enteral tubes, these should be optimally flushed through, in order to avoid tube occlusion.

Weak recommendation, low quality evidence.

Medication administration through an enteral tube requires careful evaluation. Not all drugs are safe for enteral administration. Drug – nutrient or drug – drug interactions can impact efficacy and increase toxicity [75]. Tube size and placement site should be considered before the introduction of a medication. Narrow-bore tubes (< 12-Fr; 1 Fr = 0.33 mm)] are more comfortable but increase the risk of clogging [75]. An incorrect administration method could also lead to tube obstruction. The placement site of the tube may also affect drug absorption; the majority of drugs are absorbed within the small intestine but some are absorbed within the stomach. For medications with a high first-pass hepatic metabolism, jejunal access could increase their absorption and consequently, their systemic effects [150]. The administration process should also take into account the timing of drug delivery with respect to flushing protocols, administration of other medications, and the enteral nutrition regimen [75]. In this regard, an integrated training program for nurses delivered by a clinical pharmacist has been shown to significantly improve drug administration via enteral feeding tubes [151].

Drug dose adjustment may be required and liquid formulations are preferred, in order to prevent tube occlusion. Diluted liquid medication can help reduce osmolality shifts and enhance drug delivery rates. If specific liquid medication is unavailable or inappropriate, a solid formulation may have to be used. Tablets may be crushed to a powder for suspension and hard gelatin capsules may be opened and mixed with purified water. Distinct syringes (the recognized standard, ISO 80369-3 for enteral tubes ["ENFit"]) should be used when administering drugs through an enteral tube, in order to avoid accidental parenteral injection. Appropriate irrigation of the enteral tube is mandatory before any drug administration. The tube should be flushed with 30 mL of water [1]. The flush is repeated between medications and after the last administration. Enteral nutrition should be stopped 30 minutes before drug administration and may be restarted 30 to 60 minutes after [146]. In the case of a drug–nutrient interaction, enteral nutrition should be discontinued for 2 hours before drug administration.

4.6 Enteral tube replacement

RECOMMENDATION
ESGE recommends PEG tube replacement in the case of tube fracture, dislodgment, degradation, persisting peristomal wound infection/leakage, or skin ulceration.
Strong recommendation, low quality evidence.

RECOMMENDATION
ESGE recommends against routine replacement of PEG tubes with internal bumpers.
Strong recommendation, low quality evidence.

RECOMMENDATION
ESGE recommends replacement of balloon-type PEG tubes at 3- to 6-month intervals, or according to brand instructions, to prevent balloon failure.
Strong recommendation, low quality evidence.

There is no optimal evidence-based guideline regarding the replacement of non-balloon and balloon-type PEG tubes; however, there are several recommendations which can be divided into those concerning scheduled or unscheduled replacements. Indications for unscheduled replacement are catheter breakage, occlusions that cannot be resolved conservatively, dislodgment, or dysfunction. In addition, persisting peristomal infection/leakage after appropriate antibiotic treatment, fungal colonization with material deterioration, and non-healing skin ulceration despite optimal wound care, may also be indications to remove and/or replace the tube [1, 75, 152].

Scheduled replacements are dependent on the internal fixation type of the enteral tube. PEG tubes with internal bumpers are long-lasting; up to 70 % can stay in place for more than 2 years [20, 153] and do not require scheduled replacement. Conversely, for balloon-type tubes, it is recommended to develop local protocols that reflect manufacturer guidelines, as balloon failure can occur and lead to tube dislodgment. Most balloon-type tubes have to be replaced regularly at 3- to 6-month intervals [20, 130].

The balloon is deflated and retrieved, and a new balloon-type tube is inserted and inflated with sterile water (not saline) according to specifications (usually 5 to 10 mL) [62]. Water volume may be checked every week to prevent spontaneous balloon deflation because of water leakage [1].

Dislodged PEG tubes often demand emergency consultations in a frail patient population and should be managed appropriately as soon as possible [154].

4.7 Definitive enteral tube removal

RECOMMENDATION
ESGE recommends against removing a percutaneous enteral tube within 4 weeks of insertion.
Strong recommendation, low quality evidence.

RECOMMENDATION
ESGE suggests using the “cut and push” technique for removing enteral tubes with internal bumpers. However, in patients with previous bowel surgery, strictures, or ileus, endoscopic removal of the internal bumper is suggested.
Weak recommendation, low quality evidence.

When a percutaneous enteral tube (PEG/PEG-J/D-PEJ) is no longer required, it should be removed. However, before removal, it is advisable to ensure that the patient is able to keep a stable weight for a couple of weeks, without EN support [1]. Furthermore, it usually takes up to 4 weeks after insertion for a percutaneous tract to mature, or even longer in frail patients with significant comorbidities [1]. Therefore, a percutaneous enteral tube should not be removed within 4 weeks of insertion, in order to avoid the risk of internal leakage and peritonitis.

For a bumper-type tube, removal is performed by cutting the tube at the abdominal skin level and pushing the internal bumper into the intestinal lumen with a blunt stylet (“cut and push” technique) [155, 156]. This is particularly useful for patients with a D-PEJ, in whom endoscopic retrieval can be particularly challenging and invasive [36]. Endoscopic retrieval of the bumper is recommended in cases with previous bowel surgery and for patients at risk of strictures or ileus, which could hinder spontaneous migration and elimination of the tube remnant and bumper [1, 157, 158].

4.8 Optimal outpatient care for patients with enteral tubes

RECOMMENDATION
ESGE recommends that patients with enteral tubes are regularly monitored by a dedicated multidisciplinary team (in collaboration with home caregivers, nurses, and general practitioners), for efficacy of EN support and for potential complications.
Strong recommendation, low quality evidence.

Despite the overall positive effect of home enteral nutrition, tube-related complications are frequent and can lead to a hospital readmission rate as high as 23 % at 6 months [159]. A small prospective study of 8 patients with home enteral nutrition showed that, despite systematic monthly follow-up by a

dedicated nurse, there was an average of 5.4 unscheduled healthcare contacts over 10.5 months, mostly for tube-related complications [160]. Therefore, monitoring after discharge should include not only surveillance of efficacy regarding enteral nutrition administration (weight, nutritional parameters, muscle strength, food intake), but also of tolerance (digestive tolerance, tube-related complications) [1]. The modalities of outpatient monitoring depend upon patient-related factors (underlying disease, nutritional status on discharge, active treatment or palliative care), and structure-related factors (home care or institution) [1]. In any case, communication between the in-hospital prescribing multidisciplinary nutrition team and the home or institution caregivers, as well as adequate training of the caregivers are crucial elements to assure optimal management.

In a prospective study involving 313 patients with PEG who were followed up by a dedicated team, 371 complications were encountered. Through this collaborative approach, most of these were resolved without recourse to hospitalization, resulting in a significant reduction of PEG-related hospital readmissions to 2 % ($P<0.0001$) [159]. These encouraging results were echoed by the findings of an multicenter observational study from Poland, where collaborative care by a dedicated team was shown to reduce overall morbidity and costs relating to long-term home enteral nutrition [161].

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Competing interests

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Supplementary material

Table 1(a)s. Randomized controlled trials evaluating the efficacy of prophylactic antibiotic administration in patients undergoing PEG placement

Name (Year) [References as in main Guideline]	Study design	Country	PEG technique	Intervention group	Control group	Participants (n), overall (per group)	Any/systematic infection	Peristomal wound infection	Adverse events
Adachi (2016) [42]	RCT	Japan	Introducer "push"	1.5g ampicillin IV 30' before PEG	Placebo (saline) IV 30' before PEG	91 (46/45)	4/46 vs. 7/45; p=0.35 (at 7 days)	3/46 vs. 5/45; p=0.48	NA
Blomberg (2010) [43]	RCT	Sweden	"Pull"	20ml co-trimoxazole (800mg sulfamethoxazole - 160mg trimethoprim) in PEG catheter once in place	1.5g cefuroxime IV 60' before PEG	234 (116/118)	NA	10/100 vs. 13/100; p>0.5*	NA
Shastri (2008) [19]	RCT	Germany	Introducer "push"	2g ceftriaxone IV 30' before PEG	Placebo IV 30' before PEG	97 (49/48)	NA	1/47 vs. 1/46*, **	NA
Radhakrishnan (2006) [44]	RCT	UK	"Pull"	Groups A: 750mg cefuroxime IV just before PEG and 2 further doses at 8h intervals Group B: single	Group C: cefuroxime IV as above plus local antiseptic spray	96 (34/28/34)	NA	11/34 vs. 9/28 vs. 1/34; p=0.0013	NA

Supplementary material

				application of povidone–iodine 2.5 w/w local antiseptic spray					
Saadeddin (2005) [45]	RCT	UK	"Pull"	2.2g co-amoxiclav (or 2g cefotaxime if penicillin-allergic) IV at the time of PEG placement	placebo IV at the time of PEG placement	99 (51/48)	8/50 vs. 18/47; p=0.0238*	5/45 vs. 18/38; p=0.001*	NA
Ahmad (2003) [48]	RCT	UK	"Pull"	750mg cefuroxime IV 30' PEG	Placebo (saline) IV 30' before PEG	101 (50/51)	NA	1/33 vs. 6/33; p=0.04*	C. difficile infection: 3/50 vs. 0/51
Panigrahi (2002) [46]	RCT	UK	"Pull"	Co•amoxiclav IV 15•30' before PEG	Placebo (saline) IV 15•30' before PEG	29/29	NA	2/29 vs. 7/29; p=0.1444*	NA
Dormann (2000) [47]	RCT	Germany	"Pull"	1g ceftriaxone IV 30' before PEG	No prophylaxis	216 (106/110)	13.3% vs. 36.3%; p<0.05	11.4% vs. 224.5%; p<0.05	NA
Preclik (1999) [49]	RCT	Germany	"Pull"	2.2g co-amoxiclav IV 30' before PEG	Placebo (saline) IV 30' before PEG	97 (47/50)	8/41vs. 28/43; p<0.001*	6/41 vs. 19/43; p=0.004*	Co-amoxiclav: nausea (n=1), seizures (n=1)

Supplementary material

Gossner (1999) [50]	RCT	Germany	"Pull"	Group A: 2g cefotaxime IV 30' before PEG Group B: 2g piperacillin/0.5g tazobactam 30' before PEG and over 20'	Group C: no prophylaxis.	307 (101/100/106)	NA	9/101 vs. 11/100 vs. 28/106; p<0.01***	Placebo: vomiting (n=1), exanthema (n=1)
Akkersdijk (1995) [51]	RCT	The Netherlands	Groups A and B: "pull" Group C: introducer "push"	Group A: 1.2g co-amoxiclav 30' before PEG and and 2 further doses at 8h intervals	Group B: no prophylaxis Group C: no prophylaxis	100 (37/34/29)	NA	5/36 vs. 10/33 vs. 11/27; p=0.05	NA
Sturgis (1996) [52]	RCT	USA	NA	1g cefazolin IV 30' before PEG	Placebo (saline) IV 30' before PEG	61 (30/31)	NA	4/30 vs/ 6/31	NA
Jain (1987) [53]	RCT	USA	"Pull"	1g cefazolin 30' before PEG	Placebo (saline) IV 30' before PEG	55 (27/28)	NA	2/27 vs. 9/28; p<0.025	NA
Jonas (1985)	RCT	USA	"Pull"	1g cefoxitin IV 30' before PEG and 2 further doses at 6h	Placebo (saline) IV 30' before	33 (17/16)	NA	5/17 vs. 5/16	NA

Supplementary material

[54]				intervals	PEG				

*per protocol analysis

**grade •III according to Gossner et al

***grade • according to Jain et al

RCT: randomized controlled trial; PEG: percutaneous endoscopic gastrostomy; IV: intra-venous; NA: non applicable

Supplementary material

Table 1(b)s. Meta-analyses of RCTs evaluating systemic versus placebo, no intervention, or skin antiseptic in patients undergoing PEG placement

Author (Year) [References as in main Guideline]	Interventions evaluated	Number of studies included	Participants, overall (intervention/control)	Outcomes		
				Peristomal site infection	Adverse events related to systematic antibiotic administration	Mortality
Lipp (2013) [56]	Antimicrobial prophylaxis compared with placebo, no intervention or usual care and comparisons between different antimicrobial regimens	13	1637	12 studies 1271 (671/600) patients 63/671 (9.4%) vs. 145/600 (24.2%) OR(95%CI): 0.36 (0.2.50)	5 trials reporting no AE 6 trials reporting AE, but not associated to antibiotics administration 1 trial: 6% C. difficile infection in antibiotic group vs. 0% in control 1 trial: two AE in the antibiotic group (nausea, seizure), and AE in the control group (vomiting, allergic exanthema)	2 trials no reporting mortality 1 trial reporting no mortality 10 trials reporting mortality but not associated to antibiotics administration
Jafri (2007) [55]	Antimicrobial prophylaxis compared with placebo or no intervention	10	1059	43/565 (7.6%) vs. 126/494 (25.5%) RR(95%CI): 0.36 (0.2.50)	NA	NA

AE: Adverse events; NA: non applicable

Thieme

Supplementary material

Table 2s. Meta-analyses of randomized controlled trials evaluating early vs. delayed feeding after PEG insertion

				Outcomes assessed		
Name (Year) [References as in main Guideline]	**Interventions evaluated**	**Number of studies included**	**Participants, overall (early/delayed)**	**Complications**	**Death at 72h**	**Significant residual gastric volume at 24h**
Bechtold (2008) [82]	Early (•4h) vs. delayed/next day feeding <1h, 2 studies •3h, 3 studies •4 h, 1 study	6 (2 as abstracts)	467 (232/235)	25/182 vs. 29/185 OR (95%CI): 0.86 (0.458)	4/155 vs. 8/155 OR (95%CI): 0.56 (0.1.74)	40/205 vs. 25/205 OR (95%CI): 1.80 (1.0.19)
Szary (2011) [83]	Early (•3h) vs. delayed/next day feeding <1h, 2 studies •3h, 3 studies	5 (2 as abstracts)	355 (175/180)	18/125 vs. 23/130 OR (95%CI): 0.78 (0.3.53)	4/98 vs. 7/100 OR (95%CI): 0.60 (0.1.99)	26/148 vs. 20/150 OR (95%CI): 1.46 (0.7.84)

OR: Odds ratio; PEG: Percutaneous endoscopic gastrostomy

Thieme

Supplementary material

Table 3s. Studies evaluating complications rate, mortality rate and risk factors for mortality after PEG insertion

Author (year) [References as in main Guideline]	Country	Study design (period)	Number of patients	Indications n (%)	Adverse events, n (%)		Mortality	Risk factors for mortality OR(95%CI)*
Vujasinovic (2019) [58]	Sweden	Retrospective single center (01.08.2013 - 31.12.2015)	495	Neurologic 257 (52) Oncologic 158 (32) Trauma 36 (7) Other 44 (9)	Minor Redness, tenderness or leakage at the site of incision 186 (37.5) Mild infection 65 (13) Mild bleeding 6 (1.2%)	Major Overall 10 (2%) Infection 4 (0.8) BBS 3 (0.6) Hematemesis 3 (0.6)	8 (1.6%) died in first 7 days, PEG not direct cause of death 9% at 30 days 31% 6m 55% 2 years	Neurology group at 2 years Age (>80) at 30 days BMI <25 kg/m2 at 6 months and 2 years
Anderloni (2019) [85]	Italy	Prospective cohort, multicenter (15.09.2015 - 15.09.2016)	594	Neurologic 426 (71.8) Oncologic 106 (17.8) Other	Overall: 28 (4.8) Infection: 14 (2.4) Bleeding: 9 (1.5)		5.2% at 30 days, but all unrelated to procedure	Age 1.08 (1.0.16) INR 6.02 (1.53.5)

Supplementary material

Schneider (2014) [86]	Germany	Prospective observational, single center (11.2013.2012)	119	62 (10.4)	Tube dislodgement: 4 (0.7) BBS: 1 (0.2)	Neurologic 35 (29.4) Oncologic 68 (57.2) Other 16 (13.4)	Post-operative 21 (17.6) 17/21 tube dislodgment	Major Overall 12 (10.1) Pneumonia 6 (5) Severe pain 6 (5) Aspiration 1 (0.8)	10.1% at 30 days 38.7% at 6 months	BMI 0.86 (0.7.96) Albumin 0.38 (0.1.08) Neurology group (p=0.002)
Pih (2018) [87]	Korea	Retrospective, single center (01.2002.2015)	401			Neurologic 240 (59.8) Oncologic 70 (17.4) Other 91 (22.7)	Acute (•7days) Overall 96 (23.9) Bleeding 23 (5.7) Aspiration pneumonia	Chronic (>7 days) Overall 104 (26.2) Wound infection 18 (4.5)	5% at 30 days	Neurologic disease (other than stroke) 0.12 (0.02-.99) PLT•100.000/µL 14.3 (3.0.9) CRP • 5 md/dl

Supplementary material

								3.1 (1.0.41)
Clarke (2017) [91]	UK	Prospectively collected data, single center (01.01.2001.12.2012)	350	Neurologic 280 (80) Nutritional support 31 (8.9)	3 (0.7) Pneumoperitoneum 38 (9.5) Ileus 26 (6.5) Wound infection 2 (0.5) Mallory-Weiss tear 4 (1)	Leakage 29 (7.2) Tube obstruction 42 (10.5) Spontaneous removal 10 (2.5) BBS 2 (0.5) Aspiration Pneumonia 4 (1)	Wound infection 133 (38) Replacement due to dislodgment or blockage ~4% Granuloma 7 (2)	8% at 30 days 16% at 3 months 35% at 12	NR

Supplementary material

Lee (2013) [92]	Korea	Retrospective, multicentric (01.2002.2011)	1625	GI Dysmotility 19 (5.4) Oncologic 17 (4.8) Other 3 (0.9)	BBS 5 (1.4) (no case directly associated with PEG placement)	2.4% at 30 days 14% at the end of the follow-up	For 30-day mortality: Albumin <31.5 g/L 8.55 (3.13.45) CRP >215 mg/L 3.01 (1.2.16)
				Neurologic 908 (55.9) Oncologic 308 (18.9) Other 409 (25.2)	Overall 215 (13.2) Fever 57 (3.5) Wound infection 56 (3.4) Aspiration pneumonia 25 (1.5) Bleeding 19 (1.2) Peritonitis 13 (0.8) Pneumonia 11 (0.7)		

Supplementary material

					Peristomal leakage 8 (0.5) Others 26 (1.6)		
Barbosa (2016) [93]	Portugal	Retrospective, single center (05.2001.2013)	135	Neurologic 122 (90.4) Oncologic 13 (9.6)	NR	14% at 30 days 29% at 3 months 43% at 6 months 62% at the end of the follow-up	For 30-days: Increased CRP 1.008 (1.00.014) For 3-months: Neurologic indication 0.221 (0.05.935) Platelets 0.994 (0.99.998) CRP 1.013 (1.00.021) For 6-months: Female gender 0.382 (0.17.834) Urea 1.022 (1.00.039)

Supplementary material

Kara (2016) [90]	Turkey	Retrospective, single center (10.2008.2015	500	Neurologic 448 (89.6) Other 52 (10.4)	Early (•30 days) Overall 28.5% Aspiration pneumonia 18.0% Peristomal leakage 10.4% Fever without evident infection 6.8% Bleeding 4.8% Tube displacement 4.2% Tube blockage 2.8%	Late (>30 days) Overall 20% Tube blockage 13% Aspiration Pneumonia 10.1% Tube displacement 1.4% Fever without evident infection 1.1% Other 0.9%	11.3% at 30 days 28.3% at 3 months 46.8% at 1 year 56.3% at 2 years 63% at 3 years 67.8% at 5 years	CRP 1.009 (1.00.018) For overall mortality: Stroke as indication 2.20 (1.5.19)

Supplementary material

Sbeit (2019) [89]	Israel	Retrospective, single center (01.01.2010.12.2018)	272	Neurologic 245 (90) Oncologic 27 (10)	Other 6.4%	23.5% at 30 days	For short-term (•30 days): Age 1.1 (1.05–1.1) Creatinine 1.6 (0.96–2.6) CRP-to-albumin ratio 1.1 (1.03–1.1) For long-term (>30 days): Hemoglobin 1.18 (0.99.401)
Blomberg (2011) [88]	Sweden	Prospective single center (3.06.2000.11.2009)	484	Neurologic 209 (44) Oncologic 214 (44) Other 60 (12)	NR	12% at 30 days	For short-term (•30 days): Albumin < 30 g/L 3.46 (1.7.88)

Supplementary material

						CRP > 10 mg/L 3.47(1.6.18) Age > 65 years 2.26 (1.2.25) body mass index < 18.5 2.04 (0.9.31)

*if applicable; BBS: Buried bumper syndrome; CRP: C-reactive protein; NR: not reported, PEG: percutaneous endoscopic gastrostomy

Supplementary material

						CRP > 10 mg/L 3.47(1.6.18) Age > 65 years 2.26 (1.2.25) body mass index < 18.5 2.04 (0.9.31)

*if applicable; BBS: Buried bumper syndrome; CRP: C-reactive protein; NR: not reported, PEG: percutaneous endoscopic gastrostomy