Approach to Oral and Enteral Nutrition in Adults

Module 8.1

Indications, Contraindications, Complications and Monitoring of EN

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Learning Objectives

- To understand the main indications and contraindications for EN;
- To identify patients who might benefit from EN;
- To understand the most important complications of EN;
- To know how to prevent or counteract complications;
- To know how to monitor patients on enteral nutritional support.

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Key Messages

- EN is a safe and effective approach to nutritional therapy;
- The main indication for EN is prevention and treatment of malnutrition to improve outcome;
- The main contraindications are severe disturbances of the gastrointestinal tract and metabolic instability;
- Most complications of EN are the result of application errors;
- Certain underlying diseases are associated with increased risk of specific complications;
- Acceptance of EN can be enhanced by adequate monitoring / early recognition of complications and modification of the type of EN and its application;
- Careful monitoring of EN is especially important in intensive care, in elderly patients and in patients with neurological impairment.
1. What Exactly is EN?

Enteral nutrition generally refers to any method of artificial feeding that uses the gastrointestinal (GI) tract to deliver part or all of caloric requirements. It includes the use of oral nutritional supplements or delivery of part or all of the daily requirements by use of nasogastric/enteral or percutaneous (gastric or jejunal) tube (tube feeding) (1). Thus, enteral nutrition comprises all forms of nutritional support that imply the use of “dietary foods for special medical purposes” as defined in the European legal regulation of the commission directive 1999/21/EC of 25 March 1999 and which are further strengthened in the Regulation (UE) 609/2013 that has applied since July 2016 (2). Enteral nutrition is a safe, effective and generally well tolerated approach to nutritional therapy in patients with a normal or relatively normally functioning gastrointestinal tract.

The main goal of EN is prevention or treatment of malnutrition in order to improve outcome. This is obvious from a pathophysiological point of view, but there is also strong evidence from a number of excellent studies which show that malnutrition is an independent risk factor for poor outcome in terms of morbidity, delayed convalescence after surgery or trauma, higher readmission rates, increased length of hospital stay, higher treatment costs, and higher mortality rates (3–5).

In this context it is worth mentioning the editorial accompanying the 2006 ESPEN guidelines on Enteral Nutrition (6): “Although nutritional support is therapy in most cases it is exactly what it says – supportive rather than specific treatment of the underlying disease.”

2. Indications for EN

Irrespective of the underlying disease or clinical setting EN should be given to maintain or improve nutritional status to all patients who are expected to experience inadequate oral food intake for more than 7 days. In addition, it should be prescribed in the presence of current or imminent malnutrition.

2.1 Definition of Malnutrition and Nutritional Risk

The term malnutrition can be used both for deficiency and excess of macro- or micronutrients (1). However, in clinical practice and in the context of enteral nutrition or other nutritional interventions malnutrition is “a state resulting from lack of uptake or intake of nutrition leading to altered body composition (decreased fat free mass) and impaired clinical outcome from disease” (7).

The term nutritional risk is used to describe a state of malnutrition with impaired outcome. The consensus (expert opinion level) statement of ESPEN states that for the diagnosis of malnutrition it is mandatory first of all to fulfil criteria for being “at risk” of malnutrition by any validated risk screening tool (8). No specific tool is recommended, as long as it is validated for the setting where it is applied. The SGA (Subjective Global Assessment) was established by Detsky and coworkers (9) and relies on the patient’s history regarding weight loss, dietary intake, gastrointestinal symptoms, functional capacity, and physical signs of malnutrition (loss of subcutaneous fat or muscle mass, oedema, ascites). The NRS (Nutritional Risk Screening 2002) was established by Kondrup and coworkers (10) and considers weight loss, food intake, BMI, disease severity and age. Both scores are useful to identify patients at nutritional risk who might benefit from enteral nutrition. Once the risk of malnutrition is established, malnutrition can be diagnosed in two alternative ways:

- BMI <18.5 kg/m²
- Weight loss (unintentional) > 10% indefinite of time, or >5% over the last 3 months combined with either
  - BMI <20 kg/m² if <70 years of age, or <22 kg/m² if >70 years of age
  - Fat Free Mass Index (FFMI) <15 and 17 kg/m² in women and men, respectively

either using bioelectrical impedance analyzers or DXA machines.
The criteria for the definition of malnutrition in geriatric patients were modified due to the reduced capacity of these individuals to recover from nutritional deficits, which therefore require early intervention (11). Thresholds of FFMI are based on data obtained in a reference population (12).

2.2 Specific Indications for EN According to the ESPEN Guidelines

The 2006 ESPEN guidelines on EN have reviewed and analyzed hundreds of interventional studies to create evidence-based recommendations for the use of EN in different diseases and clinical settings (13). These guidelines have been implemented in the following years with specific recommendations for selected diseases (14-15). The following table summarizes the main indications for EN considering the evidence levels provided by the ESPEN guidelines. The grades of recommendation are:

- Grade A: Meta-analysis of randomized controlled trials or at least one randomized controlled trial
- Grade B: At least one well-designed controlled trial without randomization or at least one other type of well-designed, quasi-experimental study or well-designed non-experimental descriptive studies such as comparative studies, correlation studies, case-control studies
- Grade C: Expert opinion and/or clinical experience of respected authorities

Table 1 Specific indications for EN in selected diseases/clinical situations

<table>
<thead>
<tr>
<th>Disease/Setting</th>
<th>Indication</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensive Care</td>
<td>All patients who are not expected to be on a full oral diet within 3 days.</td>
<td>C</td>
</tr>
<tr>
<td>Surgery</td>
<td>Perioperative: Use nutritional support in patients with severe nutritional risk for 10-14 days prior to major surgery even if surgery has to be delayed. Initiate nutritional support without delay: - even in patients without obvious undernutrition, if it is anticipated that the patient will be unable to eat for more than 7 days. - in patients who cannot maintain oral intake above 60% of recommended intake for more than 10 days.</td>
<td>A</td>
</tr>
<tr>
<td>Organ transplantation</td>
<td>Before transplantation: In undernutrition, use additional ONS or even TF. Assess nutritional status regularly while monitoring patients on the waiting list. After transplantation: Initiate early normal food or EN after heart, lung, liver, pancreas and kidney transplantation. Even after transplantation of the small intestine, nutritional support can be initiated early, but should be increased very carefully.</td>
<td>C</td>
</tr>
<tr>
<td>Non-surgical oncology</td>
<td>General: If undernutrition already exists or if it is anticipated that the patient will be unable to eat for &gt; 7 days or if intake is &lt; 60 % of estimated requirement for &gt; 10 days. In patients with weight loss due to insufficient nutritional intake. Perioperative: Patients with severe nutritional risk benefit from nutritional support 10-14 days prior to major surgery even if surgery has to be delayed.</td>
<td>C</td>
</tr>
</tbody>
</table>
During radio- or radiochemotherapy: Use intensive dietary advice and oral nutritional supplements to increase dietary intake and to prevent therapy-associated weight loss and interruption of therapy. Start EN if this is not sufficient. During chemotherapy: Routine enteral nutrition is not useful.

<table>
<thead>
<tr>
<th>Disease</th>
<th>Active disease</th>
<th>Maintenance of remission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crohn’s Disease</td>
<td>Use enteral nutrition as sole therapy for the acute phase mainly when treatment with corticosteroids is not feasible. Use combined therapy (EN and drugs) in undernourished patients or in patients with inflammatory stenosis of the intestine. Maintenance of remission: Use ONS in case of persistent intestinal inflammation (steroid dependent patients).</td>
<td></td>
</tr>
<tr>
<td>Ulcerative colitis</td>
<td>EN is not recommended as treatment of active ulcerative colitis unless the patient is malnourished. Maintenance of remission: EN is not recommended.</td>
<td></td>
</tr>
<tr>
<td>Pancreas</td>
<td>Mild acute Pancreatitis: EN is unnecessary if the patient can consume normal food after 5-7 days. EN within 5-7 days has no positive impact on the course of the disease and is therefore not recommended. Tube feed if oral nutrition is not possible due to consistent pain for more than 5 days. Severe necrotising pancreatitis: EN is indicated if possible. EN should be supplemented by parenteral nutrition if needed. In severe acute pancreatitis with complications tube feeding can be performed successfully. Chronic pancreatitis: 10-15% of all patients require ONS, tube feeding is indicated in approximately 5%.</td>
<td></td>
</tr>
<tr>
<td>Liver disease</td>
<td>Use ONS or TF (even in presence of oesophageal varices) if caloric requirements cannot be met through oral intake. PEG placement is not recommended.</td>
<td></td>
</tr>
<tr>
<td>Renal disease</td>
<td>Consider EN when oral feeding is not possible; when oral intake is insufficient overnight TF might be indicated. Haemodialysis therapy (HD): Use EN when normal nutrition is not possible due to intercurrent catabolic acute conditions. Consider TF when oral intake is inadequate and in unconscious patients.</td>
<td></td>
</tr>
<tr>
<td>Infectious Disease</td>
<td>HIV: Start nutritional therapy when weight loss or loss of body cell mass has occurred (&gt;5% in 3 months) or BMI is &lt;18.5 kg/m². Diarrhea and/or malabsorption are not contraindications for EN (A positive effect on nutritional status will not be prevented: PN has similar effects, EN has a positive impact on stool frequency and consistency).</td>
<td></td>
</tr>
<tr>
<td>Chronic Heart Failure</td>
<td>EN is recommended to stop or reverse weight loss in cardiac cachexia, but not in prophylaxis of cardiac cachexia.</td>
<td></td>
</tr>
<tr>
<td>COPD</td>
<td>Evidence of beneficial effects of EN in COPD patients is limited. In combination with exercise and anabolic pharmacotherapy it might improve nutritional status and function.</td>
<td></td>
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</tbody>
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ONS - oral nutritional supplement; TF - tube feeding

It has to be mentioned that this table gives only a rough overview on selected indications for EN. More detailed recommendations on further clinical situations and the modes of application including routes for enteral feeding and choice of formulae are given in the full text of the ESPEN guidelines (published on-line via www.espen.org)

Note: Especially in geriatrics a variety of specific indications exists, because this group of patients carries the highest risk for malnutrition. This broad topic is treated in detail in the LLL-module “nutritional therapy in elderly patients”.

For postoperative patients, early enteral nutrition (<24 hours) is possible and is generally associated with beneficial effects decreasing the rate of infectious complications. Early nutrition is a component of most protocols for enhanced recovery after surgery (16). Another situation in which early start of enteral nutrition (within 12 hours of injury) is strongly recommended is major burns (14). A specifically difficult clinical situation is the nutritional support of demented and incurable patients. In dementia ESPEN guidelines recommend enteral nutrition in patients with mild or moderate disease to overcome a crisis situation with markedly insufficient oral intake if this is caused by a potentially reversible condition. EN is not recommended in severe dementia or in terminal phases of life (15). Nutritional interventions should be used in patients with advanced incurable disease if their expected benefit outweighs the potential harm. The consensus (expert opinion level) of the ESPEN “non-surgical oncology” working group is, that cancer patients with incurable disease should receive “enteral nutrition in order to minimize weight loss as long as the patient consents and the dying phase has not yet started”. In patients who are imminently dying treatment should be based on comfort. Artificial nutrition is unlikely to provide any benefit for most of these patients. In this situation most patients only require minimal amounts of food and little water to reduce thirst and hunger. This helps to avoid dehydration and states of confusion.

The situation becomes even more complex when the patient is not able to give consent or when it is uncertain whether tube feeding will be beneficial and the prognosis of the underlying condition is uncertain. The ethical and legal aspects of such situations have been extensively discussed by Druml and colleagues (17).

3. Contraindications to EN

Contraindications to EN encompass the clinical situations where there is insufficient gastrointestinal function, or severe metabolic and circulatory instability (18), and in particular:

<table>
<thead>
<tr>
<th>Gastrointestinal</th>
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<tbody>
<tr>
<td>Intestinal obstruction / ileus</td>
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<tr>
<td>Intestinal ischaemia</td>
</tr>
<tr>
<td>Severe peritonitis</td>
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<tr>
<td>Nausea / vomiting</td>
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<tr>
<td>Malassimilation</td>
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</table>

<table>
<thead>
<tr>
<th>Metabolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetic ketoacidosis</td>
</tr>
<tr>
<td>Diabetic coma</td>
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<tr>
<td>Hepatic coma</td>
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</table>

<table>
<thead>
<tr>
<th>Circulatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Severe acute cardiac insufficiency</td>
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<tr>
<td>Shock of any origin</td>
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</table>

Nausea and malassimilation are not strict contraindications, and EN might be possible when the underlying condition is adequately treated or specific formulae are applied. General contraindications for endoscopic tube placement are discussed in the LLL-module 8.3 “Techniques of EN”. According to the ESPEN guidelines PEG placement is not recommended in patients with liver cirrhosis or in those on chronic ambulatory peritoneal dialysis due to
the increased risk of peritonitis and other complications. In patients with advanced cirrhosis, however, oesophageal varices are not associated with increased risk of bleeding, and thus, nasogastric tube feeding is possible. In case of variceal bleeding it is recommended to wait 48h after endoscopic therapy before initiating enteral feeding (19).

4. Gastrointestinal Complications of EN

Enteral nutrition is a safe, effective and generally well-tolerated approach to nutritional therapy in patients with a normally functioning gastrointestinal tract. Interruption of enteral nutrition is frequently related to gastrointestinal complications. There is paucity of evidence in the literature reporting the frequency of adverse effects of enteral nutrition, suggesting that most complications are the result of application errors. Complications of EN can be divided into those of gastrointestinal, tube related and metabolic origin.

<table>
<thead>
<tr>
<th>Complications of enteral nutrition</th>
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</thead>
<tbody>
<tr>
<td><strong>Problem</strong></td>
</tr>
<tr>
<td>Compliance</td>
</tr>
<tr>
<td>Tube malposition/displacement</td>
</tr>
<tr>
<td>Nausea/vomiting</td>
</tr>
<tr>
<td>Diarrhoea</td>
</tr>
<tr>
<td>Infections</td>
</tr>
<tr>
<td>Severe metabolic complications</td>
</tr>
<tr>
<td>Aspiration</td>
</tr>
</tbody>
</table>

**Fig. 1** Complications of enteral nutrition

4.1 Diarrhoea

Diarrhoea is a fairly common gastrointestinal complication of EN. There is a wide range of prevalence data for diarrhoea in the literature which is most likely explained by the different definitions used. The prevalence of EN related diarrhoea is estimated to be 25% on general wards and up to 60% in ICU patients.

The exact mechanism is unknown, but it probably involves alteration of intestinal transit or of the intestinal microbiota. Reasons for diarrhoea include intolerance of bolus application or a high delivery rate, high osmolality, bacterial contamination or inappropriate temperature of the formula diet. There is limited evidence that low serum albumin (<25 g/L) can cause diarrhoea because of malabsorption as a consequence of intestinal wall oedema.
### Reasons for diarrhoea during enteral nutrition

- Bolus application
- High delivery rate
- High osmolality
- Bacterial contamination of the formula diet
- Formula diet is too cold
- Gastrointestinal infections
- Malabsorption

**Fig. 2** Reasons for diarrhoea during enteral nutrition

The ideal temperature of the formula is 20 to 25 °C. Furthermore, a number of medications (i.e. macrolides, proton pump inhibitors, atropine, metoclopramide etc.) or medications in suspension can cause diarrhoea. The latter often contain sorbitol, a non-absorbable sugar that causes diarrhoea when administered in high quantities. Before intolerance of EN is considered, one must also exclude gastrointestinal infections and disturbances of nutrient absorption (e.g. due to milk protein allergy, exocrine pancreatic insufficiency or lactose intolerance).

The **work-up for diarrhoea** occurring during EN should include the following issues:

- When bolus application has initially been performed switch to continuous application using an electronic pump system. Continuous application of EN is generally better tolerated than bolus application, even if the latter appears to be more physiological.
- Decrease the delivery rate (sometimes it is effective to decrease the delivery rate only for one or two days and than increase the rate to the initial level). The maximum tolerated delivery rate does usually not exceed 120 ml/h which is equivalent to the physiological flux into the duodenum.
- Avoid bacterial contamination of the formula diet: change the drip line daily; review the manufacturers’ guidelines for the use of the formula; when open systems are used, the formula diet should be delivered within 6 to 10 hours; feeds should not be made up in advance
- Review patients’ prescriptions regarding diarrhoea-inducing drugs
- Exclude gastrointestinal infections (stool culture including screening for Clostridium difficile toxin)
- If malabsorption is suspected change to low molecular diets
- If diarrhoea persists change to a fibre-free EN formula

Before the inclusion of fibre into standard feeds addition of fibre was the most widely accepted intervention for diarrhoea if no cause was found. However, there is no strong evidence in either direction with respect to diarrhoea. Fibres included in formulas are usually soluble because they are not associated with clogging of the feeding tubes. It
remains reasonable to review the fibre content in the feed being given to a patient with diarrhoea and to omit it if given and add it if not.
To date, there is contradictory evidence regarding the efficacy of probiotics in preventing diarrhoea in patients receiving enteral nutrition and therefore they should not be routinely used (20).

### 4.2 Nausea and Vomiting

Nausea occurs in 15-20% of patients, although many patients who receive enteral nutrition suffer from diseases which are themselves associated with a high risk of nausea and vomiting (e.g. cancer of the upper GI tract). Furthermore antineoplastic therapy (i.e. radio- or chemotherapy) is a strong trigger for nausea and vomiting and consequently requires antiemetic therapy before EN is initiated.

#### Reasons for impaired gastric emptying during EN

- **Pre-existing diseases:**
  - Diabetes mellitus
  - Vagotomy
  - Systemic scleroderma
  - Myopathies
- **Acute disease related:**
  - Pain and stress
  - Pancreatitis
  - Spinal cord injury
  - Extensive trauma, abdominal surgery, burn injuries
- **Medication:**
  - Opioids
  - Anticholinergics

*Fig. 3 Reasons for impaired gastric emptying during EN*

In some cancer patients nausea might be so dominant that EN becomes impossible and total parenteral nutrition must be considered.
Delayed gastric emptying is the most common cause of nausea related to tube feeding and this may be aggravated by pain, ascites, immobilisation, sedatives, antibiotics etc. In ventilated patients a high positive end expiratory pressure (PEEP) might induce vomiting (with the risk of aspiration). In some patients after initiating EN abdominal distension and nausea might occur only transiently.

**The work-up of nausea/vomiting** occurring during EN should include the following issues:
- In case of cancer / antineoplastic therapy: initiate adequate antiemetic / analgesic therapy
- Exclude bowel obstruction (auscultation, x-ray abdomen)
- Review patients’ prescriptions regarding nausea-inducing drugs
- If delayed gastric emptying is considered: reduce delivery rate, try prokinetic drugs
4.3 Constipation

Constipation is less common than diarrhoea during EN, and more prevalent in patients requiring long-term EN. Decreased fluid intake, the use of high energy dense formulae and lack of dietary fibre are possible reasons for constipation associated with EN. Furthermore, immobilisation and decreased bowel motility (as a result of sedatives or opioids) may contribute to constipation. The primary goal of constipation management is prevention.

The **work-up of constipation** occurring during EN should include the following issues:
- Review patients’ EN prescription
- Increase fluid intake, reduce density of formula or switch to fibre-containing formulae if for some reason these have not been the first line choice
- Exclude bowel obstruction (auscultation, x-ray abdomen)
- If these steps fail consider stool softener (e.g. lactulose) or bowel stimulants

5. Aspiration

Aspiration of oropharyngeal secretions or, less commonly, of gastric and small-bowel contents is the most critical complication of EN and may result in pneumonia and sepsis. Pulmonary aspiration may occur with no clear evidence of vomiting. Pulmonary aspiration is more common when patients are fed via nasogastric tubes than via PEG and is caused by a combination of factors including supine position favouring gravitational back-flow, impaired lower oesophageal sphincter relaxation induced by swallow, infrequent oesophageal contractions, and the presence of the tube across the cardia. Further risk factors are: neurological impairment, decreased level of consciousness or diminished gag reflexes postoperative or drug induced delayed gastric emptying, high GI reflux.

![Major causes of enteral tube feeding intolerance in ICU and non-ICU patients (n=754)](Wang K J Parent Ent Nutr 2016)

<table>
<thead>
<tr>
<th>Problem</th>
<th>Incidence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enteral tube feeding intolerance</td>
<td>32</td>
</tr>
<tr>
<td>Causes</td>
<td></td>
</tr>
<tr>
<td>Large gastric residual volume</td>
<td>63</td>
</tr>
<tr>
<td>Nausea/vomiting</td>
<td>36</td>
</tr>
<tr>
<td>Abdominal pain or distension</td>
<td>29</td>
</tr>
<tr>
<td>Diarrhoea</td>
<td>5</td>
</tr>
<tr>
<td>Combination of symptoms and/or signs</td>
<td>29</td>
</tr>
<tr>
<td>Large GRV and nausea/vomiting</td>
<td>12</td>
</tr>
<tr>
<td>Large GRV and nausea/vomiting</td>
<td>9</td>
</tr>
<tr>
<td>Nausea/vomiting and abdominal pain/distension</td>
<td>9</td>
</tr>
</tbody>
</table>

**Fig. 4** Problems of enteral nutrition in ICU and non ICU patients (21)

Various strategies to reduce aspiration can be adopted. They include backrest elevation and in high-risk patients post-pyloric feeding. Although recommended by some authors the use of prokinetics in the prevention of aspiration has not been proven. Routine checking of gastric residual volumes is not necessary in asymptomatic patients receiving enteral nutrition as it doesn’t impact clinical outcomes but it may hamper calorie delivery (22).
these patients, if gastric residual volumes are assessed, a volume ≤500 ml should not result in impact on the delivery of enteral nutrition. In the presence of clinical changes, such as abdominal pain, distension, nausea or vomiting measurement of gastric residual volumes is recommended (followed by possible interruption of infusion for several hours).

In order to prevent aspiration in high risk patients the following issues should be considered:
- Prefer a semi-recumbent position (30-45°)
- Prefer nasojejunal instead of nasogastric tube feeding
- In the presence of clinical changes measure gastric residual volume, adjust the delivery rate (prolong delivery period)

6. Tube Related Complications

The use of nasal tubes should be limited to short-term enteral feeding (4-6 weeks), in order to prevent necrosis or ulceration of the nasopharyngeal, oesophageal, gastric or duodenal mucosa. These complications however became very rare after introduction of the modern fine-bore tubes. These are made from polyurethane or silicon. They are filiform (7 to 8 Ch, maximum 12 Ch), soft and flexible. However, even with these modern and convenient fine-bore tubes, tolerance of nasogastric tubes is usually limited especially in the conscious patient and in geriatric patients with acute confusional states; in addition they may cause reflux esophagitis and tend to dislocate.

Primary tube malposition as result of blind insertion has been described in 0.5-16% of cases causing pulmonary/pleural formula infusion, pneumothorax or even pulmonary abscess (23). It is therefore mandatory to ensure adequate post-placement monitoring for immediate correction. Air instillation and auscultation are inaccurate methods for validating the position, especially in patients with neurological impairment, decreased level of consciousness or diminished gag reflexes. Misplacement is often not recognized either by the patients (who might not even cough) or by the staff unless a radiograph is obtained. Therefore radiological review of tube position is recommended in many countries. Validation of tube placement by demonstration of acid pH from aspiration of the luminal contents is considered sufficiently convincing in some healthcare systems, and is particularly helpful in patients in whom repeated tube replacement is required.

In patients with nasopharyngeal or facial injuries transnasal tube placement is contraindicated. In patients who are candidates for logopedic rehabilitation for potentially reversible dysphagia the presence of a nasal tube should be carefully evaluated since it significantly interferes with swallowing retraining.

When long term EN (> 4-6 weeks) is anticipated, insertion of gastrostomy tube should be considered (24). Complications of gastrostomy tube placement may be minor or major. Most complications are minor and range from skin maceration due to leakage of gastric contents around the stoma to peristomal pain with a frequency of 13-40%. This wide range reflects differences in the definitions used and in the populations studied. Complications are however more likely to occur in geriatric patients with comorbid conditions such as infectious illnesses, or in the presence of a history of aspiration.

Local wound infections are the most common complications of percutaneous gastrostomies. Most of them are minor and resolve with antibiotic treatment. Factors predisposing to infection are (1) technique-related, such as lack of antibiotic prophylaxis; (2) patient-related, e.g., malnutrition, malignancy, diabetes, obesity, immunosuppressive therapy; (3) nursing care-related, such as inappropriate wound dressing or excessive traction. While regular skin and stomal care are crucial for the prevention of infection, the infection rate can be reduced by pre-interventional use of antibiotics (30 min before PEG insertion using a 3rd generation cephalosporin or a broad spectrum penicillin). This is recommended especially in patients with impaired immune function or malignant disease.

A frequent complication of all kinds of feeding tubes is tube obstruction. This can be avoided by adequate flushing with water (40 ml or more) before and after feeding and after
delivering medications or whenever an interruption of feeding is necessary. If possible, all medications should be completely dissolved in water prior to flushing or applied as liquid formulations. When fine-bore tubes are used flushing should be performed every 4 to 6 hours even during feeding. Application of warm water, sodium bicarbonate or pancreatic enzymes is not always successful in dislodging the blockage, and, therefore, tube replacement might be necessary. Since low pH promotes protein coagulation, gastric residual aspiration should be avoided or minimized. Also flushing with saline solutions should be avoided, as salts can crystallize within the tube and promote clogging. Haemorrhagic episodes are not uncommon following PEG placement. Acute bleeding is usually a consequence of vessel injury at the skin level or from the gastric mucosa. Delayed bleeding after PEG placement can be caused by oesophagitis, gastritis, gastric or duodenal ulcer. Acute bleeding can be prevented by a careful evaluation of concomitant anticoagulant therapy. While aspirin and non-steroidal anti-inflammatory drugs can be continued in high-risk patients, clopidogrel and warfarin, together with the newer oral anticoagulants, should normally be discontinued using heparin as bridging therapy when relevant (25).

The most common complications of PEG are listed in the following Table.

### Complications of percutaneous endoscopy gastrostomy (PEG) (26)

#### MAJOR COMPLICATIONS

<table>
<thead>
<tr>
<th>Complication</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspiration</td>
<td>0.3-1%</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>0-2.5%</td>
</tr>
<tr>
<td>Peritonitis</td>
<td>0.5-1.3%</td>
</tr>
<tr>
<td>Necrotizing fascitis</td>
<td>Rare</td>
</tr>
<tr>
<td>Death</td>
<td>0-2.1%</td>
</tr>
<tr>
<td>Tumour implantation</td>
<td>Rare</td>
</tr>
</tbody>
</table>

#### MINOR COMPLICATIONS

<table>
<thead>
<tr>
<th>Complication</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube occlusion</td>
<td>25-35%</td>
</tr>
<tr>
<td>Peristomal infection</td>
<td>5.4-30%</td>
</tr>
<tr>
<td>Inadvertent removal</td>
<td>1.6-4.4%</td>
</tr>
<tr>
<td>Stomal leakage</td>
<td>1-2%</td>
</tr>
<tr>
<td>Fistulous tracks</td>
<td>0.3-6.7%</td>
</tr>
<tr>
<td>Buried bumper</td>
<td>0.3-2.4%</td>
</tr>
<tr>
<td>Gastric ulcer</td>
<td>0.3-1.2%</td>
</tr>
<tr>
<td>Ileus</td>
<td>1-2%</td>
</tr>
</tbody>
</table>

### 7. Metabolic Complications

Compared to parenteral nutrition EN is a more physiological approach to nutritional support which is reflected by a lower frequency and severity of metabolic complications. However, disturbances of the hydration status might occur, if treatment focuses only on caloric intake and fluid balance is ignored. Overhydration and dehydration are usually accompanied by hyponatraemia and hypernatraemia, respectively, and are treated by fluid restriction or additional fluid supplements. Overhydration occurs frequently, particularly when patients are receiving concomitant intravenous fluids. Concomitant comorbidity impacting on the hydration state, including renal and liver failure must be taken into account. A severe form of dehydration is called the “tube-feeding syndrome”, where a hyperosmolar formula diet causes diarrhoea and intestinal fluid losses, acidosis, and impairment of renal function. Such disturbances can be avoided when adequate monitoring of EN is performed. A further metabolic complication is the “refeeding syndrome” (RFS), which is the potentially life-threatening result of rapid and excessive food intake in severely malnourished subjects. It was first clearly described in Far East prisoners after the second world war who manifested cardiac and neurological symptoms soon after starting to eat (27).
The refeeding syndrome is characterized by hypophosphataemia, hypokalaemia, hypomagnesaemia, thiamine deficiency and fluid retention and can ultimately result in cardiac arrhythmias, congestive cardiac failure and Wernicke’s encephalopathy. Milder forms of the refeeding syndrome are probably not so uncommon and may be identified by biochemical alterations (hypophosphataemia) in the absence of clinical symptoms.

### Refeeding Syndrome - Findings

- Hypophosphataemia
- Hypokalaemia
- Hypomagnesaemia
- Thiamine (and other vitamin) deficiency
- Fluid retention

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**Fig. 5** The refeeding syndrome

**Fig. 6** Refeeding syndrome - findings and consequences

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Although anorexia represents the typical syndrome complicated by RFS, other common predisposing conditions include severe chronic malnutrition, hyperemesis, alcoholism, cancer, prolonged fasting and malabsorptive syndromes such as short bowel syndrome, inflammatory bowel disease, cystic fibrosis, and bariatric surgery.

In order to prevent the RFS in patients at risk it is important to introduce and advance feeding gradually over several days while closely monitoring vital functions, plasma electrolytes (phosphate, magnesium, calcium, potassium) and renal function, heart rate and ventilatory function. To avoid fluid overload, fluid balance should be carefully controlled. Initial fluid and sodium restriction to prevent congestive heart failure can be considered. Before the onset of nutritional support electrolyte and fluid deficiencies must be corrected (28-29). Nutritional support has to be started with reduced amounts of energy (25-50% of planned energy intake, about 500-1000 kcal/day or 10-15 kcal/kg) daily, particularly during the first week of refeeding, and be increased by approximately 20% daily until the determined goal is reached. The patient’s needs for fluid and electrolytes should be infused separately. The average weekly weight gain, particularly in extremely undernourished patients should not exceed 0.5 kg/wk. With regard to vitamin replacement, thiamine supplementation (parenteral or enteral) should be given before starting refeeding and always if there are any features of Wernicke’s encephalopathy, recognising that once neurological symptoms develop they are rarely fully reversible (30-31).

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### Refeeding Syndrome - prevention

- Identify patients at risk
- Start nutritional support with < 50 % of calculated energy
- Monitor phosphorus, K, Na, Cl, Mg
- Supplement Vitamins (B1, B6, B12 etc.) and electrolytes as mandatory

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**Fig. 7** Refeeding syndrome: prevention

### 8. Monitoring of EN

It is important to monitor EN for two reasons: 1. to monitor the patient’s progress if enteral feeding is to be successful and adequate for the patient’s needs; and 2. to recognize possible (metabolic) complications early.

It is important to mention that in many clinical situations monitoring of nutrition cannot be separated from monitoring of other medical interventions (e.g. fluid balance in necrotizing pancreatitis with renal failure). The following recommendations can only be used for rough orientation and should be adjusted to the patient’s individual needs.
Monitoring of enteral nutrition

- **Feed administration**: daily
- **Fluid balance**: daily
- **Laboratory tests**
  - Na, K, Glucose: initially daily
  - P, Ca, Urea, Creatinine, ALT, Blood count: initially twice/week
- **Nutritional status**: weekly/every 2nd week
  - Weight, albumin, Bioimpedance analysis
- **Functional status**: weekly
  - Hand grip strength

**Fig. 8** Monitoring of EN

Monitoring of EN should consider the following issues:

- **Feed administration**: Check delivery rates at intervals to ensure even flow. Measure gastric residual volumes only if problems are encountered.
- **Fluid balance**: Fluid balance charts must be strictly maintained throughout enteral feeding. Check hydration status clinically; in patients with diarrhoea, fever or other non-physiological fluid losses, assess urinary output daily.
- **Laboratory tests**: Electrolytes and glucose should initially be monitored daily, with serum urea, calcium, magnesium and phosphate levels twice weekly until feeding is well established. Keep in mind that many cancer and acutely ill patients have insulin resistance and might develop diabetes mellitus under EN. Serum albumin should be measured initially and then at weekly intervals.
- **Nutritional status**: weigh patient daily until feeding is well established, then weigh patient weekly. If available perform analysis of body composition by bioelectrical impedance analysis every second week. A good functional outcome measure of tube feeding is hand-grip strength which can easily be performed every week.

**9. Summary**

In this module indications and contraindications for enteral nutrition with special respect to selected diagnoses and clinical situations are highlighted. In addition diagnosis and treatment of gastrointestinal, tube-related and metabolic complications of EN are discussed. Most complications of EN are the result of application errors and can be avoided by an adequate approach and appropriate monitoring. The recommendations are based on the published ESPEN guidelines on enteral nutrition and on available recent literature.

**10. References**


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