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Gastrostomy versus Gastrojejunostomy and/or Jejunostomy Feeding Tubes: A Review of Clinical Effectiveness, Cost-Effectiveness and Guidelines

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Abbreviations

ACG	American College of Gastroenterology
ESPGHAN	European Society for Paediatric Gastroenterology, Hepatology and Nutrition
G	gastrostomy
GJ	gastrojejunostomy
GRADE	Grading of Recommendations, Assessment, Development, and Evaluation
J	jejunostomy
ND	nasoduodenal
NG	nasogastric
NICE	National Institute for Clinical Excellence
NJ	nasojejunal
PEG	percutaneous endoscopy gastrostomy
RCT	randomized controlled trial
SR	Systematic review

Context and Policy Issues

Maintaining adequate nutrition in patients with acute and chronic illnesses that interfere with the patient's oral intake is vitally important. Providing nutrients through the gastrointestinal tract, or enteral nutrition, is generally preferred over parenteral nutrition.[1] Gastric feeding is well tolerated by most patients, however, there are many reasons for which post-pyloric feeding might be indicated (e.g., severe gastroesophageal reflux).[1]

There are two options for providing gastric or post-pyloric nutrition: temporary and permanent tubes.[2,3] Temporary tubes include the nasogastric (NG) tube and the nasojejunal (NJ) tube; these tubes are inserted through the nose and advanced through the esophagus and into the stomach (NG tube), through the pylorus, and into the jejunum (NJ tube).[2] Permanent feeding tubes are placed directly into the stomach (gastrostomy [G] tubes) or intestine (jejunostomy [J] tubes or gastrojejunostomy [GJ] tubes), either percutaneously, laparoscopically, or surgically.[3] Temporary tubes are generally the first means of supplying enteral nutrition support, however, if enteral nutrition is needed for longer than four to five weeks, a permanent feeding tube should be considered.[1]

In Canada, some hospitals may not be equipped to insert or replace both types of feeding tubes, and patients with GJ and J tubes may need to be referred to a different hospital for replacement of the tubes. It is unknown whether feeding tubes into the jejunum are still worthy, or whether G tubes into the stomach are acceptable replacements for preventing aspiration in patients who require feeding tubes.

The purpose of this report is to synthesize and critically appraise the available evidence on the clinical effectiveness, cost-effectiveness, and guidelines for the use of G tubes versus J tubes in patients requiring feeding tubes.

Research Questions

1. What is the comparative clinical effectiveness of gastrostomy tubes versus gastrojejunostomy and/or jejunostomy tubes in patients requiring a feeding tube?
2. What is the comparative cost-effectiveness of gastrostomy tubes versus gastrojejunostomy and/or jejunostomy tubes for preventing aspiration in patients requiring a feeding tube?
3. What are guidelines informing the use of gastrostomy, gastrojejunostomy and/or jejunostomy tubes for preventing aspiration in patients requiring a feeding tube?

Key Findings

Four systematic reviews were identified that addressed the research question in patients requiring temporary feeding tubes; three in critically ill patients, and one in preterm infants. In critically ill patients, the three systematic reviews had numerous overlapping studies and found moderate to high quality evidence that nasogastric tubes were no different in terms of the risk of mortality, aspiration, gastrointestinal complications, or length of stay in hospital, when compared to nasojejunal or nasoduodenal feeding tubes. These systematic reviews also identified moderate to high quality evidence that nasojejunal or nasoduodenal feeding tubes are associated with a lower risk of pneumonia compared to gastric tubes. In preterm infants, evidence from one moderate quality systematic review indicated that post-pyloric tubes were associated with an increased risk of mortality and gastrointestinal complications when compared to gastric feeding tubes, but there was no difference in aspiration pneumonia.

In patients requiring permanent feeding tubes, limited evidence from low quality non-randomized studies suggests that gastrostomy tubes offer a modest benefit or no benefit when compared to jejunostomy tubes.

No evidence regarding the comparative cost-effectiveness of gastrostomy tubes, gastrojejunostomy and/or jejunostomy tubes for preventing aspiration in patients requiring a feeding tube was identified.

Three evidence-based guidelines were identified, and all three recommended gastric feeding tubes as the preferred method of enteral feeding, unless there is upper gastrointestinal dysfunction, in which case post-pyloric feeding is recommended.

Methods

Literature Search Methods

A limited literature search was conducted on key resources including PubMed, The Cochrane Library, University of York Centre for Reviews and Dissemination databases, Canadian and major international health technology agencies, as well as a focused Internet search. No filters were applied to limit the retrieval by study type. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2013 and June 26, 2018.

Selection Criteria and Methods

One reviewer screened citations and selected studies. In the first level of screening, titles and abstracts were reviewed and potentially relevant articles were retrieved and assessed for inclusion. The final selection of full-text articles was based on the inclusion criteria presented in Table 1.

For the context of this report, G tubes were considered any feeding tubes inserted into the stomach, including NG and percutaneous endoscopy gastrostomy (PEG) tubes; and GJ and J tubes also encompassed NJ and nasoduodenal (ND) tubes.

Table 1: Selection Criteria

Population	Patients (of any age) requiring a feeding tube
Intervention	Gastrostomy tubes (G tubes)
Comparator	Gastrojejunostomy and/or jejunostomy tubes (GJ and/or J tubes)
Outcomes	Clinical effectiveness (e.g., tolerance, patient satisfaction, digestion) harms (e.g., aspiration, tube blockage), cost-effectiveness, guidelines
Study Designs	Health technology assessments, systematic reviews, or meta-analyses, randomized controlled studies, economic evaluations, non-randomized studies, evidence based guidelines

G = Gastrostomy; GJ = Gastrojejunostomy; J = Jejunostomy

Exclusion Criteria

Articles were excluded if they did not meet the selection criteria outlined in Table 1, they were duplicate publications, or were published prior to 2008. Guidelines with unclear methodology were excluded.

Critical Appraisal of Individual Studies

The included systematic reviews were critically appraised by one reviewer using AMSTAR II,[4] non-randomized studies were critically appraised using the Downs and Black checklist, [5] and guidelines were assessed with the AGREE II instrument.[6] Summary scores were not calculated for the included studies; rather, a review of the strengths and limitations of each included study were described narratively.

Summary of Evidence

Quantity of Research Available

A total of 489 citations were identified in the literature search. Following screening of titles and abstracts, 459 citations were excluded and 30 potentially relevant reports from the electronic search were retrieved for full-text review. 30 potentially relevant publications were retrieved from the grey literature search for full text review. Of these potentially relevant articles, 46 publications were excluded for various reasons, and 14 publications met the inclusion criteria and were included in this report. These comprised 4 systematic reviews, 7 non-randomized studies, and 3 evidence-based guidelines.

Appendix 1 presents the PRISMA[7] flowchart of the study selection.

Additional references of potential interest are provided in Appendix 6.

Summary of Study Characteristics

Additional details regarding the characteristics of included publications are provided in Appendix 2.

Study Design

Four systematic reviews (SRs) with the objective of comparing the clinical effectiveness of post-pyloric versus gastric feeding tubes were identified.[8-11] The reviews included literature searches up to 2011,[9] 2012,[11] and 2013[8]; one SR did not provide the dates of their search strategy but was published in 2014.[10] Three SRs included only randomized controlled trials (RCTs), and there was overlap with 16 RCTs in these SRs (See Appendix 5: Overlap between Included Systematic Reviews for the overlap of RCTs between the SRs.).[8-10] The other SR included RCTs and quasi-randomized controlled trials.[11] All SRs pooled results across studies using meta-analyses where appropriate.

Six retrospective cohort studies[12-17] and one prospective cohort study[18] comparing gastric and post-pyloric feeding tubes were identified.

No relevant economic studies were identified.

Three relevant evidence based guidelines were identified by the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN),[19] the National Institute for Clinical Excellence (NICE),[20] and the American College of Gastroenterology (ACG).[21] All three guidelines used a literature search to identify the evidence. The ESPGHAN guideline included SRs, prospective or retrospective controlled studies, and prospective or retrospective cohort studies, used GRADE to rate the quality of the evidence, and a consensus meeting with voting to develop the recommendations.[19] The NICE guideline included only SRs, meta-analyses of RCTs and RCTs, graded the type of evidence and the strength of the evidence, and a multidisciplinary guideline group to develop the recommendations. [20] The ACG guideline used GRADE to evaluate the evidence, and an expert committee to develop the recommendations, but they did not specify the types of literature they included.[21]

Country of Origin

The SRs were led by authors based in Canada,[8] China,[9] and the UK.[10,11] The non-randomized studies were led by authors based in Canada,[12,17] China,[15] France,[13] Turkey,[18] and the US.[14,16] The guidelines are meant to apply to Europe,[19] the UK,[20] and the US.[21]

Patient Population

Three SRs included critically ill patients,[8-10] and one included preterm infants requiring enteral tube feeding.[11]

Two of the non-randomized studies examined adult patients (18 years of age or greater) requiring feeding tubes; one examined tube insertion (n = 559)[17] and the other examined emergency department visits (n = 94).[18] Two retrospective cohort studies examined pediatric patients; one with pediatric cancer patients undergoing tube placement (n = 122; less than 21 years of age),[14] and the other with children presenting to the emergency department with feeding tube complications (n = 31; less than 18 years of age).[16] The other non-randomized study populations included patients who underwent

pancreatoduodenectomy with pancreaticogastrostomy for pancreatic tumor (n = 86; aged 25 to 80 years,[13] patients who underwent esophagectomy with gastric tract reconstruction (n = 274; aged 44 to 78 years),[15] and patients discharged from a home enteral nutrition program (n = 129; mean age greater than 55 years).[12]

The intended users of the NICE guideline are healthcare professionals, patients and their carers, and the guideline targets adult patients who are malnourished or at risk of malnutrition.[20] The ESPGHAN and ACG guidelines do not report an intended user for their guidelines, but the guidelines target children with neurological impairments[19] and the hospitalized patient,[21] respectively.

Interventions and Comparators

The SRs included studies examining temporary enteral feeding tubes that used catheters passed via the nose or the mouth, and compared NG feeding tubes to post-pyloric (ND or NJ) feeding tubes. [8-11]

The non-randomized studies examined permanent feeding tubes; three studies compared G tubes to GJ tubes,[13,16,17] three studies compared G or PEG tubes with J tubes, [12,14,15] and one study compared PEG tubes to ND/NJ tubes.[18]

The three guidelines examine which type of feeding tube to use.[19-21]

Outcomes

In the SRs, the outcomes related to the clinical effectiveness of gastric and post-pyloric feeding tubes were: time to achieve nutritional target,[8] caloric delivery,[8,10] gastric residual volume,[10] and growth (rate of change in weight),[11] The outcomes related to harms were: pneumonia,[8-11] mortality,[8,10,11] length of stay in the intensive care unit,[8,10] gastrointestinal complications,[8,10,11] duration of mechanical ventailation,[8] complications from tube insertion and maintenance,[8] vomiting,[9] aspiration,[9] necrotising enterocolitis,[11] and intestinal perforation.[11] The length of follow-up ranged from the time in the hospital,[9,11] from the time of tube insertion until removal or tube or death,[8] and up to 24 weeks.[10]

In the non-randomized studies, the outcomes related to the clinical effectiveness were: caregiver satisfaction,[18] and time to removal feeding tube.[15] The outcomes related to harms were: complication rate,[13,14,16,17] mortality,[13,17,18] readmission to the hospital,[13] length of stay in hospital,[13,15] obstructions,[12,15] dislodgement,[12] leakage,[12] aspiration complications,[18] surgery complications,[15] complications with the catheter,[15] abdominal distension,[15] and non-routine tube replacement.[15] The length of follow-up ranged from the time in-hospital,[18] 30 days,[13,14,17] 6 months,[18] 3 years,[12] and 5 years.[16]

Summary of Critical Appraisal

Additional details regarding the strengths and limitations of included publications are provided in Appendix 3.

Systematic Reviews and Meta-Analyses

The AMSTAR II assessment of the four SRs found that none of the reviews contained an explicit reference to a protocol.[8-11] Although one SR did mention deviations from a protocol, it was unclear whether the protocol was registered and how the protocol was used to guide the work.[8] In general, the SRs reported adequate methods for study selection and data extraction, including the use of a comprehensive literature search strategy, duplicate data extraction and detailed descriptions of the included studies. However, none of the SRs

justified only including RCTs, and only two provided a list of the excluded studies.[8,11] In one SR it was unclear whether study selection was performed in duplicate, and this SR also lacked details about the study populations.[10]

All of the SRs reported assessing the risk of bias of the included RCTs, but none reported the sources of funding of the included studies. Three SRs did not assess the potential impact of the risk of bias in the individual studies on the meta-analysis,[8,10,11] while two SRs did not account for study quality when interpreting their results.[8,10]

The methods reported for the synthesis of the results was appropriate in three SRs,[8,9,11] and in the remaining SR it was unclear whether the results were weighted appropriately and whether they adjusted for heterogeneity.[10] The review authors declared no conflicts of interest in the four SRs, but one review did not investigate the risk of publication bias.[10]

Non-Randomized Studies

All seven non-randomized studies included in this report were either single[12,14-18] or two[13] center cohort studies, of which all but one[18] had a retrospective design; as such, no randomization of the interventions took place. In addition, due to the nature of the interventions and study designs, it was not possible to blind the patients or data abstractors in any of the studies. Taken together, these studies are limited by high risk of bias for selection and detection bias. In addition, two studies had additional concerns with regards to patient selection and treatment allocation.[12,18] One study did not provide the details of their systematic sampling of a larger cohort to obtain a convenience sample for one of their groups,[12] and therefore it is unknown whether the selection of this group is biased. In another study, patients were allowed to choose their treatment, but they were presented with the treatment options in a sequential manner. They were only presented the next option after refusing the previous one, and therefore treatment allocation may be biased.[18]

The quality of the reporting in the non-randomized studies was generally well done, with all studies clearly outlining their objective, providing detailed descriptions of their patient population and the treatments, and reporting actual probability values. However, one study failed to clearly define the main outcomes of the study and did not clearly describe their findings,[16] while two studies did not report results for some of their listed outcomes.[15,18]

In four studies, the statistical tests were unclear or not appropriate: in two studies, statistical tests designed for comparing two groups (e.g., chi square, Fisher's exact test, or student's t-test) were used in analyses where three groups were being compared and a different statistical test would have been more appropriate (e.g., ANOVA or Kruskal-Wallis test),[13,14] in one study, it is unclear if the odds ratios were calculated correctly,[16] and in other study, a log rank test was used inappropriately to conclude which group was different from the other two.[18] Furthermore, it was not possible to determine whether all analyses were planned a prior in some studies,[12-14,16] and adjusting for confounders was only done in three studies;[12,13,15] meanwhile two studies explicitly stated that there was significant difference in age between the groups but then failed to adjust for age in their analysis.[16,18]

Guidelines

There was one high quality guideline,[20] one moderate quality guideline,[19] and one poor quality guideline.[21] All three guidelines clearly describe their scope and purpose, and provide clear, easily identifiable recommendations. The NICE guideline reports rigorous methods for the development of their recommendations, including the details of stakeholder involvement, such as a diverse guideline development group and the views of the target

population.[20] The development of the ESPGHAN guideline is well reported, but the authors do not describe the strengths and limitations of the evidence, and the guideline lacks a procedure for being updated.[19] On the contrary, the ACG guideline does not report all the details of their search strategy, the criteria for selecting the evidence, the methods for formulating the recommendations, the strengths and limitations of the evidence, whether the guideline was externally reviewed, and the procedure for updating the guideline.[21]

Summary of Findings

The overall findings of this review are summarized below. Additional details are available in Appendix 4, in which the main study findings and author's conclusions are provided. There is considerable overlap between the primary studies included in three of the SRs (See Appendix 5: Overlap between Included Systematic Reviews).[8-10]

Clinical Effectiveness of gastrostomy tubes versus gastrojejunostomy and/or jejunostomy tubes in patients requiring a feeding tube

Mortality

Two SRs[8,10], with considerable overlap between primary studies, found that based on evidence they evaluated to be of moderate quality that there was no difference in mortality between critically ill patients with gastric versus post-pyloric feeding tubes. A SR of preterm infants found a statistically significant increase in risk of death prior to discharge with transpyloric versus gastric feeding tubes.[11]

Two non-randomized studies reported on mortality.[13,18] In patients who underwent pancreatoduodenectomy with pancreaticogastrostomy for pancreatic tumor, there was no difference in post-operative mortality between patients with a G (n = 3) or NG (n = 0) feeding tube when compared to those with a GJ tube (n = 2),[13] however, a statistical test designed to compare two groups was used to compare three groups. In women admitted to the emergency department due to aspiration pneumonia, there was a statistically significant difference in estimated mean survival between the PEG (4.8 months), ND/NJ (2.0 months), and oral feeding (4.7 months) groups, however, the statistical test used can only determine that a difference exists between the groups, and not the magnitude of the difference between groups.[18]

Pneumonia

All four SRs reported pneumonia as a study outcome. In critically ill patients, three SRs with considerable overlap between primary studies, found that based on evidence they evaluated to be of moderate to high quality evidence that post-pyloric feeding tubes were associated with a statistically significant lower risk of pneumonia compared to gastric feeding tubes.[8-10] In preterm infants, a SR with five primary studies did not show any difference in aspiration pneumonia prior to hospital discharge.[11]

One non-randomized study reported the incidence of pneumonia as statistically significantly higher in patients with a J tube (26.1%) versus a G tube (11.6%) after esophagectomy with gastric tract reconstruction surgery.[15]

Aspiration

One SR in critically ill patients reported aspiration as an outcome, but did not observe any difference in risk of aspiration between post-pyloric and gastric feeding tubes, even when only the authors only included studies that they determined to be of high quality in the analysis.[9]

In one non-randomized study, in patients who were admitted to the emergency department due to aspiration pneumonia, a statistically significant difference in re-aspiration rates was detected between the three groups: PEG tubes (58%), ND/NJ tubes (78%), and oral feeding (91%).[18]

Gastrointestinal Complications

In critically ill patients, two SRs reported vomiting as an outcome,[8,9] one SR reported diarrhoea,[8] and one reported on gastrointestinal complications which included nausea, vomiting, diarrhoea, abdominal distension, reflux and gastrointestinal minor or major bleeding.[10] The risk of vomiting was not different between gastric and post-pyloric feeding tubes, except when the authors only included two studies that they determined to be of high quality in a sensitivity analysis, and then post-pyloric feeding was associated with a statistically significant lower risk of vomiting.[9] The feeding tubes did not differ in their risk of diarrhoea (evidence quality not evaluated by the authors),[8] or the odds of gastrointestinal complications between nasogastric and post-pyloric feeding tubes (based on high quality evidence, as evaluated by the author).[10] In preterm infants, transpyloric feeding tubes were associated with a statistically significant increased risk of gastrointestinal disturbances (including diarrhoea) prior to hospital discharge.[11]

Hospital Length of Stay

Two SRs[8,10], with considerable overlap between primary studies, reported no differences in length of stay in the intensive care unit between the gastric and post-pyloric feeding tubes, but the quality of the evidence was only evaluated by the authors of one SR, and they found the evidence to be of moderate quality.[10]

Two non-randomized studies reported length of stay as an outcome.[13,15] In patients who underwent pancreatoduodenectomy with pancreaticogastrostomy for pancreatic tumors, the mean length of stay was not statistically different between G or NG versus GJ tubes,[13] however, an inappropriate statistical test may have been used. In patients who underwent esophagectomy with gastric tract reconstruction, patients with J tubes had a significantly longer median length of stay (15 days) versus patients with a G tube (11 days).[15]

Gastric Residual Volume

One SR found based on moderate quality evidence a statistically significant higher odds of high gastric residual volume for nasogastric feeding tubes compared to post-pyloric feeding tubes.[10]

Complications

Three non-randomized studies reported overall complication rates,[13,14,17] while three non-randomized studies reported specific complications.[12,15,16]

In adults undergoing a primary G or GJ tube insertion, the overall 30-day complication rate was significantly higher in the GJ tube group (13.5% versus 5.8%), but there was no significant difference between the rate of major or minor complications.[17] In patients who underwent pancreatoduodenectomy with pancreaticogastrostomy for pancreatic tumor, there was no significant difference in overall morbidity or severe morbidity when GJ tubes were compared to NG or G tubes,[13] however, an inappropriate statistical test may have been used. Similarly, in pediatric (less than 21 years of age) cancer patients undergoing the placement of enteral feeding tubes, there was no difference in the rate of any complications

or major complications when J, G, and both J and G tubes were compared,[14] however, an inappropriate statistical test may have been used.

In children (less than 18 years of age) who presented to the emergency department with a G or GJ tube related complication, the odds of a dislodgement, clogging, or leaking were similar between the G and GJ tubes,[16] although the accuracy of the statistical analysis is unclear. In patients discharged from a home enteral nutrition program, J tubes were associated with a significantly higher rate of non-routine tube replacement (45.3%) compared to PEG tubes (13.8%), however, there was no difference in the indications for tube replacement, such as obstruction, dislodged, leakage, or infection.[12] In patients who underwent esophagectomy with gastric tract reconstruction, J tubes were associated with a significantly higher rate of bowel obstructions and abdominal distention when compared with G tubes.[15]

Caregiver Satisfaction

One non-randomized study reported statistically significantly higher care giver satisfaction scores with PEG tubes compared to ND/NJ tubes and oral feeding at 6 months in adult patients requiring long term-enteral feeding.[18]

Cost Effectiveness of gastrostomy tubes versus gastrojejunostomy and/or jejunostomy tubes in patients requiring a feeding tube

No relevant evidence regarding the cost effectiveness of G versus GJ and/or J tubes was identified.

Guidelines

All three guidelines make recommendations in support of gastric feeding tubes as the first choice in treatment, with post-pyloric feeding tubes recommended if gastric feeding is poorly tolerated.[19-21]

The NICE guideline makes one recommendation based on high quality, evidence: adults who are malnourished or at risk of malnutrition should be fed via a tube into the stomach unless there is upper gastrointestinal dysfunction.[20] This guideline also provides a good clinical practice point, based on expert opinion: patients who are malnourished or at risk of malnutrition with upper gastrointestinal dysfunction should be considered for post-pyloric feeding.

The ESPGHAN guideline makes two recommendations for feeding tubes in children with neurological impairments, based on a moderate level of evidence.[19] They recommend that G tubes be used as the preferred intragastric access for long-term tube feeding in children with neurological impairments, and that jejunal feeding can be used in cases of aspiration due to gastroesophageal reflux disease, refractory vomiting, retching, and bloating.[19]

The ACG guideline for the hospitalized patient makes one recommendation based on moderate-to-high level of evidence: “conversion to post-pyloric feeding tube should be carried out only when gastric feeding has been shown to be poorly tolerated or the patient is at high risk for aspiration”(p. 324).[21] The guideline makes other conditional recommendations, but they are based on a very low level of evidence.

Limitations

There are various limitations associated with the evidence in our report comparing the use of G tubes versus GJ and/or J tubes.

A key limitation was the availability of evidence. Despite the inclusion of four SRs, seven non-randomized studies, and three guidelines, there is still a paucity of recent, high quality evidence. In each of the three SRs on critically ill patients requiring temporary enteral feeding there was considerable overlap between the RCTs; in two SRs[8,9] there was only one RCT that was uniquely captured in that review and in the other SR[10] there were three RCTs that were uniquely captured in that review, with the remaining RCTs overlapping across the SRs. In addition, the literature in these reviews was only searched until 2013, and therefore, there was no evidence from RCTs in the past 5 years.

Another limitation was the lack of evidence comparing the different types of feeding tubes; specifically there was no high quality evidence directly comparing permanent G versus GJ/J tubes. The four SRs[8-11] only included RCTs of temporary enteral feeding tubes that passed first through the nose or mouth before entering the stomach or intestine (i.e. NG versus ND or NJ tubes). No SRs or RCTs were identified that compared permanent feedings tubes that go directly into the stomach (i.e. G tubes) with feeding tubes that go into the jejunum (i.e. J or GJ tubes). Although seven non-randomized studies were identified comparing G with GJ/J tubes, the retrospective and prospective cohort study designs only provide low quality evidence.

The inclusion criteria for the population of this report was very broad (patients of any age requiring a feeding tube), which ensured that all relevant populations were captured, however, some of the patient populations were very specific, particularly in the non-randomized studies (e.g., patients who underwent pancreatoduodenectomy with pancreaticogastrostomy for pancreatic tumor,[13] or patients who underwent esophagectomy with gastric tract reconstruction by a retrosternally positioned gastric tube[15]) which may limit the generalizability of the findings.

One SR was conducted by Canadian authors,[8] but only included the findings from one RCT conducted in Canada. Two non-randomized studies were conducted in Canada; one study of adults undergoing G or GJ tube insertion[17], and the other study of patients discharged from a home enteral nutrition program.[12] It is unknown if the results from the other studies are generalizable to Canadian clinical practice as there may be geographic differences in the manner in which care for patients with feeding tubes is provided between countries.

Several outcomes were captured in the body of evidence for this report, however, most outcomes were only reported in two to four studies across a variety of populations and feeding tube types, therefore making it challenging to form definitive conclusions.

Unfortunately, no cost-effectiveness studies were identified in the literature search, nor were any studies found that included patient satisfaction as an outcome.

Conclusions and Implications for Decision or Policy Making

This report identified four SRs[8-11] and seven non-randomized studies[12-18] that compared the clinical effectiveness of gastric versus post-pyloric feeding tubes. No cost-effectiveness studies were identified. Three guidelines were summarized that inform the use of G and J tubes for preventing aspiration in patients requiring a feeding tube.[19-21]

For temporary gastric and post-pyloric feeding tubes that are first passed through the nose or mouth tubes, the findings differed between critically ill patients and pre-term infants. In critically ill patients, three SRs of moderate quality, with a considerable number or overlapping RCTs, found evidence evaluated by the authors to be of moderate to high quality that there was no difference between gastric and post-pyloric feeding tubes for mortality,[8,10] aspiration,[9] gastrointestinal complications,[8-10] or length of stay in hospital.[8,10] Meanwhile, the three SRs found evidence evaluated by the authors to be of moderate to high quality that post-pyloric feeding tubes were associated with a lower risk of pneumonia compared to gastric tubes.[8-10] In contrast, in preterm infants, one moderate quality SR found that transpyloric tubes were associated with an increased risk of death and gastrointestinal complications prior to discharge compared to gastric feeding tubes, with no difference in risk of aspiration pneumonia.[11]

For permanent feeding tubes, only limited evidence from low quality cohort studies was available comparing G versus J tubes, but in general, G tubes had a beneficial or no effect when compared to J tubes or NJ/ND tubes. Evidence from high risk of bias cohort studies found no difference in post-operative mortality between patients with G, NG and GJ tubes,[13] and longer survival in patients with PEG tubes compared to NJ/ND tubes.[18] One low quality study reported higher rates of pneumonia in patients with J tubes versus G tubes,[15] and one study of low quality reported higher aspiration rates with NJ/ND tubes compared to PEG tubes.[18] Following feeding tube insertion, three low quality studies reported no differences in overall complication rates.[13,14,17] Two low quality studies reported higher rates of non-routine replacements[12], bowel obstructions,[15] and abdominal distensions,[15] for J tubes, and one high risk of bias study reported similar odds of dislodgement, clogging, or leaking in children with G and GJ tubes.[12] Similarly, one low quality study reported longer lengths of stay in patients with J tubes,[15] while a study with a high risk of bias reported no differences in the length of stay.[13] Further research from well conducted RCTs is required to reduce the uncertainty with regards to the clinical effectiveness of G versus J tubes.

No evidence was identified regarding the cost-effectiveness of G tubes versus GJ and/or J tubes for preventing aspiration in patients requiring a feeding tube.

Three evidence-based guidelines were identified, all of which recommend the use of gastric feeding tubes as the first choice of treatment, and the use of post-pyloric feeding tubes if gastric feeding is poorly tolerated.[19-21]

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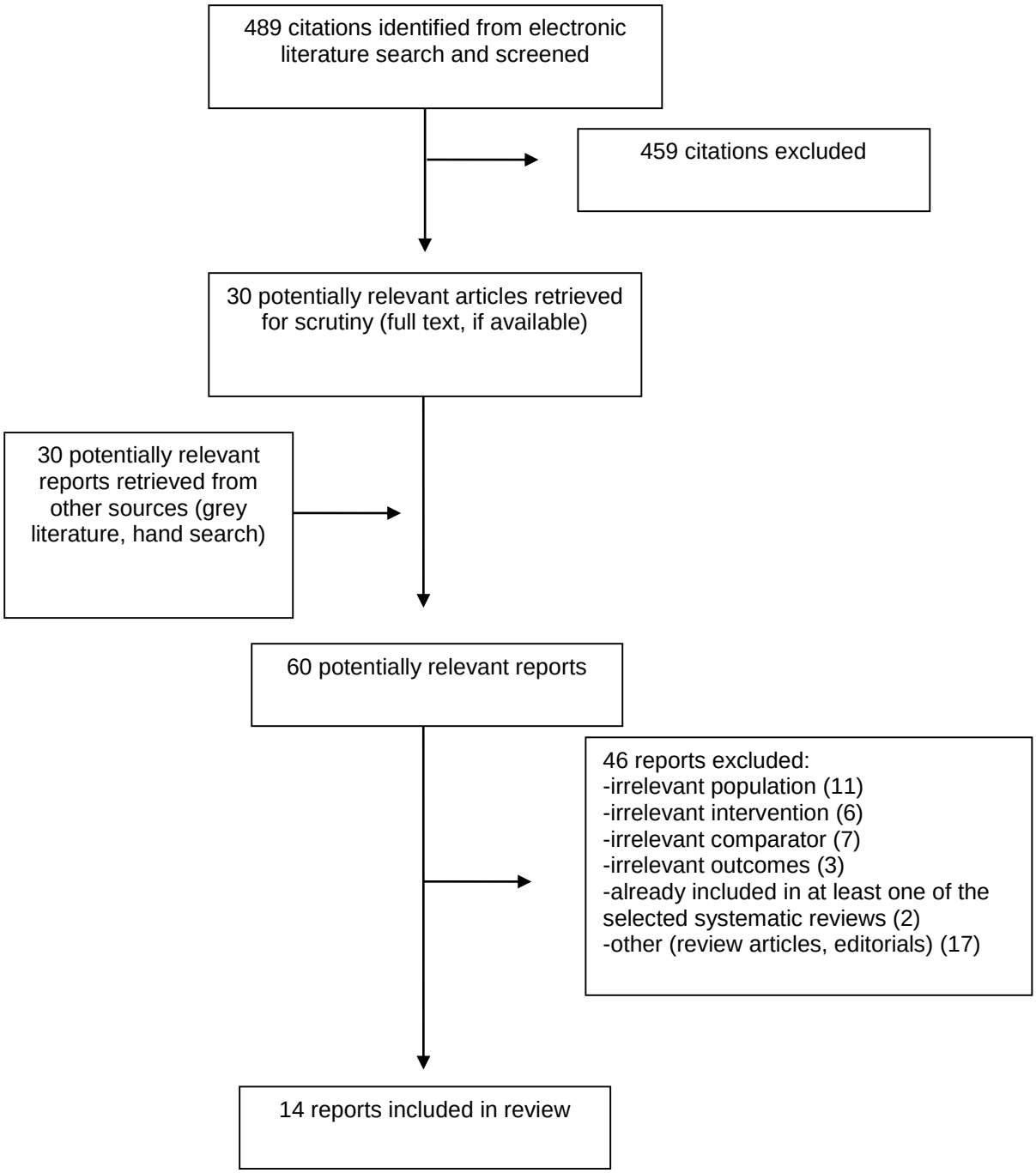
Appendix 1: Selection of Included Studies



Appendix 2: Characteristics of Included Publications

Table 2: Characteristics of Included Systematic Reviews and Meta-Analyses

First Author, Publication Year, Country	Study Designs and Numbers of Primary Studies Included	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
Alkhawaja, 2015 **Canada**	Literature up to October 2013; 14 RCTs	Adults (> 18 years) who received treatment in a critical care setting, who would require enteral tube feeding for at least 48 hours	Enteral feeding tubes (catheters passed via the nose or mouth). Post-pyloric (duodenum or jejunum) feeding tubes vs. gastric feeding tubes	Primary: Pneumonia, mortality, Percentage total nutrition delivered to the patient, Time to achieve full nutritional target Secondary: ICU LOS, duration of mechanical ventilation, gastrointestinal complications, complications related to tube insertion and tube maintenance, time to start feeding Follow up: from time of tube insertion until removal of tube or death
Sajid, 2014 **UK**	Search dates not provided; 20 RCTs	Critically ill patients admitted to the intensive therapy unit requiring nutritional support for any reason	NG vs. post-pyloric (NJ or ND)	Primary: Aspiration pneumonia (ventilator-associated pneumonia or nosocomial pneumonia) Secondary: higher gastric residual volume, overall mortality, length of ITU stay, reduced caloric delivery and gastrointestinal complications Follow up: 1 – 24 weeks
Jiyong, 2013 **China**	Literature up to August 2011; 15 RCTs	Critically ill patients (not defined)	Post-pyloric (jejunal or duodenal) vs. gastric feeding	Primary: pneumonia Secondary: vomiting, aspiration Follow up: in hospital
Watson, 2013 **UK**	Literature up to June 2012; 5 quasi-randomized controlled trials 4 RCTs	Preterm infants (not defined) who receive enteral tube feeding	Enteral feeding tubes (catheters passed via the nose or mouth). Transpyloric vs. gastric tube feeding	Primary: growth (rate of change in weight) Secondary: death prior to discharge, gastrointestinal disturbances, Necrotising enterocolitis, aspiration pneumonia, intestinal perforation Follow up: prior to hospital discharge

ICU = intensive care unit; ITU = intensive therapy unit; LOS = length of stay; ND = nasoduodenal; NG = nasogastric; NJ = nasojenunal; RCT = randomized controlled trial;

Table 3: Characteristics of Included Primary Clinical Studies

First Author, Publication Year, Country	Study Design	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
Zener 2018 **Canada**	Single-center retrospective cohort study. Consecutive patients from July 2011 to June 2014. n = 473 GJ tube insertions n = 86 G tube insertions	Adults (range 18 to 94 years) undergoing primary G or GJ tube insertion.	G vs. GJ tube. Insertions using a single puncture, dual-anchor gastropexy enteral tube insertion technique deploying two non-absorbable suture anchors and a peel-away sheath	30 day complication and procedure related mortality rate
Guilbaud 2017 **France**	Two center retrospective cohort. Patients between January 1, 2013 and March 1, 2016. n = 12 GJ with EN n = 31 NG with TPN n = 43 G with TPN	All patients who underwent pancreatoduodenectomy with pancreaticogastrostomy for pancreatic tumor (range 25 to 80 years).	NG tube with TPN, G tube with TPN, GJ tube with EN	Postoperative mortality (all deaths prior to discharge or within 30 days of surgery), all complications following the surgery until discharge, readmission within 30 days.
Hamilton 2017 **US**	Single-center retrospective cohort. Patients between January 2004 and January 2014 n = 10 with J tube n = 75 with G tube n = 37 with both G and J tubes	Pediatric cancer patients (21 years old or younger) undergoing placement of enteral feeding tube.	J vs. G Both G and J tubes vs. G	Primary: frequency of any complication Secondary: frequency of major complications At least 30 days.
Ronning 2017 **US**	Single-center retrospective cohort study during 2007 – 2012. n = 15 with G tube n = 16 with GJ tube	Children less than 18 years of age, with a G or GJ tube, who presented to the emergency department with a complication relating to the tube.	G vs. GJ tubes	Number and type of feeding tube complications. Number of complications reported in the 5 year period.
Ao 2015 **Canada**	Chart review of 560 patients from January 2010 to December 2011. n = 64 J tube patients n = 65 PEG tube patients (496 PEG tube patients were eligible; systematic sampling was used to obtain a convenience sample)	Patients who were discharged from the Northern Alberta Home Enteral Nutrition Program. Program criteria include: inability to meet 75% of one's nutrition requirements orally, insertion of an enteral access device, and an estimated duration of enteral nutrition support for ≥1 month. Mean age was	PEG vs. J tubes	Feeding tube complications: obstructions, dislodgement, leakage Follow up until 3 years or discharge from program, whichever was earliest

First Author, Publication Year, Country	Study Design	Population Characteristics	Intervention and Comparator(s)	Clinical Outcomes, Length of Follow-Up
		56 (J tubes) and 59 (PEG tubes).		
Huang 2014 **China**	Single-center retrospective study between June 2008 and September 2012. Study design is unclear. Authors report both retrospective study and dividing the groups randomly. n = 153 with J tubes n = 121 with G tubes	Patients (ranged 44 – 78 years) who underwent esophagectomy with gastric tract reconstruction by a retrosternally positioned gastric tube.	Retrosternal route G vs. J	Surgery complications, complications with the catheter (wound infection, peritonitis, catheter displacement, and catheter Blockade), digestive system complications (bowel obstruction and abdominal distension); time to removal of the indwelling feeding tube and gastric tube, length hospital stay Follow up = time in hospital
Onur 2013 **Turkey**	Single-center, prospective cohort study between June 2010 and January 2011. Patient was offered the PEG tube first and if they declined then the ND/NJ tube was offered, and if that was declined, then oral feeding was offered. n = 42 with ND/NJ tubes n = 29 with PEG tubes n = 23 with oral feeding	Adult patients (18 years or older) admitted to the emergency department, due to aspiration pneumonia, requiring long-term enteral feeding.	ND/NJ compared to PEG or oral feeding	Aspiration complications, survival, caregiver satisfaction. Follow up to 6 months.

EN = enteral nutrition; G = gastrostomy; GJ = gastrojejunostomy; J = jejenostomy; NG = nasogastric; ND/NJ = nasoduodenal/nasojejunal; PEG = percutaneous endoscopy gastrostomy; RCT = randomized controlled trial; TPN = total parenteral nutrition

Table 4: Characteristics of Included Guidelines

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
European Society for Paediatric Gastroenterology, Hepatology and Nutrition Guidelines for the Evaluation and Treatment of Gastrointestinal and Nutritional Complications in Children With Neurological Impairment, 2017[19]						
NR Children with neurological impairment	Evaluation and treatment of GI problems. Includes: Which type of tube to use? What are the indications for jejunal feeding?	Not specified a priori. Reports adverse events, mortality, tube failure, safety	Systematic literature search from 1980 to December 2015. SRs, prospective or retrospective controlled studies, prospective or retrospective cohort studies	GRADE system[22] Level of evidence graded as follows: 1. High: Further research is unlikely to change our confidence in the estimate of effect. 2. Moderate: Further research is likely to have impact on our confidence in the estimate of effect and may change the estimate. 3. Low: Further research is likely to have an impact on our confidence in the estimate of effect and likely to change the estimate. 4. Very low: Any estimate of effect is uncertain.	Consensus meeting and voting, expert opinion was applied when no RCTs were available	NR
National Institute for Clinical Excellence, Nutrition Support for Adults Oral Nutrition Support, Enteral Tube Feeding and Parenteral Nutrition, updated 2017 [20]						
Healthcare professionals, patients and their carers. Adult patients who are malnourished or at risk of malnutrition.	Guidance on oral, enteral and parenteral nutrition support in adult patients. Benefit of one mode of intervention over another.	All outcomes, with the exception of biochemical outcomes that are not clearly associated with clinical benefit.	Systematic literature search of systematic reviews, meta-analyses of RCTs, and RCTs. Meta-analysis where appropriate. SIGN quality checklist to	Levels of evidence for intervention studies graded by type of evidence. Levels ranged from 1++ (high quality meta-analysis, SRs of RCTs, or RCTs with low risk of bias) to 4 (expert opinion). Grading of recommendations	Multidisciplinary guideline development group met every 6-8 weeks. When no RCTs were available, surveys or expert opinions were used.	NR

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
			asses quality of included studies.	by strength of the evidence. Levels ranged from A (at least one study rated at 1++ and directly applicable to the population or a body of evidence rated as 1+, directly applicable to the population, and consistent results) to D (GPP) (good practice point based on expert opinion)		
American College of Gastroenterology (ACG) Clinical Guideline: Nutrition Therapy in the Adult Hospitalized Patient [21]						
NR Hospitalized patient.	Enteral nutrition via an enteral access device. Includes: at what level of the GI tract the tube be inserted	Not specified a priori. Reports various complications.	Literature search (literature type unspecified)	GRADE system[23] Quality of evidence ranged from High (++++) (RCTs) to very low (expert opinion). Levels of evidence: High: We are very confident that the true effect lies close to that of the estimate of effect Moderate: We are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different Low: Our confidence in the effect estimate is limited: the true effect may be substantially different from the estimate of effect	Expert committee	NR

Intended Users, Target Population	Intervention and Practice Considered	Major Outcomes Considered	Evidence Collection, Selection, and Synthesis	Evidence Quality Assessment	Recommendations Development and Evaluation	Guideline Validation
				Very low: We have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect		

GI = gastrointestinal; GRADE = Grades of Recommendation, Assessment, Development and Evaluation; NR = not reported; RCT = randomized controlled trial; SRs = systematic reviews

Appendix 3: Critical Appraisal of Included Publications

Table 5: Strengths and Limitations of Systematic Reviews and Meta-Analyses using AMSTAR II[4]

Strengths	Limitations
Alkhawaja, 2015 [8]	
- Well described research question and inclusion criteria - Deviations from the protocol were justified - Comprehensive literature search - Study selection and data extraction performed in duplicate - List of excluded studies provided - Included studies described in detail - Scientific quality assessed for all included studies - Appropriate methods used for quantitative synthesis - Heterogeneity of the studies was considered in the analysis - Quality of the evidence considered when interpreting results - Publication bias was reported - No conflicts of interest reported	- No explanation for only using RCTs - Did not report sources of funding for individual studies - Scientific quality of individual studies not considered when synthesising evidence
Sajid, 2014 [10]	
- Comprehensive literature search - Data extraction performed in duplicate - Included studies are well described - Scientific quality assessed for all included studies - Quality of the evidence is reported - No conflicts of interest reported	- Inclusion criteria is lacking details - No written protocol - No search dates provided - No explanation for only using RCTs - Study selection no performed in duplicate - Does not provide list of excluded studies - Did not report sources of funding for individual studies - Methods of meta-analysis are unclear - Heterogeneity of the studies is reported but not explained - Scientific quality of individual studies not considered when synthesising evidence - Publication bias not reported
Jiyong, 2013 [9]	
- Well described research question and inclusion criteria - Comprehensive literature search - Study selection and data extraction performed in duplicate - Included studies described in detail - Appropriate methods used for quantitative synthesis - Scientific quality of individual studies considered when synthesising evidence - Heterogeneity of the studies was considered in the analysis - Publication bias was reported - No conflicts of interest reported	- No written protocol - No explanation for only using RCTs - Does not provide list of excluded studies - Did not report sources of funding for individual studies - Quality of the evidence not considered when interpreting results
Watson, 2013 [11]	
- Well described research question and inclusion criteria	- Unclear whether a prior protocol followed

Strengths	Limitations
- Comprehensive literature search - Study selection and data extraction performed in duplicate - List of excluded studies provided - Included studies described in detail - Scientific quality assessed for all included studies and considered in the discussion of the results - Appropriate methods used for quantitative synthesis - Heterogeneity of the studies was considered in the analysis - Publication bias was reported - No conflicts of interest reported	- No explanation for only using RCTs - Did not report sources of funding for individual studies - Scientific quality only considered for one study when synthesising evidence - Quality of the evidence not considered when interpreting results

RCTs = randomized controlled trials

Table 6: Strengths and Limitations of Non-Randomized Studies using the Downs and Black checklist[5]

Strengths	Limitations
Zener, 2018[17]	
The objective was clearly stated The inclusion criteria were stated Patient characteristics, intervention, and outcomes were described No loss to follow up due to retrospective cohort design Appropriate statistical analysis	The exclusion criteria were not explicitly stated Did not account for confounding factors Not possible to blind patients or those collecting the data from prospective database Sample size not calculated No mention of conflicts of interest Overstated results in discussion
Guilbaud, 2017 [13]	
The objective was clearly stated The inclusion and exclusion criteria were stated Patient characteristics, intervention, and outcomes were described Confounding factors measured across groups No loss to follow up due to retrospective cohort design Authors report no conflicts of interest	Not possible to blind patients or those collecting the data from the electronic medical records Inappropriate statistical tests used. Sample size not calculated
Hamilton, 2017[14]	
The objective was clearly stated The inclusion and exclusion criteria were stated Patient characteristics, intervention, and outcomes were described No loss to follow up due to retrospective cohort design	Not possible to blind patients or those collecting the data Confounding factors measured but not described across groups Selection of confounding factors to include in multivariate analysis is poorly described Inappropriate statistical tests used Sample size not calculated No mention of conflicts of interest Overstated results in discussion Overstated results in discussion
Ronning, 2017[16]	
The objective was clearly stated The inclusion and exclusion criteria, and patient characteristics were stated No loss to follow up due to retrospective cohort design	Main outcomes not clearly described Main findings not clearly described Not possible to blind patients or those collecting the data from electronic health records

Strengths	Limitations
	Unclear if all analyses were planned a priori Unclear if statistical tests were appropriate Main confounding factor (age) not accounted for in the analyses Sample size not calculated No mention of conflicts of interest Overstated results in discussion
Ao, 2015[12]	
The objective was clearly stated The inclusion and exclusion criteria were stated Patient characteristics, intervention, and outcomes were described No loss to follow up due to retrospective cohort design Appropriate statistical analysis Confounding factors measured across groups	Systematic sampling of one group of patients not described Not possible to blind patients or those collecting the data from patient charts Sample size not calculated No mention of conflicts of interest
Huang, 2014[15]	
The objective was clearly stated The inclusion and exclusion criteria, and patient characteristics were stated No loss to follow up due to retrospective cohort design Appropriate statistical analysis Confounding factors measured across groups Authors report no conflicts of interest	Mortality is described as an out in the methods, but not mentioned in the rest of the paper Not possible to blind patients or those collecting the data from patient charts Sample size not calculated
Onur, 2013[18]	
The objective was clearly stated The inclusion and exclusion criteria, and patient characteristics were stated No loss to follow up Authors report no conflicts of interest	Complications and readmission to the hospital are listed as outcomes in the methods, but not mentioned in the rest of the paper Not possible to blind patients or those collecting the data Inappropriate statistical analyses Patient preference was used to select the surgical procedure, but alternative options only offered after previous options rejected Major confounding factor (age) not adjusted for in the analyses Sample size not calculated Findings overstated or misinterpreted

Table 7: Strengths and Limitations of Guidelines using AGREE II[6]

Item	Guideline		
	ESPGHAN, 2017 [19]	NICE 2017 [20]	ACC 2016 [21]
Domain 1: Scope and Purpose			
1. The overall objective(s) of the guideline is (are) specifically described.	Yes	Yes	Yes
2. The health question(s) covered by the guideline is (are) specifically described.	Yes	yes	Yes
3. The population (patients, public, etc.) to whom the guideline is	Yes	Yes	Yes

Item	Guideline		
meant to apply is specifically described.			
Domain 2: Stakeholder Involvement			
4. The guideline development group includes individuals from all relevant professional groups.	No	Yes	No
5. The views and preferences of the target population (patients, public, etc.) have been sought.	No	Yes	No
6. The target users of the guideline are clearly defined.	No	Yes	No
Domain 3: Rigour of Development			
7. Systematic methods were used to search for evidence.	Yes	Yes	No
8. The criteria for selecting the evidence are clearly described.	Yes	Yes	No
9. The strengths and limitations of the body of evidence are clearly described.	No	Yes	No
10. The methods for formulating the recommendations are clearly described.	Yes	Yes	No
11. The health benefits, side effects, and risks have been considered in formulating the recommendations.	Yes	Yes	Yes
12. There is an explicit link between the recommendations and the supporting evidence.	Yes	Yes	Yes
13. The guideline has been externally reviewed by experts prior to its publication.	Yes	Yes	No
14. A procedure for updating the guideline is provided.	No	Yes	No
Domain 4: Clarity of Presentation			
15. The recommendations are specific and unambiguous.	Yes	Yes	Yes
16. The different options for management of the condition or health issue are clearly presented.	Yes	Yes	Yes
17. Key recommendations are easily identifiable.	Yes	Yes	Yes
Domain 5: Applicability			
18. The guideline describes facilitators and barriers to its application.	No	Yes	No
19. The guideline provides advice and/or tools on how the recommendations can be put into practice.	No	No	No
20. The potential resource implications of applying the recommendations have been considered.	No	Yes	No
21. The guideline presents monitoring and/or auditing criteria.	No	Yes	No
Domain 6: Editorial Independence			
22. The views of the funding body have not influenced the content of the guideline.	No	No	Yes
23. Competing interests of guideline development group members have been recorded and addressed.	Yes	No	Yes

Appendix 4: Main Study Findings and Authors' Conclusions

Table 8: Summary of Findings Included Systematic Reviews and Meta-Analyses

Main Study Findings	Authors' Conclusion
Alkhawaja, 2015[8]	
The following outcomes were significantly different between pyloric feeding tubes and gastric feeding tubes: **Pneumonia:** RR = 0.65; 95% CI, 0.51 to 0.84 - 9 studies, N = 819 - Moderate quality evidence (author's appraisal) **Percentage of total nutrition delivered**: 7.8 higher; 95% CI, 1.43 to 14.18 higher - 7 studies, N = 692 - Low quality evidence (author's appraisal) **Time to start feeding:** Mean difference = 11.05; 95% CI, 3.05 to 19.05 - 5 studies, N = 374 - Quality of the evidence not evaluated by the authors The following outcomes were <u>not</u> significantly different between pyloric feeding tubes and gastric feeding tubes: **Mortality**: RR = 1.03; 95% CI, 0.83 to 1.29 - 11 studies, N = 977 - Moderate quality evidence (author's appraisal) **Time required to achieve full nutritional target (hours):** 1.99 lower; 95% CI, 10.97 lower to 6.99 higher - 5 studies, N = 432 - Very low quality evidence (author's appraisal) **Duration of mechanical ventilation (days)**: 0.92 lower; 95% CI, 2.11 lower to 0.28 higher - 5 studies, N = 549 - Moderate quality evidence (author's appraisal) **Complications related to tube insertion:** RR = 0.51; 95% CI, 0.19 to 1.36 - 4 studies, N = 324 - Low quality evidence (author's appraisal) **Complications related to tube maintenance:** RR = 1.63; 95% CI, 0.93 to 2.86 - 7 studies, N = 638 - Low quality evidence (author's appraisal) **ICU Length of stay (days):** Mean difference = -0.70; 95% CI, -17.16 to 9.19 - 7 studies, N = 585 - Quality of the evidence not evaluated by the authors	"*Some benefit for post-pyloric feeding compared with feeding by the gastric route for critically ill adult patients. We found evidence of moderate quality for a lower rate of pneumonia and evidence of low quality for an increase in the percentage of nutrients delivered to the participant. However, these outcomes were not reflected in other important clinical outcomes such as duration of mechanical ventilation, mortality and ICU length of stay, which did not differ between the two groups*." p21 "*We found no evidence that participants fed by post-pyloric tube reach their full nutritional target earlier than those fed by gastric tube, regardless of whether the tube was inserted under fluoroscopic guidance/endoscopy or blindly at the bedside*." p21 "*Our results revealed no significant differences in adverse effects between the two groups. No evidence suggested that post-pyloric feeding was associated with an increase in gastrointestinal complications such as vomiting or diarrhoea, and no evidence was found of an increase in the rate of complications related to tube insertion, such as upper gastrointestinal bleeding, or of complications related to tube maintenance, such as the need for tube replacement, repositioning or blockage*." p21

Main Study Findings	Authors' Conclusion
Vomiting: RR = 1.01; 95% CI, 0.54 to 1.89 - 6 studies, N = 543 - Quality of the evidence not evaluated by the authors **Diarrhoea:** RR = 0.96; 95% CI, 0.74 to 1.25 - 8 studies, N = 675 - Quality of the evidence not evaluated by the authors	
Sajid, 2014[10]	
The following outcomes were significantly different between NG and post-pyloric feeding tubes: **Aspiration pneumonia:** OR = 1.41; 95% CI, 1.01 to 1.98, *P* < 0.04 - 17 studies, N = 1208 - High quality of evidence (author's appraisal) **Incidence of high gastric residual volume:** OR = 3.95; 95% CI, 1.19 to 13.14, *P* < 0.03 - 7 studies, N = 565 - Moderate quality evidence (author's appraisal) The following outcomes were <u>not</u> significantly different between NG and post-pyloric feeding tubes: **Gastrointestinal complications** (nausea, vomiting, diarrhoea, abdominal distension, reflux and gastrointestinal minor or major bleeding)**:** OR = 0.96; 95% CI, 0.56 to 1.64, *P* = 0.87 - 13 studies, N = 974 - High quality evidence (author's appraisal) **Mortality:** OR = 0.86; 95% CI, 0.64 to 1.15, *P* = 0.31 - 16 studies, N = 1346 - Moderate quality evidence (author's appraisal) **Length of stay in ITU**: Standardized mean difference = 0.15 SD lower; 95% CI, 0.39 lower to 0.09 higher, *P* = 0.23 - 11 studies, N = 882 - Moderate quality evidence (author's appraisal) **Reduced caloric delivery:** Standardized mean difference = 1.02 SD lower; 95% CI, 1.73 to 0.31 lower - 10 studies, N = 773 - Moderate quality evidence (author's appraisal)	*"the risk of developing aspiration pneumonia in ITU patients was statistically lower following the use of post-pyloric feeding."* p429 "*the risk of developing gastrointestinal complications such as nausea, vomiting, diarrhoea, abdominal distension, reflux and gastrointestinal minor or major bleeding in ITU patients was statistically similar in both groups. However, this outcome may be considered inadequate and biased owing to the presence of significant heterogeneity among included studies.*" p429 *"overall mortality was statistically similar in NG and post-pyloric feeding groups*." p429 "*the length of ITU stay was similar between NG feeding and post-pyloric feeding groups. However, this outcome may be considered inadequate and biased due the presence of significant heterogeneity among included studies*." p429
Jiyong, 2013[9]	
The following outcomes were significantly different between post-pyloric and gastric feeding tubes: **Pneumonia**: RR = 0.63; 95% CI, 0.48 to 0.83, *P* = 0.001 - 10 studies, N = 757	"*The principal finding of the present study was that the use of post-pyloric feeding instead of gastric feeding in patients with critical illness was associated with a decrease in the incidence of pneumonia*" p12

Main Study Findings	Authors' Conclusion
- High quality studies only (author's appraisal) (7 studies): RR = 0.59; 95% CI, 0.42 to 0.82, P = 0.002 The following outcomes were not significantly different between post-pyloric and gastric feeding tubes: **Aspiration**: RR = 1.11; 95% CI, 0.80 to 1.53, *P* = 0.55 - 7 studies - High quality studies only (author's appraisal) (3 studies): RR = 1.59; 95% CI, 0.34 to 7.41, *P* = 0.243 - Omitting pediatric studies: RR = 0.97; 95% CI, 0.51 to 1.84, *P* = 0.91 **Vomiting**: RR = 0.80; 95% CI, 0.38 to 1.67, *P* = 0.56 - 6 studies - High quality studies only (author's appraisal) (2 studies): RR = 0.14; 95% CI, 0.03 to 0.58, *P* = 0.007 - Omitting pediatric studies: RR = 0.624; 95% CI, 0.175 to 2.224, *P* = 0.47	"*And we also found that the beneficial effect of post-pyloric on pulmonary infection was not accompanied with increased gastroesophageal regurgitation*" p13-14 "*Post-pyloric feedings should be used in the intensive care units where obtaining small-bowel access is feasible. Although we also found that the rates of aspiration and vomiting were similar between different routes of enteral nutrition*." p14
Watson, 2013[11]	
The following outcomes were significantly different between transpyloric and gastric feeding tubes: **Death prior to hospital discharge**: RR = 2.46; 95% CI, 1.36 to 4.46 - 6 studies, N = 245 - Excluding one study with suspected preferential allocation of sicker infants to the transpyloric group: RR = 2.19; 95% CI, 0.89 to 5.35 **Gastrointestinal disturbance (including diarrhoea) prior to hospital discharge**: RR = 1.48; 95% CI, 1.05 to 2.09 - 7 studies, N = 297 The following outcomes were not significantly different between transpyloric and gastric feeding tubes: **Growth, change in weight (g per week):** mean difference = -5.50; 95% CI, -26.88 to 15.89 - 4 studies, N = 93 **Necrotising enterocolitis prior to hospital discharge:** RR = 0.63; 95% CI, 0.26 to 1.53 - 7 studies, N = 298 **Aspiration pneumonia prior to hospital discharge:** RR = 1.35; 95% CI, 0.44 to 4.14 - 5 studies, N = 171 **Intestinal perforation prior to hospital discharge**: RR = 2.31; 95% CI, 0.10 to 50.85	*"We did not find any evidence of benefit of transpyloric compared with gastric feeding in preterm infants. We found some evidence that transpyloric feeding increases the risk of gastrointestinal disturbance and mortality. However, many of the studies included in the review had a variety of methodological weaknesses and these findings need to be interpreted and applied with caution"* p10

ICU = intensive care unit; ITU = intensive therapy unit; NG = nasogastric; OR = odds ratio; RR = risk ratio; SD = standard deviation

Table 9: Summary of Findings of Included Primary Clinical Studies

<table>
<tr><th>Main Study Findings</th><th>Authors' Conclusion</th></tr>
<tr><td colspan="2">Zener, 2018[17]</td></tr>
<tr><td>Overall 30-day complication rate: GJ = 13.5% vs. G = 5.8%, P = 0.049

30-day major complication rate: GJ = 1.7% vs. G = 1.2%, P = 1.0
- Includes: Intra-abdominal sepsis requiring surgical intervention and intra-abdominal sepsis leading to death

30-day minor complication rate: GJ = 11.8% vs. G = 4.7%, P = 0.056
- Includes: minor leak, peri-stomal infection, tube malfunction, pain

Mortality rate: not compared across feeding tube types</td><td>"Percutaneous G and GJ tube insertion are relatively safe procedures with overall low major complication rates. There was no statistically significant difference in complication rates among indications for insertion and underlying primary diagnosis" p107

"Despite a predilection for G over GJ tube insertion in certain patient populations, our large study has demonstrated that there are no significant differences in 30-day major complication or procedure- related mortality for GJ and G tube placement using the a single puncture, dual-anchor technique described, and therefore GJ placement is still valid when required to avoid the increased risk of GER." p107</td></tr>
<tr><td colspan="2">Guilbaud, 2017[13]</td></tr>
<tr><td>NG = NG tube with TPN
G = G tube with TPN
GJ = GJ tube with EN

<table>
<tr><td></td><td></td><td></td><td></td><td>P value</td><td></td></tr>
<tr><td></td><td>GJ (n =12)</td><td>NG (n = 31)</td><td>G (n = 43)</td><td>GJ vs. NG</td><td>GJ vs. G</td></tr>
<tr><td>% Mortality</td><td>17</td><td>0</td><td>7</td><td>0.07</td><td>0.30</td></tr>
<tr><td>% Overall morbidity</td><td>92</td><td>61</td><td>77</td><td>0.07</td><td>0.42</td></tr>
<tr><td>% Severe morbidity</td><td>50</td><td>48</td><td>60</td><td>1.00</td><td>0.53</td></tr>
<tr><td>% Reoperation</td><td>7</td><td>0</td><td>12</td><td>0.07</td><td>0.64</td></tr>
<tr><td>% ICU hospitalization</td><td>50</td><td>45</td><td>67</td><td>1.00</td><td>0.32</td></tr>
<tr><td>ICU length of stay (days)</td><td>5 (10)</td><td>2 (3)</td><td>3 (8)</td><td>0.11</td><td>0.78</td></tr>
<tr><td>Nutrition time (days)</td><td>13 (10)</td><td>9 (12)</td><td>19 (16)</td><td>0.16</td><td>0.81</td></tr>
<tr><td>Length of hospital stay (days)</td><td>27 (12)</td><td>22 (13)</td><td>29 (16)</td><td>0.16</td><td>0.81</td></tr>
<tr><td>% 30 day readmission</td><td>17</td><td>16</td><td>19</td><td>1.00</td><td>1.00</td></tr>
</table>
Values in parentheses are standard deviation

Cost Analysis
<table>
<tr><td>Cost</td><td></td><td></td><td></td><td>P value</td><td></td></tr>
<tr><td></td><td>GJ</td><td>NG</td><td>G</td><td>GJ vs. NG</td><td>GJ vs. G</td></tr>
<tr><td>Nutrition cost (Euros)</td><td>843 (336)</td><td>773 (177)</td><td>1884 (252)</td><td>1.00</td><td><0.01</td></tr>
</table>
</td><td>"The mortality rate was 6% and was in accordance with the literature, with no difference between the three groups. However, the morbidity rate was 73%, including 55% severe morbidity (Clavien-Dindo grade 3/4), and tended to be higher in the GT and GJ groups in univariate analyses." p7

"Considering the costs of different devices, nutritional protocols, and length of hospital stay, we found no advantages to EN through a GJ tube when compared to an NG tube or a G tube with TPN in our series." p8</td></tr>
</table>

Main Study Findings	Authors' Conclusion

Global hospitalization cost (Euros)	18,854 (3127)	14,226 (1797)	21,026 (1889)	0.22	1.00

Values in parentheses are standard deviation

Hamilton, 2017[14]

Frequency of complications for a minimum of 30 days and until the patient had the tube removed, died, or was lost to follow up.

	J (n = 10)	G (n = 75)	J and G (n = 37)	*P* value
% Any complication	80	53	62	0.24
% Major complication	40	16	11	0.08

Major complications = any unplanned event resulting in admission to the hospital or a complication-related surgical or interventional procedure.
Minor complications = peritubal wound infection or inflammation, tube dislodgement, tube blockage, chronic pain, tube leakage, granulation tissue, feeding intolerance, bleeding, pneumonia, urinary tract infection, fever, other non-infectious adverse events, and other systemic adverse events

Prediction of any surgery complication:
J and G vs. G: OR = 1.99; 95% CI, 0.70 to 5.68, *P* = 0.80
J vs. G: OR = 5.31; 95% CI, 0.93 to 30.30, *P* = 0.12
Multivariate analysis covariates include: concomitant laparotomy, steroid use, surgical technique, abdominal radiation

Prediction of major surgery complication:
J and G vs. G: OR = 0.52; 95% CI, 0.14 to 1.90, *P* = 0.06
J vs. G: OR = 3.44; 95% CI, 0.76 to 15.52, *P* = 0.04
Multivariate analysis covariates include: surgical technique

"*There was a trend for jejunostomy tubes to be associated with major complications. In total, 40% (4) of patients with jejunostomy tubes had major complications, compared with 16% (12) of patients with gastrostomy tubes, and 11% (4) with separate gastrostomy and jejunostomy tubes (P=0.08*)." pe344

"*There were no patient or surgical factors associated with having any complications or major complications that reached statistical significance on multivariate analysis.*" pe344

"*In our multivariate analysis, patient and procedure-associated risk factors for any complication were not readily identified. However, there was a trend for jejunostomy tubes, PEG tubes, and abdominal radiation to be associated with the development of any complication and placement of a jejunostomy tube to be associated with major complications.*" pe344

Ronning, 2017[16]

Emergency department visits owing to a complication of a G or GJ tube. Multiple visits by the same patient were treated as separate complications.

Type of complication:

	Number of complications		
	GJ	G	OR
Dislodgement	18	14	OR = 2.1; 95% CI, 0.9 to 4.6, *P* = 0.06
Clogging	1	6	OR = 0.1; 95% CI, 0.0 to 0.9, *P* = 0.06
Leaking	0	1	OR = 0.5; 95% CI, 0.2 to 1.5, *P* = 0.2
Other	1	0	OR = 0.5; 95% CI, 0.2 to

"*The most common causes of feeding tube problems in our patient population were dislodgement and clogging, which is consistent with previous studies*" pe73

"*In our study, children with GJ complications had a higher charge per emergency department visit than children with G complications*." pe73

"Although Gs and GJs had similar rates of complications and emergency department visits, GJ complications were more likely to result in hospital admission and intervention by radiology, require specialist involvement, and result in significant additional cost charged" pe73

Main Study Findings	Authors' Conclusion

			1.5, *P* = 0.2

The children with GJ tubes were older than those with G tubes (7.1 vs. 2.8 years, *P* <0.0001)

Cost Data (reported as charge to the patient):
Mean GJ charge: US $1987
Mean G charge: US $913.10
P value for the difference in cost: *P* = 0.052

Ao, 2015[12]

Follow up time: J = 357 ± 45 days vs. PEG = 344 ± 37 days, *P* = 0.825

	J (n = 64)	PEG (n = 65)	*P* value
% Patients requiring non-routine tube replacement	45.3	13.8	<0.001
Days to first tube replacement, mean (standard error)	160 (26.3)	331 (53.6)	0.010
Indications for tube replacement			
% Obstruction	22.2	12.1	0.305
% Dislodged	35.6	27.2	0.518
% Leakage	13.3	6.1	0.348
% Infection	10.0	0	0.111

"*In the present study, J-tubes had higher rates of tube replacement at 48.4% compared with PEG tubes at 21.5% (P = .002). Factoring out routine tube replacement, there is a significant difference in tube-related complications requiring replacement between the J-tube cohort and the PEG tube group at 45.3% and 13.8%, respectively*" p396

"*Not only were J-tubes associated with higher complication rates, but they were also prone to earlier complications post insertion. J-tubes required replacement much earlier than did PEG tubes*" p396

"*However, in individuals who require postpyloric enteral nutrition, J-tubes remain a viable alternative, notwithstanding a higher risk of tube-related complications, as shown by the present study. Given the higher rate of complications with J-tube–related feeds, patients with J-tubes may benefit from more frequent follow-up than their PEG tube cohorts*." p397

Huang, 2014[15]

	G	J	*P* value
Median length of hospital stay (days)	11	15	<0.001
Median time to removal of feeding tube	9	14	<0.001
Intubation time (days [standard deviation])	4.5 (2.3)	8.0 (2.6)	<0.001
Surgical Complications			
% Wound infection	7.4	11.1	0.303
% Anastomotic leak	4.1	6.5	0.385
% Chylous leaking	1.7	2.0	0.850
% Arrhythmias	10.7	12.4	0.668
% Pneumonia	11.6	26.1	0.003
Catheter related complications			
% Wound infection	1.7	6.5	0.050
% Peritonitis	0	7.2	0.003
% Catheter displacement	0	1.3	0.207
% Catheter blockade	3.3	5.9	0.319
Digestive system complications			
% Bowel obstruction	0	7.2	0.003
% Abdominal distension	9.1	19	0.022

"*Our data show a clear advantage for G over J. In 153 J patients, we recorded a longer intubation time of the indwelling stomach tube and higher incidences of three complications, including 11 bowel obstructions, 11 cases of peritonitis, and 40 cases of pneumonia. In contrast, 121 patients that underwent G had no or few feeding tube or digestive tract associated complications and a lower incidence of pulmonary infection*." pe89190

Main Study Findings	Authors' Conclusion

% Backflow	10.7	13.7	0.457

Values in parentheses are % or standard deviation

Onur, 2013[18]

Mean age: PEG patients were older (88.31 ± 4.62) than ND/NJ (73.5 ± 10.06) and oral feeding groups (72.57 ± 8.13) (*P* < 0.001)

Caregiver satisfaction score (scoring system 0 to 10)

	PEG	ND/NJ	Oral	*P* value across groups
1st week	6.55 (0.736)	6.02 (0.643)	7.96 (0.475)	< 0.0005
1st month	7.31 (1.65)	6.95 (1.306)	7.22 (2.11)	> 0.05
3rd month	7.55 (2.114)	3.64 (2.574)	3.83 (2.424)	< 0.0005
6th month	5.90 (3.802)	2.57 (2.624)	1.57 (2.107)	< 0.0005

Mean (standard deviation)

Satisfaction scores in the PEG group were higher than the other two at 6 months (P < 0.001)

Re-aspiration rates: between groups, *P* < 0.05
PEG: 58%
ND/NJ: 78%
Oral: 91%

During the 6 month follow-up, only 1 of 34 men died, and 32 of 60 women died. As such, only women were considered in the mortality analysis.

Estimated mean survival in women: significantly lower in the ND/NJ feeding group (Log-rank, Mantel-Cox: P < 0.001).
PEG: 4.765 months, SE: 0.358
ND/NJ: 2.050 months, SE: 0.296
Oral: 4.696 months, SE: 0.458

"*We found that re-aspiration within 6 months of enteral feeding in these patients were higher in oral feeding than NJ and PEG. PEG may have a beneficial effect over NJ with regard to aspiration*." p3

"*We have seen that Satisfaction Scores in the PEG group were higher than the other two at 6th month. We think this was due to PEG feeding is better tolerated by patients than NJ and oral feeding. It is more comfortable and much easier to manage also for caregiver*." p3

EN = enteral nutrition; G = gastrostomy; GJ = gastrojejunostomy; J = jejenostomy; NG = nasogastric; ND/NJ = nasoduodenal/nasojejunal; PEG = percutaneous endoscopy gastrostomy; SE = standard error; TPN = total parenteral nutrition

Table 10: Summary of Recommendations in Included Guidelines

Recommendations	Strength of Evidence and Recommendations
European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) Guidelines for the Evaluation	

Recommendations	Strength of Evidence and Recommendations
and Treatment of Gastrointestinal and Nutritional Complications in Children With Neurological Impairment, 2017[19]	
"ESPGHAN Working group recommends using a gastrostomy as the preferred way to provide intragastric access for long-term tube feeding in children with neurological impairment." (p257) - Prospective randomized studies in children, comparing NG with G feeding in children are not available. - In adults with swallowing difficulties, a Cochrane review showed that PEG was associated with a lower probability of intervention failure. PEG was found to cause less discomfort, to be more convenient, and to interfere less with social activities. There was no difference in mortality rates, adverse events, aspiration pneumonia - A prospective cohort study of 57 children with neurological impairment with gastrostomy, showed an increase in weight gain, improved health, and reduction in feeding time with no increase in respiratory infections	Level of evidence = moderate
"ESPGHAN working suggests using jejunal feeding in cases of aspiration due to gastroesophageal reflux disease, refractory vomiting, retching, and bloating in children with neurological impairment." (p.258) - Mean functional duration of these tubes was found to be 55 days in adults and 39 days in children. - Retrograde dislodgment of the jejunal extension tube, tube obstruction, and mechanical failure are the most common device-related complications - Jejunal feeding is appropriate in patients with recurrent vomiting and/or tube feeding-related aspiration, severe gastroesophageal reflux, and gastroparesis - The combination of gastric decompression via PEG and simultaneous jejunal nutrition provides clinical benefit in patients with neurological impairment	Level of Evidence = moderate
National Institute for Clinical Excellence (NICE), Nutrition Support for Adults Oral Nutrition Support, Enteral Tube Feeding and Parenteral Nutrition, updated 2017[20]	
Nasogastric (NG) versus nasoduodenal (ND) or nasojejunal (NJ) tubes Recommendations: "People in general medical, surgical and intensive care wards who are malnourished or at risk of malnutrition and have inadequate or unsafe oral intake and a functional, accessible gastrointestinal tract should be fed via a tube into the stomach unless there is upper gastrointestinal dysfunction." (p117)	Evidence Grade = A (i)At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population, or (ii)A systematic review of RCTs or a body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results or (iii) Evidence drawn from a NICE technology appraisal
"People who are malnourished or at risk of malnutrition and have inadequate or unsafe oral intake and a functional, accessible gastrointestinal tract with upper gastrointestinal dysfunction (or an inaccessible upper gastrointestinal tract) should be considered for post-pyloric (duodenal or jejunal) feeding." (p117)	Evidence Grade = D (GPP) A good practice point (GPP) is a recommendation for best practice based on the experience of the Guideline Development Group

Recommendations	Strength of Evidence and Recommendations
Clinical evidence: - **14 RCTs (707 patients) comparing NG** feeding with nasoduodenal **or nasojejunal feeding found n**o significant differences in mortality, length of stay in intensive care or hospital, incidence of pneumonia, vomiting or diarrhoea. - Two studies reported the mean weight change, one showed no difference while the other reported a significant weight gain for the NG group. However, the weight change for the latter study was only recorded for 21 of the 38 patients entered into the study. - Four out of the five studies reported no difference in the percent of prescribed calorie intake but one showed the nasojejunal patients achieving a significantly higher percent of their daily goal caloric intake than the NgGpatients.	
ACG Clinical Guideline: Nutrition Therapy in the Adult Hospitalized Patient [21]	
"A nasogastric or orogastric feeding tube should be used as the initial access device for starting EN in a hospitalized patient" (p. 320) - Evidence from an RCT involving patients with APACHE II Scores>20, the use of small bowel feeding significantly reduced hospital length of stay, decreased total complications, and increased EN delivery compared with gastric feedings. But there was no difference in the in patients with APACHE II Scores<20 - Evidence from a meta-analysis of 12 RCTs showed a reduction in ventilator-associated pneumonia with small bowel compared with gastric feeding; but no change in duration of mechanical ventilation, hospital length of stay, and mortality	Conditional recommendation, very low level of evidence
"Radiologic confirmation of placement in the stomach should be carried out prior to feeding (except with the use of electromagnetic transmitter-guided feeding tubes). Repeated periodic radiologic confirmation of correct tube position in the GI tract is not required unless there is concern for tube displacement because of nausea/vomiting, regurgitation, coughing, retching, or overt displacement" (p324) - Radiologic confirmation of placement of a nasoenteric or an oroenteric tube is required - Alternative methods (e.g., auscultation, detection of CO_2 , measurement of pH) are not accurate enough	Conditional recommendation, very low level of evidence
"Conversion to a post-pyloric feeding tube should be carried out only when gastric feeding has been shown to be poorly tolerated or the patient is at high risk for aspiration" (p. 324) - Placement of a feeding tube in the small bowel requires greater expertise, which may lead to delays in initiation of feeding	Strong recommendation, moderate-to-high level of evidence
"Simultaneous aspiration/decompression of the stomach with jejunal feeding may be accomplished by using a dual lumen aspirate/feed nasoenteric tube, a combined percutaneous	Conditional recommendation, very low level of evidence

Recommendations	Strength of Evidence and Recommendations
gastrojejunostomy (GJ) tube, or the use of both gastrostomy and jejunostomy tubes" (p324)	
"When long-term enteral access is needed in a patient with gastroparesis or chronic pancreatitis, a jejunostomy tube should be placed" (p324) - If the patient demonstrates intolerance and evidence of gastroparesis in the days following gastrostomy tube placement, the access device is better positioned to be converted to a GJ tube	Conditional recommendation, very low level of evidence
"A percutaneous enteral access device should be placed, either via the gastric or the jejunal route, if enteral feeding is anticipated to be required for >4-week duration" (p324) - The 4-week cutoff is arbitrary. It is based on the potential morbidity of a nasoenteric tube, which includes erosion of the nares, an increase in aspiration pneumonia, sinusitis, and esophageal ulceration or stricture	Conditional recommendation, very low level of evidence
"A percutaneous gastrostomy should be placed preferentially in the gastric antrum in order to facilitate conversion to a GJ tube in the event that the patient is intolerant to gastric feeding" (p324) - In this position, there is apposition of the stomach to the anterior abdominal wall over a greater surface area, and the pathway into the stomach is shorter and more perpendicular than the more traditional position - The access device is better positioned to be converted to a GJ tube	Conditional recommendation, very low level of evidence
"For the patient at high risk for tube displacement, steps should be taken proactively to secure the access device at the time of placement" (p324) - Evidence from a meta-analysis showed that the use of a nasal bridle nearly eliminates displacement - **P**lacement with a T-fastener or "T-Tacks" keeps the stomach adherent to the anterior wall, facilitating replacement	Conditional recommendation, very low level of evidence

ACG = American College of Gastroenterology; ESPGHAN = European Society for Paediatric Gastroenterology, Hepatology and Nutrition ; G = gastrostomy; NG = nasogastric; NICE = National Institute for Clinical Excellence; PEG = percutaneous endoscopy gastrostomy

Appendix 5: Overlap between Included Systematic Reviews

Primary Study Citation	Systematic Review Citation			
	Alkhawaja, 2015[8]	Sajid, 2014[10]	Jiyong, 2013[9]	Watson, 2013[11]
Acosta-Escribano 2010	✓	✓	✓	
Boivin 2001	✓	✓		
Davies 2002	✓	✓	✓	
Davies 2012	✓	✓		
Day 2001	✓	✓	✓	
Esparza 2001	✓		✓	
Hsu 2009	✓	✓	✓	
Kearns 2000	✓	✓	✓	
Kortbeek 1999	✓	✓	✓	
Montecalvo 1992	✓	✓	✓	
Montejo 2002	✓	✓	✓	
Neumann 2002	✓	✓	✓	
White 2009	✓	✓	✓	
Zeng 2010	✓			
Eatock 2005		✓		
Heyland 2001		✓	✓	
Hsu 2006		✓		
Kumar 2006		✓	✓	
Meert 2004		✓	✓	
Singh 2012		✓		
Strong 1992		✓		
Taylor 1999		✓		
Kamat 2008			✓	
Drew 1979				✓
Laing 1986				✓

Primary Study Citation	Systematic Review Citation			
	Alkhawaja, 2015[8]	Sajid, 2014[10]	Jiyong, 2013[9]	Watson, 2013[11]
Macdonald 1992				✓
Pereira 1981				✓
Pyati 1976				✓
Roy 1977				✓
Van Caille 1975				✓
Wells 1975				✓
Whitfield 1982				✓

Appendix 6: Additional References of Potential Interest

Systematic reviews

All of the studies in those two reviews were fully captured in two of the more comprehensive reviews already included in the report, and were thus excluded to avoid overlap.

Chang YS, Fu HQ, Xiao YM, Liu JC. Nasogastric or nasojejunal feeding in predicted severe acute pancreatitis: a meta-analysis. Crit Care. 2013 Jun 20;17(3):R118.

PubMed: PM23786708

Zhang Z, Xu X, Ding J, Ni H. Comparison of postpyloric tube feeding and gastric tube feeding in intensive care unit patients: a meta-analysis. Nutr Clin Pract. 2013 Jun;28(3):371-80.

PubMed: PM23614960

Guidelines with Unclear Methodology

WRHP. Adult enteral nutrition: clinical practice guideline. Winnipeg (MB): Winnipeg Regional Health Authority (WRHP); 2017 Mar. http://www.wrha.mb.ca/extranet/eipt/files/EIPT-34-005.pdf

No direct comparison to J tubes (Rapid Review of Gastronomy)

Collins K, Gaffney L, Tan J. Gastrostomy guidelines: a rapid review. Haymarket NSW, Australia: SAX Institute; 2013 Jul. https://www.saxinstitute.org.au/wp-content/uploads/Gastrostomy-guidelines-a-rapid-review.pdf

Not a direct comparison: PEG was changed to PEG-J following aspiration pneumonia

Lawinski M, Gradowski L, Bzikowska A, Goszczynska A, Jachnis A, Forysinski K. Gastrojejunostomy inserted through peg (peg-j) in prevention of aspiration pneumonia. Clinical nutrition complication in dysphagic patients. Polski Przeglad Chirurgiczny. 2014 May;86(5):223-9.

PubMed: PM24988240