Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances (Review)

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[Intervention Review]

Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

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ABSTRACT

Background

A number of conditions compromise the passage of food along the digestive tract. Nasogastric tube (NGT) feeding is a classic, time-proven technique, although its prolonged use can lead to complications such as lesions to the nasal wing, chronic sinusitis, gastro-oesophageal reflux, and aspiration pneumonia. Another method of infusion, percutaneous endoscopy gastrostomy (PEG), is generally used when there is a need for enteral nutrition for a longer time period. There is a high demand for PEG in patients with swallowing disorders, although there is no consistent evidence about its effectiveness and safety as compared to NGT.

Objectives

To evaluate the effectiveness and safety of PEG as compared to NGT for adults with swallowing disturbances, by updating our previous Cochrane review.

Search methods

We searched *The Cochrane Library*, MEDLINE, EMBASE, and LILACS from inception to September 2011, as well as contacting main authors in the subject area. There was no language restriction in the search.

Selection criteria

We planned to include randomised controlled trials comparing PEG versus NGT for adults with swallowing disturbances or dysphagia and indications for nutritional support, with any underlying diseases. The primary outcome was intervention failure (e.g. feeding interruption, blocking or leakage of the tube, no adherence to treatment).

Data collection and analysis

Review authors performed selection, data extraction and evaluation of methodological quality of studies. For dichotomous and continuous variables, we used risk ratio (RR) and mean difference (MD), respectively with the random-effects statistical model and 95% confidence interval (CI). We assumed statistical heterogeneity when $I^2 > 50\%$.

Main results

We included nine randomised controlled studies. We did not identify new eligible studies published after our previous review literature search date (August 2009). Intervention failure occurred in 19/156 patients in the PEG group and 63/158 patients in the NGT group (RR 0.24, 95%CI 0.08 to 0.76, P = 0.01) in favour of PEG. There was no statistically significant difference between comparison groups in complications (RR 1.00, 95%CI 0.91 to 1.11, P = 0.93).

Authors' conclusions

PEG was associated with a lower probability of intervention failure, suggesting the endoscopic procedure is more effective and safe as compared to NGT. There is no significant difference of mortality rates between comparison groups, and pneumonia irrespective of underlying disease (medical diagnosis). Future studies should include previously planned and executed follow-up periods, the gastrostomy technique, and the experience of the professionals to allow more detailed subgroup analysis.

PLAIN LANGUAGE SUMMARY

Nutritional support for adults with swallowing difficulties

A number of conditions compromise the transport of food along the digestive tract. Patients with swallowing disturbances can develop low nutritional status, which affects their recovery from illness, surgery, and injury. Conditions associated with swallowing disorders include neurological diseases, dementia, cancers of the head and neck, amyotrophic lateral sclerosis, physical obstruction, and dysphagia from stroke. Nasogastric tube feeding is a time proven technique to provide nutritional support; the tube can be inserted by a nurse. Percutaneous endoscopy gastrostomy (PEG) involves a feeding tube inserted directly into the stomach through the abdomen and is particularly useful when enteral nutrition is needed for a length of time. Prolonged use of a nasal tube can lead to complications such as damage to the nose and larynx, chronic sinusitis, gastro-oesophageal reflux, and aspirative pneumonia.

We obtained updated evidence for this review from nine controlled studies comparing a nasogastric tube with PEG in a total of 686 patients. Seven studies measured feeding interruption, blocking or leakage of the feeding tube or lack of adherence to treatment in 314 patients randomised to either a nasal gastric tube or PEG. The studies showed a higher probability of treatment failure and development of pneumonia with a nasal gastric tube. The number of deaths was no different with the two methods; nor was the overall occurrence of complications. Possible limitations of this review include the small number of participants in the majority of studies, explained by the high cost of PEG and requirements for endoscopy in its use, the operational challenges to accomplish a clinical trial in this area and the different length of follow-up of the patients in the studies (from no more than four weeks to six months).

SUMMARY OF FINDINGS FOR THE MAIN COMPARISON [Explanation]

Percutaneous endoscopic gastrostomy compared with nasogastric tube feeding for adults with swallowing disturbances

Patient or population: adult patients with swallowing disturbances
Settings: in-patient
Intervention: percutaneous endoscopic gastrostomy
Comparison: nasogastric tube feeding

Outcomes	Illustrative comparative risks* (95% CI)		Relative effect (95% CI)	No of Participants (studies)	Quality of the evidence (GRADE)	Comments
	Assumed risk	Corresponding risk				
	Nasogastric tube feeding	Percutaneous endoscopic gastrostomy				
Treatment failure Feeding interruption, blocking or leakage of the tube, non-adherence Follow-up: 0 to 6 months	**Study population**		**RR 0.24** (0.08 to 0.76)	314 (7 studies)	⊕⊕◯◯ **low**[1,2]	The subgroup of stroke/ neurological diseases was associated with a lower risk of intervention failure compared with the subgroup composed of mixed diseases
	40 per 100	**10 per 100** (3 to 30)				
	Low					
	20 per 100	**5 per 100** (2 to 15)				
	High					
	95 per 100	**23 per 100** (8 to 72)				
Mortality irrespective of follow-up time Follow-up: 0 to 6 months	**36 per 100**	**34 per 100** (23 to 51)	**RR 0.96** (0.64 to 1.44)	584 (8 studies)	⊕◯◯◯ **very low**[1,2,3]	

Pneumonia irrespective of follow-up time Follow-up: 0 to 6 months	**39 per 100**	**33 per 100** (24 to 45)	**RR 0.84** (0.61 to 1.14)	585 (6 studies)	⊕⊕◯◯ **low**[1,3]
Complications irrespective of follow-up time Follow-up: 0-17 months	**43 per 100**	**43 per 100** (39 to 47)	**RR 1** (0.91 to 1.11)	503 (5 studies)	⊕⊕⊕◯ **moderate**

*The basis for the **assumed risk** (e.g. the median control group risk across studies) is provided in footnotes. The **corresponding risk** (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).
CI: Confidence interval; **RR:** Risk ratio;

GRADE Working Group grades of evidence
High quality: Further research is very unlikely to change our confidence in the estimate of effect.
Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.
Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.
Very low quality: We are very uncertain about the estimate.

[1] Unclear sequence generation and concealment and loss to follow-up.
[2] Heterogeneity high at 68%, subgroup analysis showed differences between neurological and other diseases.
[3] Large 95% confidence intervals including the absence of difference between comparison groups

BACKGROUND

A number of conditions compromise the passage of food along the digestive tract. Disturbances may be due to blockage, as seen in stenosis and cancer of the stomach or larynx, or due to swallowing difficulties such as in stroke sequelae, cranial encephalic trauma, brain tumours, and amyotrophic lateral sclerosis (Löser 2005). Several approaches are available to provide nutritional support. Nasogastric tube feeding is a classic, time-proven technique, although its prolonged use can lead to complications such as lesions to the nasal wing, chronic sinusitis, gastro-oesophageal reflux, and aspiration pneumonia (Bastow 1986). Two meta-analyses comparing tube placement into the stomach or duodenum revealed no significant difference between the methods in terms of length of hospital stay, mortality, or complications (Marik 2003; Ho 2006). In addition to complications, the need to change the tube due to blockage inherent to its narrow gauge coupled with its disagreeable appearance in social settings have led to the election of alternative techniques whenever possible.

Gastrostomy has been used to gain access to the stomach for long-term enteral feeding in patients with swallowing limitations who require nutritional support. The main criteria for indicating gastrostomy are (i) a reasonable prospect of patient survival and (ii) normal intestinal function. This surgical procedure was first carried out successfully in humans in 1876, by Verneuil in France. Following various modifications, Stamm devised the technique most frequently used to this day (Ljungdahl 2006). In 1980, Gauderer et al described a new technique of feeding tube placement in gastrostomy using endoscopy, called percutaneous endoscopic gastrostomy (PEG). This involves a local anaesthetic and does not require laparotomy (Gauderer 1980). Since the introduction of PEG, a number of studies comparing methods of gastrostomy have been conducted, such as push and pull PEG techniques (Tucker 2003) and operative gastrostomy (Stiegmann 1990). A prospective randomised controlled trial conducted by Ljungdahl et al (Ljungdahl 2006) found a lower mean procedure time and complication rate for PEG as compared with surgical procedure (42.9% versus 74.3%, $P < 0.01$). No significant difference was observed regarding mortality. Recently published guidelines on enteral nutrition recommend the performing of gastrostomy, preferably endoscopically (Löser 2005).

Previous systematic reviews and meta-analyses on enteral nutrition approaches have been performed, but not with the broad scope we propose. Langmore 2006 published a meta-analysis that investigated enteral nutrition, specifically in amyotrophic lateral sclerosis, comparing the use of several types of feeding tubes in patients being fed orally. However, they did not find any controlled or randomised studies. Another meta-analysis compared nutrition by endoscopic gastrostomy and nasogastric tube including only post-stroke patients (Bath 1999). Thereafter, a number of controlled and randomised studies were published that compared the two methods of nutritional support in stroke patients and those admitted to intensive care units with a range of different pathologies, as well as individuals on mechanical ventilation (Dennis 2005; McClave 2005; Douzinas 2006; Hamidon 2006).

Assessment of these latest studies in patients with a range of pathologies, together with analysis of the optimal moment to commence nutritional support, warrant mapping by means of a systematic review so as to offer the best evidence available on which to base decisions.

Description of the condition

Malnutrition is a prevalent, undesired condition affecting up to 40% of hospitalised patients. It has important causal associations with morbidity and mortality. Low nutritional status may affect recovery from illness, surgery, and injury. A body mass index (BMI) of less than 20 kg/m² suggests undernutrition. Mortality rates tend to be higher in elderly people in comparison to other subgroups of hospitalised patients and in those with a BMI of less than 18 kg/m². Malnutrition may manifest as impaired cardiac function and weak muscles (including respiratory muscles), with consequent higher risk of thromboembolism, chest infection, and pressure sores (Pearce 2002). Swallowing disturbances may cause malnutrition and are common after an acute stroke. Clinical diagnosis of swallowing disturbances can be given based on clinical signals such as excessive secretions; excessive tongue movement; pocketing of food in the cheek, under the tongue or on the hard palate; or coughing or choking while eating. Although not usually used in daily practice, radiological tests like videofluoroscopic modified barium swallow and videofluoroscopic swallowing study can be used for diagnosis of dysphagia (Finestone 2003).
Patients with indications for enteral nutrition include those with conditions associated with swallowing disorders, such as motor neuron disease and multiple sclerosis; physical obstruction to swallowing, such as oesophageal tumours; an inability to ingest food due to head injury or stroke; and those with anorexia due to an underlying disease such as chronic lung disease, irritable bowel disease, or cancer. Dysphagic patients and those with anorexia, malabsorption, or excessive catabolism also may need long-term enteral feeding (Pearce 2002). Aspiration risk often is an indication for nutritional support using tubes (Corry 2008). Enteral nutrition can be provided in the form of drink supplements or, if a patient is unable to take adequate nutritional supplements orally, fed via an enteral tube into the stomach or small bowel (Löser 2005).

Description of the intervention

In general, tube systems for artificial enteral nutrition can be positioned by nasal insertion, guided percutaneous application, or surgical techniques. The superiority of percutaneously placed gastrostomies compared with the former surgical gastrostomy procedures (that is. Witzel, Stamm, Janeway techniques) has been

shown clearly in many clinical studies (Löser 2005). Lower complication rates, reduced hospital length of stay and costs have been reported (Grant 1988; Ljungdahl 2006). Most patients who require nutritional support need it for around one month or less, with the nasogastric sound probe being the main way of infusion (Pearce 2002). The probe used is made of thin polyurethane, size 14 with an internal diameter of 3.3 mm, and is inserted by a trained professional in order to prevent complications such as perforation and tracheobronchial location (Löser 2005; Hamidon 2006). Another method of infusion, percutaneous endoscopy gastrostomy (PEG), is generally used when there is a need for enteral nutrition for a longer time period (Pearce 2002; Löser 2005). This procedure can be done by either 'pull' or 'push' techniques, the former being simpler and more frequently used. Both techniques use a silicon probe (for example 24 Fr, internal diameter 5.5 mm). The puncture site is marked with gastroscopic monitoring of the anterior gastric wall in the region of the distal corpus, after adequate local anaesthesia and intravenous sedation (Löser 2005; Hamidon 2006). Prospective studies have shown that the early insertion of the probe via PEG improves the patient's nutritional state (Norton 1996; Hamidon 2006). Patients treated for head and neck carcinoma have considered PEG to be more acceptable than a nasogastric tube (NGT) even though persistent dysphagia was associated to PEG (Mekhail 2001). A cohort study verified the acceptability of PEG, with significantly higher survival time and lower aspiration rates (Dwolatzky 2001) compared to NGT. On the other hand, a narrative review (Plonk 2005) reported increased risk of death in stroke patients with PEG compared with NGT and concluded that aspiration pneumonia rates were similar.
Radiologically placed gastrostomy (RIGs) is another method of enteral nutrition, but operationally different from percutaneous endoscopic gastrostomy (PEG). RIG is not an endoscopic procedure and utilises fluoroscopy, performed in an interventional radiologic suite (Barkmeier 1998; Chiò 2004).

How the intervention might work

The percutaneous gastronomy probe is of a larger calibre compared with an NGT and is placed in the abdomen. This leads to less interruption of nutrition caused by the probe being withdrawn as well as reduced reflux with consequent aspiration, thus being less embarrassing for the patient (Dwolatzky 2001; Pearce 2002). Patients and carers believe that nutrition via PEG helps in feeding and the ability to cope, being more convenient than NGT (Anis 2006). PEG-related morbidity and mortality are 9.4% and 0.53%, respectively (Wollman 1995). There are, however, exclusive complications for endoscopy percutaneous gastrostomy, such as peritonitis, buried bumper syndrome, gastrocolocutaneous fistula, and wound infection (Potack 2008). Complications of NGT due to its nasogastric insertion and positioning are also cited, including sinusitis, laryngeal ulcerations, pneumothorax, and tracheoesophagic fistula; the latter due to incorrect positioning of the tube (Pearce 2002).

Why it is important to do this review

According to Potack 2008, there is a high demand for PEG in patients with swallowing disorders, with 160,000 to 200,000 PEG procedures performed per year in the USA. This makes PEG the procedure of choice for nutritional support in adults. The same author commented that many such procedures are performed, although there is no consistent evidence about what is the more effective and safe method. Because NGT and PEG are the most commonly used methods for feeding access (Pearce 2002), a systematic review is worth performing to resolve such questions.

OBJECTIVES

To evaluate the effectiveness and safety of PEG as compared to a nasogastric tube for adults with swallowing disturbances, by updating our previous Cochrane review (Other published versions of this review), assessing the included studies with the revised 'Risk of bias' assessments, and to assess the overall level of evidence using the GRADE approach.

METHODS

Criteria for considering studies for this review

Types of studies

Randomised controlled trials comparing PEG versus nasogastric tube (NGT) for nutrition in adults with swallowing disturbances.

Types of participants

Adult patients presenting with swallowing disturbances or dysphagia and indications for nutritional support, as identified by the authors of primary studies. Patients with any underlying diseases also were acceptable.

Types of interventions

Comparison arms of interest are as follows.

- Intervention group: percutaneous endoscopic gastrostomy performed by any method (e.g., pull and push methods, others).
- Control group: nasogastric tube irrespective of technique (e.g., conventional and looping).

We did not include studies with radiologically inserted gastrostomy (PRG), nasojejunal tubes, and jejunal tube percutaneous endoscopy gastrostomy (JET-PEG) in this review.

Types of outcome measures

Primary outcomes

- Intervention failures as defined by any event leading to failure to introduce the tube, recurrent displacement and treatment interruption (feeding interruption, blocking or leakage of the tube, no adherence to treatment) (based on Norton 1996).

Secondary outcomes

- Nutritional status, as measured by any validated instrument (such as upper-arm skin fold thickness, mid-arm circumference, body weight, serum albumin level, haemoglobin (Ramel 2008)).
- Mortality.
- Complications and adverse events (e.g., aspiration, haemorrhage, pneumonia, wound infection, sinusitis, fistula).
- Time on enteral nutrition.
- Quality of life, as measured by any validated instrument (such as EUROQoL, SF-36 (Dorman 1997)).
- Length of hospital stay.
- Costs and economic issues.

Search methods for identification of studies

Electronic searches

We performed a computerised literature search in, re-running searches from the previous search date (August 2009) until September 2011.

- The Cochrane Central Register of Controlled Trials (CENTRAL, Issue 09 2011) and other databases in *The Cochrane Library* (Appendix 1),
- MEDLINE via OVID (from inception to September 2011) Appendix 2.
- EMBASE via OVID (from inception to September 2011) Appendix 3.
- LILACS via BIREME (from inception September 2011) Appendix 4.

Search terms and their synonyms for clinical conditions of interest to us (swallowing disturbance or dysphagia) and interventions of interest (percutaneous endoscopic gastrostomy and nasogastric tube feeding) are given in the appendices. They were adapted for each of the databases. There was no language restriction in the search. Search filters to identify randomised controlled trials involving humans were used when appropriate.

Searching other resources

We compiled a reference list of relevant studies (irrespective of study design) to identify trials with the potential for inclusion. We contacted authors via email requesting the data from unpublished trials. We also tried to identify ongoing trials on the Current Controlled Trials Web site (www.currentcontrolledtrials.gov).

Data collection and analysis

Selection of studies

Two review authors (CG, RA) checked the titles and abstracts found by the search strategy and other sources researched. Whenever titles or abstracts seem relevant to the review, we analysed them by reading the full article. If they were truly randomised controlled trials that met the previously stated criteria, we included them in the review. If there remained any doubt or disagreement, all of the authors assessed the study in question.

Data extraction and management

Two review authors (CG, DRW) extracted data based on CONSORT (Moher 2001). We settled doubts by consensus of the authors.

Assessment of risk of bias in included studies

Two review authors (CG, RBA) independently assessed the methodological quality of included studies using the following items (Higgins 2011).

- Random sequence generation (selection bias)

Selection bias (biased allocation to interventions) due to inadequate generation of a randomised sequence

- Allocation concealment (selection bias)

Selection bias (biased allocation to interventions) due to inadequate concealment of allocations prior to assignment

- Blinding (performance bias and detection bias)

Performance bias or detection bias due to knowledge of the allocated interventions after assignment

- Blinding of participants and personnel (performance bias)

Performance bias due to knowledge of the allocated interventions by participants and personnel during the study

- Blinding of outcome assessment (detection bias)

Detection bias due to knowledge of the allocated interventions by outcome assessors

- Incomplete outcome data (attrition bias)

Attrition bias due to amount, nature or handling of incomplete outcome data

- Selective reporting (reporting bias)

Reporting bias due to selective outcome reporting

- Other bias

Bias due to problems not covered elsewhere in the table

For the above three biases, we classified studies according to their risk of systematic error

- High risk: when the appropriate method to avoid systematic error was not met.
- Moderate risk: when the appropriate method to avoid systematic error was not described or the information was not acquired by contacting the authors of primary studies.
- Low risk: when the appropriate method to avoid systematic error was met.

We did not use performance bias as a criterion to analyse the risk of systematic error since this was not compatible with the characteristics of the intervention.

Measures of treatment effect

For dichotomous and continuous variables, we calculated risk ratio (RR), mean difference (MD), and 95% confidence interval (CI). When data from primary studies were not parametric (for example effects are reported as medians, quartiles) or without sufficient statistical information (such as standard deviations, number of patients), we inserted them into Table 1 if authors did not provide the necessary information.

Unit of analysis issues

The unit of analysis was based on the individual patient (unit to be randomised for interventions to be compared). We planned to analyse events happening to a person more than once (for example pneumonia, bronchoaspiration) by using rate ratio, which compares the rate of events in the two groups (PEG and NGT) by dividing one by the other. We planned to analyse cross-over study designs separately from the parallel-group randomised controlled trials.

Dealing with missing data

For continuous and dichotomous data, we carried out available case analysis.

Assessment of heterogeneity

We assessed statistical heterogeneity using the I^2 statistic. We assumed a statistically significant heterogeneity between the estimated effects of included studies with $I^2 > 50\%$.

Assessment of reporting biases

We had planned to assess publication bias by preparing a funnel plot, and will do so in future versions of this review if a sufficient number of studies is available. However, we are aware that asymmetry in the funnel plot can be associated with reasons other than that of publication bias (for example by chance, real heterogeneity, or clinical particulars inherent to each one of the included studies such as patients at high risk for the outcome).

Data synthesis

Qualitative information

We synthesised qualitative information relative to methods, risk of bias, description of participants, and outcomes measures in the Characteristics of included studies table.

Quantitative information

For dichotomous variables, we calculated the risk ratio (RR). For continuous variables, we calculated the mean difference (MD) when studies reported their results through the same variables measured with the same instruments (same units of measure). On the other hand, when continuous data are relative to the same aspect but were measured with different instruments (different and non-interchangeable units of measure), we pooled them through the standardised mean difference (SMD). We used 95% CIs for all statistical methods to pool data.

Irrespective of the nature of the data, we used a random-effects statistical model as we were expecting substantial clinical and methodological heterogeneity, which could generate substantial statistical heterogeneity.

Subgroup analysis and investigation of heterogeneity

We planned to carry out subgroup analyses using different NGT and PEG methods (for example pull, push, nasal loop, conventional). We assumed that heterogeneities between studies in both direction and length of estimate effect had a suspected causal relationship (the subgroup characteristic and the estimate effect), and we have considered these in the Discussion section.

Sensitivity analysis

We planned sensitivity analysis to examine the effects of intention-to-treat (ITT) analysis and available data analysis for dichotomous data. We planned to carry out ITT analysis by using imputation based on the analysis of the total number of randomised participants, irrespective of how the original study authors analysed the data. We assumed that all missing participants experienced the event. The other factors were study quality, trials reported only in abstracts, and testing for fixed-effect and random-effects statistical models.

RESULTS

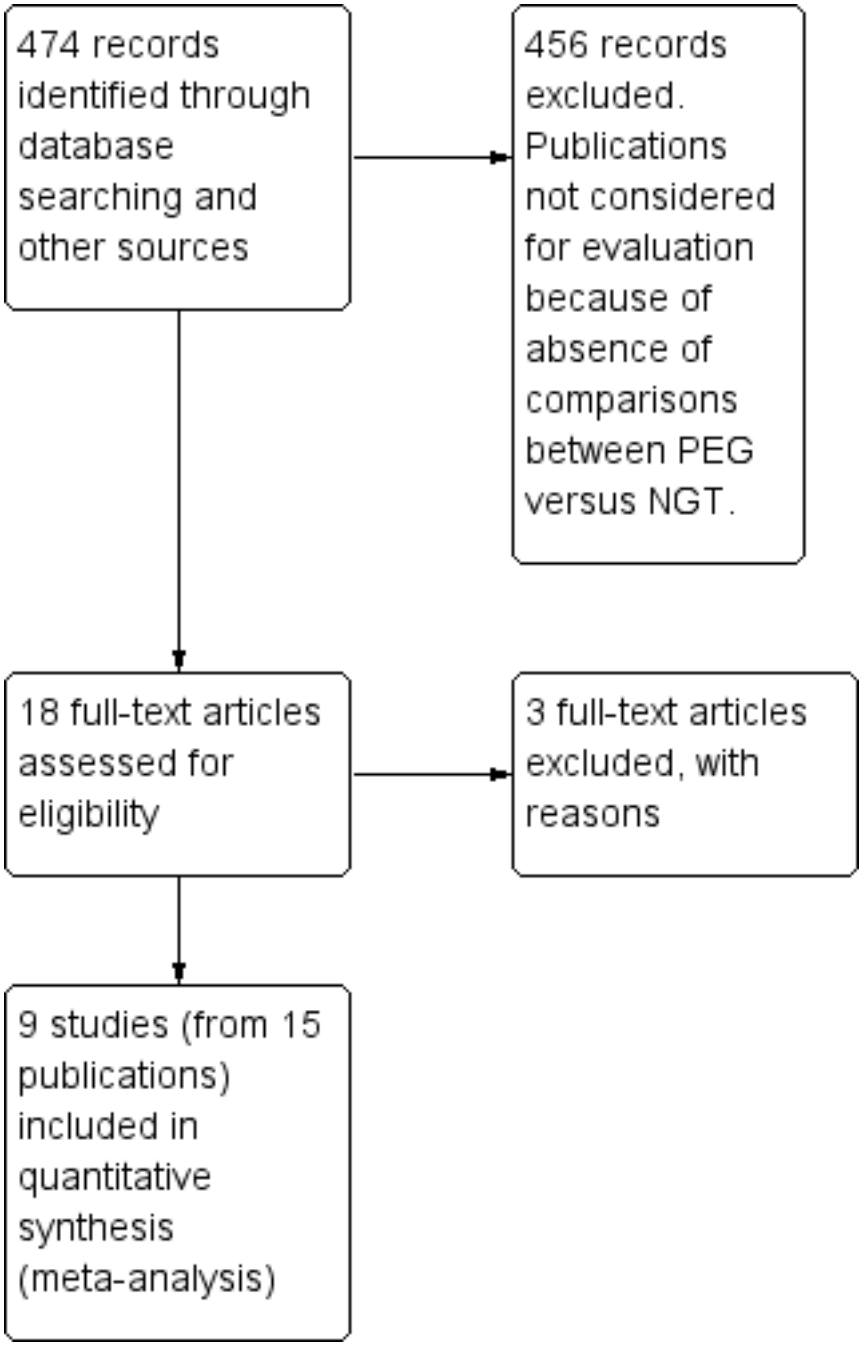
Description of studies

See: Characteristics of included studies; Characteristics of excluded studies.
See Characteristics of included studies and Characteristics of excluded studies for more information.

Results of the search

For details of the process of studies selection, see Figure 1.

Figure 1. Study flow diagram.



The most recent literature search (August 2009 to September 2011) yielded 474 hits. From this, 18 papers were retrieved for full text review. Three papers were excluded due to inappropriate study design and intervention. No additional studies were identified for inclusion in the review.

Included studies

The nine randomised controlled studies selected were published in English. The authors sought to compare percutaneous endoscopic gastrostomy (PEG) (n = 345 participants) with nasogastric tube (NGT) (n = 341 participants) placement for enteral feeding in adults (n = 686 total participants). Follow-up times varied across the nine studies analysed. Baeten 1992, Park 1992, Douzinas 2006, and Hamidon 2006 studied patients for no more than four weeks. On the contrary, the follow-up times of Norton 1996, Bath 1997, Yata 2001, Dennis 2005, and Corry 2008 ranged from three to six months. In addition, the sample in Baeten 1992 included patients with different diseases, including neoplasia of the ear, nose, and throat and neurologic and post-operative diseases. The mean age of these patients was 72 years (range: 62 to 82 years). Park 1992 included only patients with dysphagia secondary to neurologic diseases in their sample. The mean age of these patients in the NGT group was 65 years, whereas the mean age of those in the PEG group was 56 years. Norton 1996 and Bath 1997 included in their sample patients with dysphagia after acute stroke and a mean age of 77 years. Yata 2001 studied patients with dysphagia in several diseases, such as dementia, Parkinson's disease, and cerebrovascular disease. These patients had a mean age of 75.1 years (range: 50 to 96 years) in the PEG group and 76.5 years (range: 38 to 93 years) in the NGT group. Dennis 2005 included in their sample patients who presented with dysphagia after acute stroke. Their mean age was 76 years (SD = 10 years). Douzinas 2006 assessed patients with different diseases, some of whom presented with recurrent or persistent ventilator-associated pneumonia. These patients had a median age of 53 years (range: 20 to 82 years) in the PEG group and 58 years (range: 25 to 85 years) in the NGT group. Hamidon 2006 investigated patients with dysphagia after acute stroke with a median age of 65 years (range: 48 to 79 years) in the PEG group and 72 years (range: 54 to 77 years) in the NGT group. Finally, Corry 2008 included in their sample patients with cancer of the head and neck with a median age of 60 years (range: 46 to 80 years).

Excluded studies

The three excluded studies did not meet the aforementioned inclusion criteria. McClave 2005 conducted a randomised controlled trial without interventions of interest for this review; Mekhail 2001 and Schulz 2009 performed retrospective studies.

Risk of bias in included studies

See Figure 2 and Figure 3.

Figure 2. Methodological quality summary: review authors' judgements about each methodological quality item for each included study.

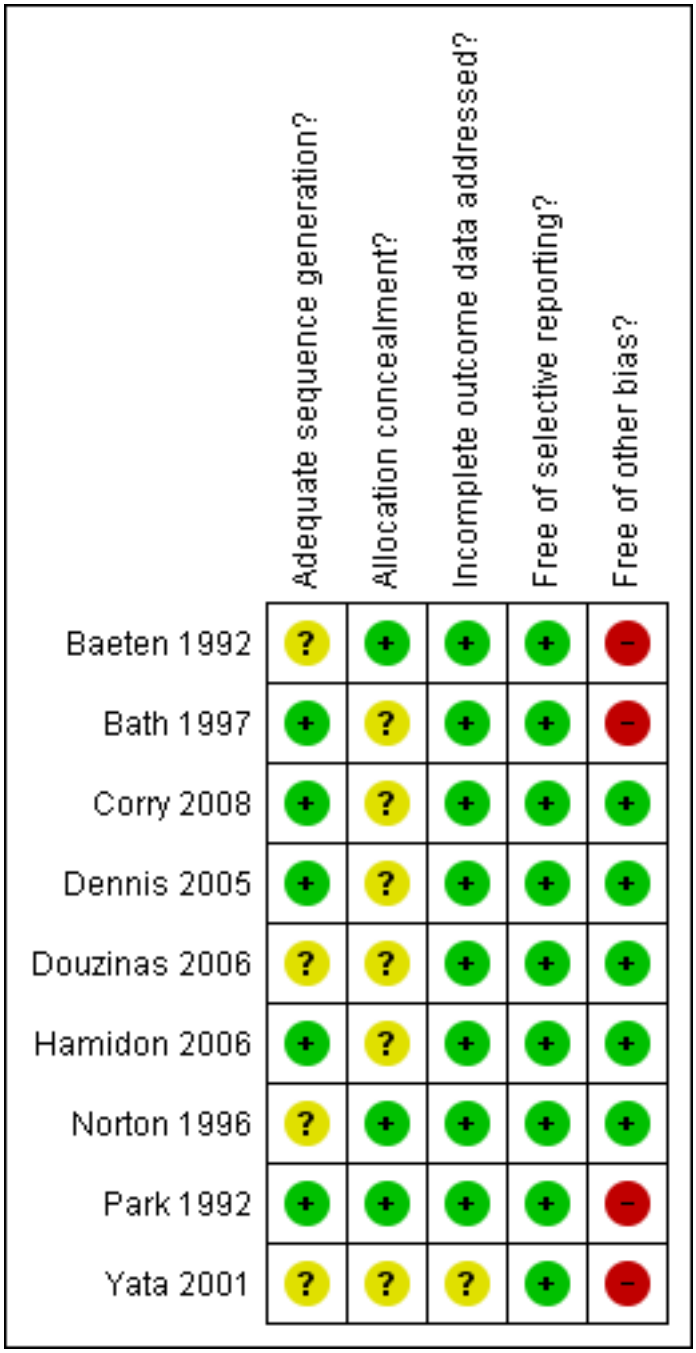
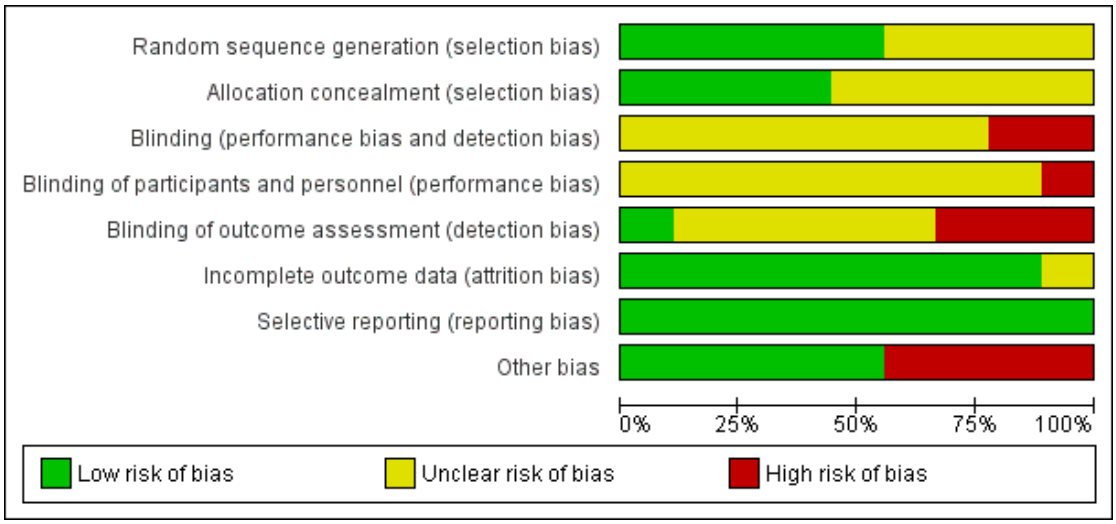


Figure 3. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



Allocation

The methods employed for allocation by Park 1992, Bath 1997, Dennis 2005, Hamidon 2006, and Corry 2008 were suitable for this procedure; therefore, they were deemed low risk for systemic errors of a methodological nature. The remaining studies in this review (i.e., Baeten 1992; Norton 1996; Yata 2001; Douzinas 2006) were considered moderate risk because the methods used for allocation were not reported.

The methods used for allocation by Baeten 1992, Park 1992, and Norton 1996 were sufficiently sound to ensure concealment of the allocation process. Consequently, they were deemed low risk for systematic errors of a methodological nature. On the contrary, the studies by Bath 1997, Yata 2001, Dennis 2005, Douzinas 2006, Hamidon 2006, and Corry 2008 were considered moderate risk for systematic error. Although the authors described random allocation, they did not report the methods used for allocation concealment.

Overall, no significant difference was found in the demographic characteristics of patients from each group on study entry.

Blinding

The characteristics of the interventions compared in this systematic review prevented the patients and physicians from being blinded to the allocations.

Incomplete outcome data

Eight authors clearly reported both missing data and the flow of the patients during the study. As a result, they were considered low risk for systematic errors in follow-up losses. However, Yata 2001 did not report losses or patient flow in their work; therefore, the study was considered moderate risk for this type of systematic error.

In Park 1992, 18 of the 19 patients in the NGT group presented intervention failure. The researchers did not follow these patients for the full 28 days. In contrast, all 19 patients from the PEG group completed the recommended follow-up. Despite the significant number of failures in the NGT group, this clinical trial was considered low risk for systematic error for dichotomous variables because the authors clearly described the flow of patients from randomisation through to the study endpoint.

Selective reporting

All of the studies were associated with a low risk of bias, given that relevant outcomes were reported in all cases.

Other potential sources of bias

The following studies were rated as having a high risk of bias: Baeten 1992 (follow-up not previously established), Bath 1997

and Yata 2001 (unpublished studies), Park 1992 (dropout rate of 95% (19/20) in the NGT group due to treatment failure and death).

Effects of interventions

See: **Summary of findings for the main comparison** Percutaneous endoscopic gastrostomy compared to nasogastric tube feeding for adults with swallowing disturbances

Dichotomous outcomes

Intervention failure

The outcome of intervention failure was examined in seven studies (314 patients). Failure occurred in 12.17% (19 out of 156 patients) in the PEG group and 39.87% (63 out of 158 patients) in the NGT group. The risk ratio (RR) on the random-effects model was 0.24 (95% CI 0.08 to 0.76, P = 0.01) in favour of PEG (Mantel-Haenszel's statistical method). We observed statistically significant heterogeneity in this outcome: I^2 statistic = 68% (P = 0.05). We investigated the possible reasons for this heterogeneity using sub-group analysis. Therefore, we grouped the studies by endoscopic gastrostomy technique into *pull* (n = 90), *push* (n = 33), and unreported (n = 191). We observed a significant difference favouring PEG in the *pull* (RR 0.07, 95% CI 0.01 to 0.35, P = 0.001) and *push* (RR 0.05, 95% CI 0.00 to 0.74, P = 0.03) techniques. We found no significant difference in cases where technique was not reported (RR 0.81, 95% CI 0.48 to 1.37, P = 0.43). In addition, no statistically significant heterogeneity was found in either the *pull* (I^2 statistic = 0% and P = 0.67) or unreported technique sub-groups (I^2 statistic = 0% and P = 0.40). The *push* subgroup contained only one clinical trial. Irrespective of the subgroup, the ITT analysis for intervention failure yielded a RR of 0.51 (95% CI 0.31 to 0.83, P = 0.007 I^2 statistic = 52%) also favouring the PEG group compared with the NGT group.

Patients were also split into subgroups according to underlying disease: neurological (n = 109) or other (n = 205) disease. A RR = 0.08, 95% CI 0.02 to 0.33, P = 0.0005 favouring PEG was observed in the neurological diseases group, and we found no statistical heterogeneity among the studies (I^2 statistic = 0% and P = 0.81). However, we found no significant difference in the other diseases group (RR 0.62, 95% CI 0.23 to 1.72, P = 0.36). We found statistical heterogeneity among studies (I^2 statistic = 63% and P = 0.07).

Mortality

The outcome of mortality was examined in eight studies (584 patients) and was assessed independently to study follow-up time. The results showed 37.24% (108 out of 290 patients) in the PEG group and 35.71% (105 out of 294 patients) in the NGT group. The risk ratio for the random-effects model was 0.96 (95% CI 0.64 to 1.44) (Mantel-Haenszels statistical method). The result of the meta-analysis for the mortality outcome revealed no statistically significant difference between comparison groups (P = 0.84). Finally, we observed no statistical heterogeneity between included studies: I^2 statistic = 38% and P = 0.14. Because of the radiologically placed gastrostomy technique used in a small number of patients in Dennis 2005, we carried out a sensitivity analysis to test the differences in the estimate effects by including and excluding this study. The sensitivity analysis shows that the inclusion of the FOOD study (Dennis 2005) has contributed only to improve the confidence in the estimate effects for mortality (RR 0.96 (95% CI 0.64 to 1.44, P = 0.84) with Dennis 2005 versus 0.93 (95% CI 0.48 to 1.78, P = 0.82) without Dennis 2005).

Complications

The outcome of complications was examined in five studies (503 patients) and was assessed independently to study follow-up time or complication severity. Although some of complications were characteristic of only one intervention, we analysed them together for the purposes of this research. The results showed 42% (105 out of 250 patients) in the PEG group and 42.68% (108 out of 253 patients) in the NGT group had complications. The RR using the random-effects model was 1.00 (P = 0.93), with 95% CI 0.91 to1.11 (Mantel-Haenszels statistical method). The result of the meta-analysis for the complications outcome revealed no significant difference. We observed no statistical heterogeneity in the comparison: I^2 statistic = 0% and P = 0.48.

Pneumonia

The outcome of pneumonia was examined in six studies (585 patients) and was assessed independently to study follow-up time. The results showed 32.53% (95 out of 292 patients) pneumonia in the PEG group and 39.24% (115 out of 293 patients) in the NGT group. The RR using the random-effects model was 0.84 (P = 0.26), with 95% CI = 0.61 to 1.14 (Mantel-Haenszel's statistical method). The result of the meta-analysis for the pneumonia outcome indicated that PEG was not statistically superior. We observed statistically significant heterogeneity between studies: I^2 statistic = 61% and P = 0.61.

Function ability

Just one study reported function ability by using a modified Rankin Scale (MRS) (Dennis 2005). The authors could find no statistically significant difference between comparison groups (Analysis 1.16) for the following ranges of MRS scales: MRS 0 to 3 (RR 0.59, 95% CI 0.34 to 1.01, P = 0.06) and MRS 4 to 5 (RR 1.20, 95% CI 0.90 to 1.61, P = 0.21) and for the outcome composed by MRS scales from 4 to 5 or death as showed by the RR of 1.10, 95% CI 1.00 to 1.20, P = 0.05).

Continuous outcomes

Of the continuous variables presented as means and standard deviations on the Forest plot, such as weight (Norton 1996) (Analysis 1.7), survival in months (Yata 2001) (Analysis 1.6), albumin (Norton 1996) (Analysis 1.9), hospital stay in days (Dennis 2005) (Analysis 1.11), enteral feeding time in days (Baeten 1992; Park 1992) (Analysis 1.12), and patients' intervention satisfaction scales (Baeten 1992) (Analysis 1.13), the only difference was on the survival variable (Yata 2001) (Analysis 1.6), suggesting that PEG was superior (difference in means = 4.30, 95% CI 3.28 to 5.32, P < 0.00001).

Among the continuous variables presented as medians or with insufficient data (see Table 1), the only difference was on blood albumin level (Hamidon 2006), mean blood albumin level (Yata 2001), and median 24-hour percentage of gastroesophageal reflux (Douzinas 2006), suggesting that PEG was superior.

DISCUSSION

Summary of main results

Overall, the estimated effects for intervention failure showed a statistically significant lower risk of deleterious effects in the PEG group compared with the NGT group. Although mortality and pneumonia were relevant outcomes, no direct causal relationship with the procedures was established. Only Dennis 2005 and Baeten 1992 reported a relationship between procedure-related mortality and global mortality, ranging from 0% to 10%. These low rates support the notion that the use of these methods may have no significant influence on risk of death.

These conclusions were not changed by the 2011 update of the review.

Overall completeness and applicability of evidence

The results of this systematic review show that the use of PEG is beneficial, as evidenced by a clinically significant outcome (intervention failure) based on an examination of approximately 300 participants who had heterogeneous clinical and demographic characteristics. Specifically, for the intervention failure outcome, the subgroup comprised patients with neurological diseases or stroke who seemingly benefited more from the use of PEG than NGT based on the direction and magnitude of the intervention effect. However, it is important to note that the endoscopy examination performed prior to PEG is indicated in all cases, as the patient might present with lesions of the gastrointestinal tract, which prevents the passage of the endoscopy device and even tubes. On the contrary, gastric tumours might also be present, which precludes gastrostomy. Partial gastric resections can also influence patients to elect to use alternative methods of enteral feeding. In routine practice, however, the costs and benefits of both procedures should be taken into account. Some health service providers, particularly under the public health system, face difficulties acquiring endoscopic gastrostomy apparatus due to their high cost. However, it is noteworthy that because nasogastric tubes are easier to introduce (more often by the nursing team) and less weight is placed on the cost of constantly changing them, endoscopic gastrostomies are less frequently indicated (Baeten 1992; Corry 2008).

Quality of the evidence

The findings of the present review of the literature should be interpreted with caution, given that almost half of the authors failed to report the method used to sequence and conceal the allocation. This is one of the main causes of error in randomised systematic studies. In addition, other potential risks of bias stemmed from the absence of prior planning of follow-up time, as well as the unpublished or high rates of losses during follow-up. However, almost all of the authors attempted to prevent attrition by making the flow of patients clear and through selective reporting bias by selecting clinically relevant outcomes. Possible reasons for the current state of the research in this area include the high cost of the procedures in question and the challenges associated with randomisation and following up with patients. These factors explain why the majority of studies involve small samples. However, this systematic review of the literature is valuable in analysing nine studies, thereby increasing the sample size to 686. Nevertheless, further randomised clinical trials that adopt a rigorous method are warranted.

Potential biases in the review process

In view of the sensitive search strategy involving electronic correspondence with the eminent authors in this area of research, we believe that it is highly unlikely that other studies meeting the inclusion criteria of this systematic review were overlooked. McClave 2008 was excluded following contact with the corresponding author to clarify the randomisation process employed. All data on the publications and data gathered through personal contact with the authors of primary studies (Bath 2009; Corry 2008b) were used to estimate the effects of the interventions for clinically relevant outcomes (i.e., treatment failure, mortality, pneumonia, complications, and length of hospital stay). Yata 2001 was only available in abstract form, which hampered the gleaning of all the relevant data, and the corresponding author could not be contacted. Data from another study (Bath 1997) came from a systematic review by the same author, and doubts were resolved via email with the corresponding author.

As outlined, all efforts were made to ensure that relevant qualitative or quantitative data were included in this review.

Agreements and disagreements with other studies or reviews

In one of the most important controlled randomised trials performed to date (Dennis 2005), the authors suggested that NGT should be the method of choice in the first two to three weeks of enteral feeding, probably in light of the increased absolute risk of death associated with the use of PEG (RR 1.02, P = 0.86) and the absolute risk of the outcome composed by MRS scale (modified Rankin scale) from 4-5 or death (RR 1.10, P = 0.05). However, combining the results of seven different studies with 314 patients, it seems that PEG choice is associated with a lower risk of intervention failure. Given the importance of this finding, selecting PEG might reduce the difference in cost between the two procedures. The findings of all of the other studies included in this analysis seem to support the use of PEG. Guidelines suggest that PEG is a highly effective and safe procedure when modern equipment is used and established standards are followed (Löser 2005). In a narrative review, Plonk 2005 suggested that the use of PEG should only be considered in amyotrophic lateral sclerosis, early head and neck cancer, intestinal blockage by malignant tumour with incoercible vomiting, and persistent dysphagia after acute stroke. However, contrary to Plonk 2005, the findings of the present systematic review show that the PEG is associated with a lower risk of treatment failure compared with the NGT, irrespective of patient baseline disease. Although no included study made available information about the use of nasal looping technique, there is some evidence that such NGT technique can be preferable to PEG (Anderson 2004).

AUTHORS' CONCLUSIONS

Implications for practice

Based on the findings of this meta-analysis, the use of PEG is superior to NGT when intervention failures are considered. However, there is no significant difference in mortality rates between comparison groups. Performing an endoscopy exam prior to PEG is indicated in all cases because patients might present with lesions of the gastrointestinal tract, which prevents passage of the endoscopy device and even tubes. On the contrary, gastric tumours might preclude gastrostomy. Partial gastric resections can also lead patients to elect to use alternative methods of enteral feeding. In routine practice, however, the costs and benefits of both procedures should be considered.

Implications for research

The high cost of the procedures in question combined with the difficulties associated with the randomisation and follow-up of patients explain why the majority of studies examine a small number of participants. Therefore, this systematic review contributes to the literature in that it analysed many studies, yielding a larger sample. Nevertheless, we believe that further randomised clinical trials should be conducted with rigorous observation of internal validity. They should also include previously planned and executed follow-up periods. Moreover, future researchers should ideally specify the technique used and the experience of the professionals involved to allow for the analysis of more specific sub-groups. Finally, data on the nutritional status of the patients would prove valuable, as would a cost/benefit analysis of the number of feeding tubes used.

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* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Baeten 1992

Methods	Single-centre parallel randomised controlled trial Setting: 1 hospital in the Netherlands Sample size: not reported
Participants	Ninety patients with neurologic problems, ear, nose and throat tumours and surgical problems. 56 male, 34 female; mean age 72 (62 to 82) Inclusion criteria: indication for enteral nutrition Exclusion criteria:contra-indication for either method
Interventions	PEG (n = 44) - Freka set (Fresenius) NGT (n = 46) -silicone tube 14 ch inserted by nurse
Outcomes	1. Mortality 2. Treatment failures 3. Complications 4. Pneumonia 5. Patient convenience 6. Nurse convenience 7. Time for enteral nutrition (days) 8. Time for insertion (minutes)
Notes	Follow-up: mean nutrition time 17.9 ± 19.9 days

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of outcome assessment (detection bias) All outcomes	High risk	Explicitly not blinded as referred by the authors

Baeten 1992 (*Continued*)

Incomplete outcome data (attrition bias) All outcomes	Low risk	There were no withdrawals reported by the authors
Selective reporting (reporting bias)	Low risk	Relevant outcomes analysed
Other bias	High risk	Follow-up was not previously established

Bath 1997

Methods	Single-centre parallel randomised controlled trial Setting: 1 hospital in UK Sample size: not reported
Participants	Nineteen patients (8 male, 11 female); mean age: 77 years (11) Baseline disease: 13 Ischaemic stroke, six haemorrhagic stroke Inclusion criteria: stroke within two weeks of stroke onset Exclusion criteria: orogastrointestinal disease concurrent severe illness, coagulopathy, pre-morbid dependency, severe dementia, psychiatric illness
Interventions	PEG: details not available NGT: details not available
Outcomes	Primary outcomes 1. Resumption of safe feeding at 12 weeks 2. Weight loss < 5% at 6 weeks 3. Discharge by 6 weeks Secondary outcomes 1. Impairment 2. Disability 3. Handicap 4. Quality of life 5. Tube failures 6. Chest infection 7. Oropharyngeal delay time at 4 weeks
Notes	Follow-up: three months Risks of bias was judged from a systematic review previously published by the author (Bath 2009) and by email contact with the author

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated by minimisation
Allocation concealment (selection bias)	Unclear risk	Not reported

Bath 1997 (*Continued*)

Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Intention-to-treat analysis
Selective reporting (reporting bias)	Low risk	Relevant outcomes were analysed
Other bias	High risk	Unpublished study

Corry 2008

Methods	Parallel randomised controlled trial Setting: hospitals in Australia; enteral feeding on an outpatient basis Sample size: the study planned to recruit 150 patients over two years, allowing a difference of at least 1.4 kg in mean weight loss to be detected between the two feeding tubes with 80% power using a two-sided test with significance level of 5%
Participants	42 patients; 24 male, 9 female; median age 60 (46 to 80) Inclusion criteria: patients with squamous cell carcinoma of the head and neck planned for curative radiotherapy or chemoradiation who were anticipated to require enteral feeding Exclusion criteria: refusal to be randomised and refusal to receive any tube for nutrition
Interventions	PEG (n = 22); push technique by Tucker (Kimberley-Clark MIC e Wilson-Cook) NGT (n = 20); fine bore tube inserted by nurse and confirmed the correct placement by a chest X-ray and aspiration of stomach contents All patients received enteral feeding at home
Outcomes	1. Nutritional status (weight, upper arm circumference, triceps skin fold thickness) 2. Duration of enteral feeding 3. Complication 4. Patient satisfaction (modified QoL questionnaire) 5. Costs All patients were assessed 6 months post-treatment
Notes	Nine patients did not receive the intervention to which they were allocated Outcome four was not considered for analysis because the instrument of evaluation is not formally validated

Corry 2008 (*Continued*)

	Outcome one was not suitable for analysis because it was not explicitly informed if they were reported as means or medians

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Adaptive biased coin technique
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of outcome assessment (detection bias) All outcomes	High risk	Explicitly referred by the authors as not blinded
Incomplete outcome data (attrition bias) All outcomes	Low risk	Flow of patients was clearly reported
Selective reporting (reporting bias)	Low risk	Relevant outcomes were analysed
Other bias	Low risk	None suspected

Dennis 2005

Methods	Multicentric parallel randomised controlled trial Setting: multicentric study involving many countries, mainly UK Sample size: 1000 patients based on 85% power to detected and absolute risk difference for death or poor outcome of 9%. Type one error: 0.05
Participants	321 patients: 144 male, 177 female; mean age 76 (10); dysphagic stroke patients Inclusion criteria: recent stroke (within 7 days before admission), first-ever or recurrent, if the responsible clinician was uncertain of the best feeding (PEG or NGT) Exclusion criteria: patients with subarachnoid haemorrhage·
Interventions	PEG (n = 162) NGT (n = 159)
Outcomes	1. Mortality or poor outcome 2. Overall survival

Dennis 2005 (*Continued*)

	3. Utility score (EUROQoL) 4. Quality of life (EUROQoL) 5. Length of hospital stay 6. Complications in hospital stay 7. Pneumonia 8. Causes of death 9. Treatment effect 10. Number of tubes inserted 11. Reasons for stopping feeding 12. Vital status 13. Functional ability (Modified Rankin scale) 14. Clinicians' satisfaction about enteral feeding 15. Time in enteral nutrition
Notes	Follow-up: six months Outcomes 3, 10 and 13 were not suitable for analysis

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer-generated, stratified by country, age, gender, and predicted probability of poor outcome (by minimisation)
Allocation concealment (selection bias)	Low risk	The randomisation systems were housed on a secure server with access permitted, via a password. Participating centres were issued with codes in order for them to access the randomisation services (three separate numerical codes) - it was impossible to guess the allocation given the use of minimisation to balance treatments between groups
Blinding (performance bias and detection bias) All outcomes	High risk	Explicitly not blinded as referred by the authors
Blinding of participants and personnel (performance bias) All outcomes	High risk	Explicitly not blinded as referred by the authors
Blinding of outcome assessment (detection bias) All outcomes	High risk	Explicitly not blinded as referred by the authors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Flow of patients was clearly reported

Dennis 2005 (*Continued*)

Selective reporting (reporting bias)	Low risk	Relevant outcomes were analysed
Other bias	Low risk	None suspected

Douzinas 2006

Methods	Single-centre parallel randomised controlled trial Setting: 1 hospital (intensive care unit) in Greece Sample size: not reported; pilot study was made
Participants	39 patients; 22 male, 14 female; median age: PEG 53 (20 to 82), NGT 58 (25 to 85) Inclusion criteria: 1. patients on mechanical ventilation with NGT in place for more than 10 days, suffering from persistent or recurrent ventilator associated pneumonia and reflux rate above 6% Exclusion criteria: unstable haemodynamic state, administration of morphine, atropine, theophylline, barbiturates, and cisapride, and a past history of GER or hiatal hernia.
Interventions	PEG (n = 19): pull technique NGT (n = 20): fine bore 14
Outcomes	1. Investigate if long-standing presence of NGT for feeding is associated with increased incidence of GER 2. Investigate if PEG combined with semi-recumbent position and avoidance of gastric nutrient retention lead to decreased incidence of GER in mechanically-ventilated patients 3. Mortality 4. Pneumonia 5. Complications
Notes	Follow-up: 20 days Three patients randomly allocated to receive PEG were excluded because of hiatal hernia (2) and intestinal bloating

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors

Douzinas 2006 (*Continued*)

Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Flow of patients was clearly reported
Selective reporting (reporting bias)	Low risk	Relevant outcomes were analysed
Other bias	Low risk	None suspected

Hamidon 2006

Methods	Single-centre parallel randomised controlled trial Setting :1 hospital in Malaysia; patients were discharged in one or two days after the intervention Sample size: not reported
Participants	23 patients; 11 male, 11 female; median age: PEG 65 (48 to 79), NGT 72 (54 to 77) Inclusion criteria: patients with acute Ischaemic stroke and persistent dysphagia for seven or more days Exclusion criteria: not related
Interventions	PEG (n = 10): pull technique, Wilson CooK silicone tube 24 FR, inserted by a doctor NGT (n = 12): Steril Cathline polyurethane tube, size 14 inserted by a nurse and checked by aspirating asteric contents
Outcomes	1. Nutritional status assessed by recording anthropometric parameters and nutritional markers 2. Treatment failure
Notes	There was one drop-out because it was impossible to contact the patient after four weeks

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer generated random table
Allocation concealment (selection bias)	Unclear risk	Not reported

Hamidon 2006 (*Continued*)

Blinding (performance bias and detection bias) All outcomes	High risk	Systematically, surgeons were responsible for the PEG and nurses by the NGT
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	not explicitly referred by the authors
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Information given by the patients by telephone
Incomplete outcome data (attrition bias) All outcomes	Low risk	Flow of patients was clearly reported (1 dropout due to failure to turn-up)
Selective reporting (reporting bias)	Low risk	Relevant outcomes were analysed
Other bias	Low risk	None suspected

Norton 1996

Methods	Parallel randomised controlled trial Setting: 1 university hospital and one district general hospital in UK Sample size: not reported
Participants	30 patients: 11 male, 19 female; mean age 77 Inclusion criteria: acute cerebrovascular accident with persisting dysphagia for eight or more days Exclusion criteria: patients with a previous history of gastrointestinal disease which would preclude siting a gastrostomy tube or who were unfit for upper gastrointestinal endoscopy and IV sedation
Interventions	PEG (n = 16): pull technique, Wilson Cook tube 24 FR or 12 FR Fresenius NGT (n = 14): fine bore tube Flocare 500, inserted by a senior nurse
Outcomes	1. Mortality 2. Treatment failure 3. Complications 4. Pneumonia 5. Amount of feed administered 6. Change in nutritional status 7. Length of hospital stay
Notes	Follow-up: six weeks for main outcomes For continuous data, results were not available for all patients
Risk of bias	

Norton 1996 (*Continued*)

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Flow of patients was clearly reported
Selective reporting (reporting bias)	Low risk	Relevant outcomes were analysed
Other bias	Low risk	None suspected

Park 1992

Methods	Parallel randomised controlled trial Setting: three teaching hospitals in Glasgow Sample size: 40 patients was selected to detect a two-sided difference between the success of gastrostomy feeding at 90% and NGT feeding at 40% with a power of 0.9 and significance of 0.05
Participants	40 patients with neurological dysphagia, 22 male, 18 female; mean age: PEG 56, NGT 65 Inclusion criteria: longstanding (4 weeks or more) dysphagia due to neurological disease; stable medical condition with likely survival of at least one month; ability to communicate verbally or in writing; and presence of a normal gastrointestinal tract Exclusion criteria: dementia; mechanical lesions causing obstruction of the oesophagus or stomach; active intra-abdominal inflammation including inflammatory bowel disease or pancreatitis; history of partial gastrectomy, reflux oesophagitis, or intestinal obstruction; and presence of ascites, notable hepatomegaly, severe obesity, coagulopathy, untreated aspiration pneumonia, and major systemic disease including malignancy and respiratory, liver, or renal failure

Park 1992 (*Continued*)

Interventions	PEG (n = 20) Bard 20Fr silicone tube, technique by Ponsky - Gauderer NGT (n = 20) fine bore Abbott Flexitube, polyurethane, 850 mm length,1.5 mm internal diameter
Outcomes	1. Mortality 2. Duration of feeding (days) 3. Treatment failure 4. Complications 5. Pneumonia 6. Nutritional status (weight, albumin, mean difference weight, mid-arm muscle circumference, triceps skinfold thickness) 7. Received/prescribed feed
Notes	Outcome six was not considered for analysis because only one patient completed the follow-up Outcome seven was not considered clinically relevant by itself, unless it causes failure or affects nutritional status (anthropometric parameters) Follow-up: 28 days

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Low risk	Computer generated random numbers (Epistat Statistical Package)
Allocation concealment (selection bias)	Low risk	Sealed envelopes
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Incomplete outcome data (attrition bias) All outcomes	Low risk	Flow of patients was clearly reported
Selective reporting (reporting bias)	Low risk	Relevant outcomes were analysed
Other bias	High risk	There was 95% (19/20) of dropouts in the NGT group due to failures in the treatment and death

Yata 2001

Methods	Single-centre parallel randomised controlled trial. Sample size: not reported Setting:1 hospital in Inagawa Town (Japan)
Participants	82 patients: 22 male,60 female; mean age: PEG 75.1 (50 to 96), NGT 76.5 (38 to 93) Inclusion criteria:dysphagic patients Exclusion criteria:not reported
Interventions	PEG n = 42 NGT n = 40
Outcomes	1. Nutrition status (albumin, haemoglobin and cholesterol) 2. Complications 3. Mean survival rate 4. Pneumonia 5. Reflux oesophagitis 6. Anaemia 7. Peristomal leakage 8. Gastric ulcer 9. Treatment failure
Notes	Study available as a meeting abstract Outcome seven was reported only for NGT group Outcomes eight and nine were reported only for the PEG group

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Random sequence generation (selection bias)	Unclear risk	Not reported
Allocation concealment (selection bias)	Unclear risk	Not reported
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of participants and personnel (performance bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not explicitly referred by the authors
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Flow of patients was not clearly reported

Yata 2001 (*Continued*)

Selective reporting (reporting bias)	Low risk	Relevant outcomes were analysed
Other bias	High risk	Unpublished study

GER: gastroesophogeal reflux
NGT: nasogastric tube
PEG: percutaneous endoscopic gastrostomy

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
McClave 2005	Retrospective study
Mekhail 2001	Randomised controlled trial with intervention out of interest for this review (patients randomised to stop the enteral nutrition according to different residual gastric volume)
Schulz 2009	Retrospective study

DATA AND ANALYSES

Comparison 1. PEG versus NGT

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 intervention failure (subgrouped by baseline disease)	7	314	Risk Ratio (M-H, Random, 95% CI)	0.24 [0.08, 0.76]
1.1 AVC/neurological baseline diseases	4	109	Risk Ratio (M-H, Random, 95% CI)	0.08 [0.02, 0.33]
1.2 mixed baseline diseases	3	205	Risk Ratio (M-H, Random, 95% CI)	0.62 [0.23, 1.72]
2 intervention failure (subgrouped by gastrostomy technique)	7	314	Risk Ratio (M-H, Random, 95% CI)	0.24 [0.08, 0.76]
2.1 pull technique	3	90	Risk Ratio (M-H, Random, 95% CI)	0.07 [0.01, 0.35]
2.2 push technique	1	33	Risk Ratio (M-H, Random, 95% CI)	0.05 [0.00, 0.74]
2.3 non-reported technique	3	191	Risk Ratio (M-H, Random, 95% CI)	0.81 [0.48, 1.37]
3 mortality irrespective of follow-up time	8	584	Risk Ratio (M-H, Random, 95% CI)	0.96 [0.64, 1.44]
4 pneumonia irrespective of follow-up time	6	585	Risk Ratio (M-H, Random, 95% CI)	0.84 [0.61, 1.14]
5 complications irrespective of follow-up time	5	503	Risk Ratio (M-H, Random, 95% CI)	1.00 [0.91, 1.11]
6 mean survival (months)	1	82	Mean Difference (IV, Random, 95% CI)	4.30 [3.28, 5.32]
7 weight (endpoint)	1	21	Mean Difference (IV, Random, 95% CI)	3.20 [-5.95, 12.35]
8 weight (change from baseline)	2	54	Mean Difference (IV, Random, 95% CI)	2.03 [-2.66, 6.72]
9 albumin (endpoint)	1	25	Mean Difference (IV, Random, 95% CI)	7.80 [5.52, 10.08]
10 reflux esophagitis	1	82	Risk Ratio (M-H, Random, 95% CI)	0.45 [0.22, 0.92]
11 length of stay (days)	1	321	Mean Difference (IV, Random, 95% CI)	2.0 [-11.23, 15.23]
12 time of enteral nutrition (days)	2	119	Mean Difference (IV, Random, 95% CI)	14.48 [-2.74, 31.71]
13 score of patients satisfaction	1	43	Mean Difference (IV, Random, 95% CI)	-0.56 [-1.32, 0.20]
14 score of inconvenience by de nurses	1	68	Mean Difference (IV, Random, 95% CI)	-0.58 [-1.18, 0.02]
15 mid-arm circumference in cm (endpoint)	1	21	Mean Difference (IV, Random, 95% CI)	2.5 [-0.64, 5.64]
16 Functional ability (MRS)	1		Risk Ratio (M-H, Random, 95% CI)	Subtotals only
16.1 MRS scale from 0-3	1	321	Risk Ratio (M-H, Random, 95% CI)	0.59 [0.34, 1.01]
16.2 MRS scale from 4-5	1	321	Risk Ratio (M-H, Random, 95% CI)	1.20 [0.90, 1.61]
16.3 MRS scale from 4-5 or death	1	321	Risk Ratio (M-H, Random, 95% CI)	1.10 [1.00, 1.20]

Analysis 1.1. Comparison 1 PEG versus NGT, Outcome 1 intervention failure (subgrouped by baseline disease).

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 1 intervention failure (subgrouped by baseline disease)

Study or subgroup	PEG n/N	NGT n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
1 AVC/neurological baseline diseases					
Bath 1997	0/10	3/9		10.2 %	0.13 [0.01, 2.22]
Hamidon 2006	0/10	5/12		10.4 %	0.11 [0.01, 1.73]
Norton 1996	0/16	3/14		10.0 %	0.13 [0.01, 2.25]
Park 1992	0/19	18/19		10.6 %	0.03 [0.00, 0.42]
Subtotal (95% CI)	**55**	**54**		**41.2 %**	**0.08 [0.02, 0.33]**
Total events: 0 (PEG), 29 (NGT)					
Heterogeneity: Tau^2 = 0.0; Chi^2 = 0.96, df = 3 (P = 0.81); I^2 =0.0%					
Test for overall effect: Z = 3.50 (P = 0.00046)					
2 mixed baseline diseases					
Baeten 1992	10/44	11/46		24.2 %	0.95 [0.45, 2.01]
Corry 2008	0/15	12/18		10.6 %	0.05 [0.00, 0.74]
Yata 2001	9/42	11/40		24.1 %	0.78 [0.36, 1.68]
Subtotal (95% CI)	**101**	**104**		**58.8 %**	**0.62 [0.23, 1.72]**
Total events: 19 (PEG), 34 (NGT)					
Heterogeneity: Tau^2 = 0.45; Chi^2 = 5.36, df = 2 (P = 0.07); I^2 =63%					
Test for overall effect: Z = 0.91 (P = 0.36)					
Total (95% CI)	**156**	**158**		**100.0 %**	**0.24 [0.08, 0.76]**
Total events: 19 (PEG), 63 (NGT)					
Heterogeneity: Tau^2 = 1.27; Chi^2 = 18.80, df = 6 (P = 0.005); I^2 =68%					
Test for overall effect: Z = 2.44 (P = 0.015)					
Test for subgroup differences: Chi^2 = 5.31, df = 1 (P = 0.02), I^2 =81%					

Analysis 1.2. Comparison 1 PEG versus NGT, Outcome 2 intervention failure (subgrouped by gastrostomy technique).

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 2 intervention failure (subgrouped by gastrostomy technique)

Study or subgroup	Favours PEG n/N	NGT n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
1 pull technique					
Hamidon 2006	0/10	5/12		10.4 %	0.11 [0.01, 1.73]
Norton 1996	0/16	3/14		10.0 %	0.13 [0.01, 2.25]
Park 1992	0/19	18/19		10.6 %	0.03 [0.00, 0.42]
Subtotal (95% CI)	**45**	**45**		**31.0 %**	**0.07 [0.01, 0.35]**
Total events: 0 (Favours PEG), 26 (NGT)					
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.79$, df = 2 (P = 0.67); $I^2 = 0.0\%$					
Test for overall effect: Z = 3.23 (P = 0.0013)					
2 push technique					
Corry 2008	0/15	12/18		10.6 %	0.05 [0.00, 0.74]
Subtotal (95% CI)	**15**	**18**		**10.6 %**	**0.05 [0.00, 0.74]**
Total events: 0 (Favours PEG), 12 (NGT)					
Heterogeneity: not applicable					
Test for overall effect: Z = 2.17 (P = 0.030)					
3 non-reported technique					
Baeten 1992	10/44	11/46		24.2 %	0.95 [0.45, 2.01]
Bath 1997	0/10	3/9		10.2 %	0.13 [0.01, 2.22]
Yata 2001	9/42	11/40		24.1 %	0.78 [0.36, 1.68]
Subtotal (95% CI)	**96**	**95**		**58.4 %**	**0.81 [0.48, 1.37]**
Total events: 19 (Favours PEG), 25 (NGT)					
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 1.84$, df = 2 (P = 0.40); $I^2 = 0.0\%$					
Test for overall effect: Z = 0.79 (P = 0.43)					
Total (95% CI)	**156**	**158**		**100.0 %**	**0.24 [0.08, 0.76]**
Total events: 19 (Favours PEG), 63 (NGT)					
Heterogeneity: $Tau^2 = 1.27$; $Chi^2 = 18.80$, df = 6 (P = 0.005); $I^2 = 68\%$					
Test for overall effect: Z = 2.44 (P = 0.015)					
Test for subgroup differences: $Chi^2 = 11.29$, df = 2 (P = 0.00), $I^2 = 82\%$					

Analysis 1.3. Comparison 1 PEG versus NGT, Outcome 3 mortality irrespective of follow-up time.

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 3 mortality irrespective of follow-up time

Study or subgroup	Favours PEG n/N	NGT n/N	Risk Ratio M-H,Random,95% CI	Risk Ratio M-H,Random,95% CI
Baeten 1992	13/41	5/42		2.66 [1.04, 6.80]
Bath 1997	6/10	6/9		0.90 [0.45, 1.79]
Corry 2008	0/15	0/18		0.0 [0.0, 0.0]
Dennis 2005	79/162	76/159		1.02 [0.81, 1.28]
Douzinas 2006	3/16	5/20		0.75 [0.21, 2.67]
Hamidon 2006	2/10	2/12		1.20 [0.20, 7.05]
Norton 1996	4/16	10/14		0.35 [0.14, 0.87]
Park 1992	1/20	1/20		1.00 [0.07, 14.90]
Total (95% CI)	**290**	**294**		**0.96 [0.64, 1.44]**

Total events: 108 (Favours PEG), 105 (NGT)

Heterogeneity: $Tau^2 = 0.10$; $Chi^2 = 9.68$, df = 6 (P = 0.14); $I^2 = 38\%$

Test for overall effect: Z = 0.21 (P = 0.84)

Test for subgroup differences: Not applicable

Analysis 1.4. Comparison 1 PEG versus NGT, Outcome 4 pneumonia irrespective of follow-up time.

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 4 pneumonia irrespective of follow-up time

Study or subgroup	PEG n/N	NGT n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Baeten 1992	2/41	2/42		2.5 %	1.02 [0.15, 6.93]
Corry 2008	4/15	6/18		7.1 %	0.80 [0.28, 2.32]
Dennis 2005	56/162	59/159		28.7 %	0.93 [0.69, 1.25]
Douzinas 2006	16/16	20/20		36.8 %	1.00 [0.90, 1.11]
Norton 1996	3/16	6/14		5.9 %	0.44 [0.13, 1.43]
Yata 2001	14/42	22/40		19.0 %	0.61 [0.36, 1.01]
Total (95% CI)	**292**	**293**		**100.0 %**	**0.84 [0.61, 1.14]**

Total events: 95 (PEG), 115 (NGT)

Heterogeneity: $Tau^2 = 0.07$; $Chi^2 = 12.79$, df = 5 (P = 0.03); $I^2 = 61\%$

Test for overall effect: Z = 1.12 (P = 0.26)

Test for subgroup differences: Not applicable

Analysis 1.5. Comparison 1 PEG versus NGT, Outcome 5 complications irrespective of follow-up time.

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 5 complications irrespective of follow-up time

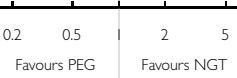
Study or subgroup	PEG n/N	NGT n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Baeten 1992	21/41	17/42		4.2 %	1.27 [0.79, 2.03]
Corry 2008	8/15	6/18		1.4 %	1.60 [0.71, 3.59]
Dennis 2005	56/162	59/159		10.9 %	0.93 [0.69, 1.25]
Douzinas 2006	16/16	20/20		82.6 %	1.00 [0.90, 1.11]
Norton 1996	4/16	6/14		0.9 %	0.58 [0.21, 1.65]
Total (95% CI)	**250**	**253**		**100.0 %**	**1.00 [0.91, 1.11]**

Total events: 105 (PEG), 108 (NGT)

Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 3.51$, df = 4 (P = 0.48); $I^2 = 0.0\%$

Test for overall effect: Z = 0.09 (P = 0.93)

Test for subgroup differences: Not applicable



Analysis 1.6. Comparison 1 PEG versus NGT, Outcome 6 mean survival (months).

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 6 mean survival (months)

Study or subgroup	PEG N	Mean(SD)	NGT N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Yata 2001	42	11.4 (1.6)	40	7.1 (2.9)		100.0 %	4.30 [3.28, 5.32]
Total (95% CI)	**42**		**40**			**100.0 %**	**4.30 [3.28, 5.32]**

Heterogeneity: not applicable

Test for overall effect: Z = 8.26 (P < 0.00001)

Test for subgroup differences: Not applicable

Analysis 1.7. Comparison 1 PEG versus NGT, Outcome 7 weight (endpoint).

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 7 weight (endpoint)

Study or subgroup	PEG N	Mean(SD)	NGT N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Norton 1996	13	61 (11)	8	57.8 (10)		100.0 %	3.20 [-5.95, 12.35]
Total (95% CI)	**13**		**8**			**100.0 %**	**3.20 [-5.95, 12.35]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.69 (P = 0.49)

Test for subgroup differences: Not applicable

Analysis 1.8. Comparison 1 PEG versus NGT, Outcome 8 weight (change from baseline).

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

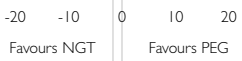
Outcome: 8 weight (change from baseline)

Study or subgroup	PEG N	Mean(SD)	NGT N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Corry 2008	15	0.28 (2.1)	18	0.32 (2.83)		57.2 %	-0.04 [-1.72, 1.64]
Norton 1996	13	2.2 (5.33)	8	-2.6 (3.93)		42.8 %	4.80 [0.82, 8.78]
Total (95% CI)	**28**		**26**			**100.0 %**	**2.03 [-2.66, 6.72]**

Heterogeneity: $Tau^2 = 9.29$; $Chi^2 = 4.83$, df = 1 (P = 0.03); $I^2 = 79\%$

Test for overall effect: Z = 0.85 (P = 0.40)

Test for subgroup differences: Not applicable



Analysis 1.9. Comparison 1 PEG versus NGT, Outcome 9 albumin (endpoint).

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

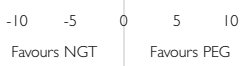
Outcome: 9 albumin (endpoint)

Study or subgroup	PEG N	Mean(SD)	NGT N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Norton 1996	15	30.1 (3.6)	10	22.3 (2.2)		100.0 %	7.80 [5.52, 10.08]
Total (95% CI)	**15**		**10**			**100.0 %**	**7.80 [5.52, 10.08]**

Heterogeneity: not applicable

Test for overall effect: Z = 6.72 (P < 0.00001)

Test for subgroup differences: Not applicable



Analysis 1.10. Comparison 1 PEG versus NGT, Outcome 10 reflux esophagitis.

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 10 reflux esophagitis

Study or subgroup	PEG n/N	NGT n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
Yata 2001	8/42	17/40		100.0 %	0.45 [0.22, 0.92]
Total (95% CI)	**42**	**40**		**100.0 %**	**0.45 [0.22, 0.92]**

Total events: 8 (PEG), 17 (NGT)

Heterogeneity: not applicable

Test for overall effect: Z = 2.18 (P = 0.029)

Test for subgroup differences: Not applicable

Analysis 1.11. Comparison 1 PEG versus NGT, Outcome 11 length of stay (days).

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 11 length of stay (days)

Study or subgroup	PEG N	Mean(SD)	NGT N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Dennis 2005	162	55 (68)	159	53 (52)		100.0 %	2.00 [-11.23, 15.23]
Total (95% CI)	**162**		**159**			**100.0 %**	**2.00 [-11.23, 15.23]**

Heterogeneity: not applicable

Test for overall effect: Z = 0.30 (P = 0.77)

Test for subgroup differences: Not applicable

Analysis 1.12. Comparison 1 PEG versus NGT, Outcome 12 time of enteral nutrition (days).

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

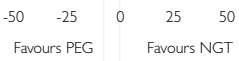
Outcome: 12 time of enteral nutrition (days)

Study or subgroup	Favours PEG N	Mean(SD)	NGT N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Baeten 1992	41	21.6 (22.4)	42	16.4 (14.4)		47.2 %	5.20 [-2.92, 13.32]
Park 1992	19	28 (0)	17	5.2 (1.5)		52.8 %	22.80 [22.09, 23.51]
Total (95% CI)	**60**		**59**			**100.0 %**	**14.48 [-2.74, 31.71]**

Heterogeneity: Tau^2 = 146.23; Chi^2 = 17.90, df = 1 (P = 0.00002); I^2 =94%

Test for overall effect: Z = 1.65 (P = 0.099)

Test for subgroup differences: Not applicable



Analysis 1.13. Comparison 1 PEG versus NGT, Outcome 13 score of patients satisfaction.

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 13 score of patients satisfaction

Study or subgroup	PEG N	Mean(SD)	NGT N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Baeten 1992	22	1.77 (1)	21	2.33 (1.49)		100.0 %	-0.56 [-1.32, 0.20]
Total (95% CI)	**22**		**21**			**100.0 %**	**-0.56 [-1.32, 0.20]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.44 (P = 0.15)

Test for subgroup differences: Not applicable

Analysis 1.14. Comparison 1 PEG versus NGT, Outcome 14 score of inconvenience by de nurses.

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 14 score of inconvenience by de nurses

Study or subgroup	PEG N	Mean(SD)	NGT N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Baeten 1992	38	2 (1.12)	30	2.58 (1.35)		100.0 %	-0.58 [-1.18, 0.02]
Total (95% CI)	**38**		**30**			**100.0 %**	**-0.58 [-1.18, 0.02]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.89 (P = 0.058)

Test for subgroup differences: Not applicable

Analysis 1.15. Comparison 1 PEG versus NGT, Outcome 15 mid-arm circumference in cm (endpoint).

Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 15 mid-arm circumference in cm (endpoint)

Study or subgroup	PEG N	Mean(SD)	NGT N	Mean(SD)	Mean Difference IV,Random,95% CI	Weight	Mean Difference IV,Random,95% CI
Norton 1996	13	26.3 (5.3)	8	23.8 (1.8)		100.0 %	2.50 [-0.64, 5.64]
Total (95% CI)	**13**		**8**			**100.0 %**	**2.50 [-0.64, 5.64]**

Heterogeneity: not applicable

Test for overall effect: Z = 1.56 (P = 0.12)

Test for subgroup differences: Not applicable

Analysis 1.16. Comparison 1 PEG versus NGT, Outcome 16 Functional ability (MRS).

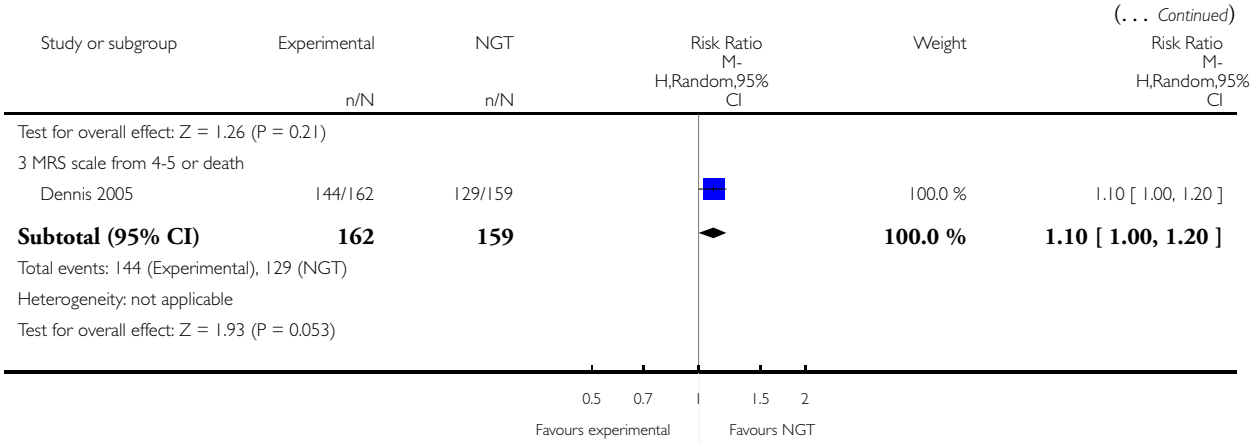
Review: Percutaneous endoscopic gastrostomy versus nasogastric tube feeding for adults with swallowing disturbances

Comparison: 1 PEG versus NGT

Outcome: 16 Functional ability (MRS)

Study or subgroup	Experimental n/N	NGT n/N	Risk Ratio M-H,Random,95% CI	Weight	Risk Ratio M-H,Random,95% CI
1 MRS scale from 0-3					
Dennis 2005	18/162	30/159		100.0 %	0.59 [0.34, 1.01]
Subtotal (95% CI)	**162**	**159**		**100.0 %**	**0.59 [0.34, 1.01]**
Total events: 18 (Experimental), 30 (NGT)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.92 (P = 0.055)					
2 MRS scale from 4-5					
Dennis 2005	65/162	53/159		100.0 %	1.20 [0.90, 1.61]
Subtotal (95% CI)	**162**	**159**		**100.0 %**	**1.20 [0.90, 1.61]**
Total events: 65 (Experimental), 53 (NGT)					
Heterogeneity: not applicable					

(*Continued* . . .)



ADDITIONAL TABLES

Table 1. Continuous data unsuitable for imputation in forest plot

1 median albumin (endpoint)			
	PEG (n = 8)	NGT (n = 10)	P value
	39.5 (R 36 to 44)	36.0 (R 31 to 45)	0.045
2 mean albumin (endpoint)			
	PEG (n = 42)	NGT (n = 40)	P value
	36	32	0.01
3 median length of stay (days)			
	PEG (n = 162)	NGT (n = 159)	P value
	34.0 (IQR 17 to 66)	37.0 (IQR 17 to 76)	not reported
4 utility mean difference between comparison groups (endpoint)			
mean difference		95%CI	P value
0.035		- 0.024 to 0.093	0.12
5 median patient overall quality of life at first week			
	PEG (n = 15)	NGT (n = 18)	P value

Table 1. Continuous data unsuitable for imputation in forest plot (*Continued*)

	4.0 (R 2.0 to 7.0)	4.0 (R 2.0 to 7.0)	0.89
6 anthropometric parameters			
	PEG (n = 8)	NGT (n = 10)	P value
median TSFT (mm)	20.1 (R 9.6 to 34)	12.7 (R 9.8 to 32)	0.076
median BSFT (mm)	10.3 (R 4.8 to 13)	7.4 (R 4.4 to 15)	0.533
median MAC (cm)	31.4 (R 22 to 36)	27.8 (R 21 to 37)	0.182
median serum albumin (g/l)	39.5 (R 36 to 44)	36.0 (R 31 to 45)	0.045
7 median change in GER (%) on day 7			
	PEG	NGT	P value
	2.7 (R 0 to 10.4)	10.8 (R 6.3 to 36.6)	P<0.01

Outcome 1 - Median albumin (endpoint) as reported in Hamidon 2006.
Outcome 2 - Mean albumin (endpoint) as reported in Yata 2001 (abstract).
Outcome 3 - Median length (days) of stay as reported in Dennis 2005.
Outcome 4 - Utility mean difference derived from Euroqol between comparison groups (endpoint) favouring NGT group, but without statistical significance (Dennis 2005)
Outcome 5 - Median patient overall quality of life at first week (endpoint) reported by Corry 2008.
Outcome 6 - Anthropometric medians (endpoint) as reported in Hamidon 2006.
Outcome 7 - Median Gastroesophageal reflux (%, endpoint) as reported in Douzinas 2006.
IQR: interquartile range
R: range
CI: confidence interval
TSFT: triceps skin-fold thickness
BSTF: biceps skin-fold thickness
MAC: mid-arm circumference

APPENDICES

Appendix 1. CENTRAL search strategy

1. esophag*
2. oesophag*
3. 1 or 2
4. disease*
5. Neoplasms/
6. cancer*
7. Adenocarcinoma/
8. or/4-7
9. 3 and 8
10. Pathologic Constriction
11. stenosis
12. stenoses
13. dysmotilit*
14. stricture
15. or/10-14
16. 3 and 15
17. (Esophageal Motility Disorders) or (Esophageal Diverticulum) or (Esophageal Diverticulosis) or (Esophageal Stenosis) or (Esophageal Achalasia)
18. Deglutition Disorders/
19. dysphagia
20. swallowing disorder*
21. swallowing disturbance*
22. Esophageal Diseases/
23. or/16-22
24. Enteral Nutrition/
25. Gastrointestinal Intubation/
26. tube feeding
27. gastroenteral tube
28. nasoenteral tube
29. nasojejunal feeding tube
30. nasojejunal tube
31. enteral feeding
32. gastric feeding tube*
33. Feeding Apparatus/ or Nutritional Support/ or Enteric Feeding/ or Tube Feeding/
34. force feeding*
35. Nasogastric Tube/
36. post-pyloric feeding
37. postpyloric feeding
38. Enteric Feeding/
39. trans-pyloric feeding
40. nasoduodenal tube
41. Gastrointestinal Endoscopy/ or Digestive System Endoscopy/
42. endoscop*
43. Endoscopic Surgical Procedure*
44. Gastrostom*
45. Gastrostomy/
46. percutaneous endoscopic gastrostomy
47. or/24-46
48. (9 or 23) and 47

Appendix 2. MEDLINE search strategy

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. clinical trials as topic.sh.
6. randomly.ab.
7. trial.ti.
8. or/1-7
9. (animals not (humans and animals)).sh.
10. 8 not 9
11. esophag$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
12. oesophag$.mp. [mp=title, original title, abstract, name of substance word, subject heading word]
13. 11 or 12
14. disease$.ab,ti.
15. exp Neoplasms/
16. cancer$.mp.
17. exp Adenocarcinoma/
18. or/14-17
19. 13 and 18
20. exp Constriction, Pathologic/
21. stenosis.mp.
22. stenoses.mp.
23. dysmotilit$.mp.
24. stricture.mp.
25. or/20-24
26. 13 and 25
27. Esophageal Motility Disorders/ or Diverticulum, Esophageal/ or Diverticulosis, Esophageal/ or Esophageal Stenosis/ or Esophageal Achalasia/
28. exp Deglutition Disorders/
29. dysphagia.ab,ti.
30. swallowing disorder$.ab,ti.
31. swallowing disturbance$.ab,ti.
32. Esophageal Diseases/
33. or/26-32
34. exp Enteral Nutrition/
35. exp Intubation, Gastrointestinal/
36. tube feeding.ab,ti.
37. gastroenteral tube.ab,ti.
38. nasoenteral tube.ab,ti.
39. nasojejunal feeding tube.ab,ti.
40. nasojejunal tube.ab,ti.
41. enteral feeding.ab,ti.
42. gastric feeding tube$.ab,ti.
43. exp Feeding Apparatus/ or exp Nutritional Support/ or exp Enteric Feeding/ or exp Tube Feeding/
44. force feeding$.ab,ti.
45. Nasogastric Tube/
46. post-pyloric feeding.ab,ti.
47. postpyloric feeding.ab,ti.
48. Enteric Feeding/
49. trans-pyloric feeding.ab,ti.
50. nasoduodenal tube.ab,ti.

51. exp Endoscopy, Gastrointestinal/ or exp Endoscopy, Digestive System/
52. endoscop$.ab,ti.
53. Endoscopic Surgical Procedure$.mp.
54. Gastrostom$.mp.
55. exp Gastrostomy/
56. percutaneous endoscopic gastrostomy.mp.
57. or/34-56
58. (19 or 33) and 57
59. 10 and 58

Appendix 3. EMBASE search strategy

1. (random$ or placebo$).ti,ab.
2. ((single$ or double$ or triple$ or treble$) and (blind$ or mask$)).ti,ab.
3. controlled clinical trial$.ti,ab.
4. RETRACTED ARTICLE/
5. or/1-4
6. (animal$ not human$).sh,hw.
7. 5 not 6
8. esophag$.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
9. oesophag$.mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
10. 8 or 9
11. disease$.ab,ti.
12. exp Neoplasms/
13. cancer$.mp.
14. exp Adenocarcinoma/
15. or/11-14
16. 10 and 15
17. exp Constriction, Pathologic/
18. stenosis.mp.
19. stenoses.mp.
20. dysmotilit$.mp.
21. stricture.mp.
22. or/17-21
23. 10 and 22
24. Esophageal Motility Disorders/ or Diverticulum, Esophageal/ or Diverticulosis, Esophageal/ or Esophageal Stenosis/ or Esophageal Achalasia/
25. exp Deglutition Disorders/
26. dysphagia.ab,ti.
27. swallowing disorder$.ab,ti.
28. swallowing disturbance$.ab,ti.
29. Esophageal Diseases/
30. or/23-29
31. exp Enteral Nutrition/
32. exp Intubation, Gastrointestinal/
33. tube feeding.ab,ti.
34. gastroenteral tube.ab,ti.
35. nasoenteral tube.ab,ti.
36. nasojejunal feeding tube.ab,ti.
37. nasojejunal tube.ab,ti.

38. enteral feeding.ab,ti.
39. gastric feeding tube$.ab,ti.
40. exp Feeding Apparatus/ or exp Nutritional Support/ or exp Enteric Feeding/ or exp Tube Feeding/
41. force feeding$.ab,ti.
42. Nasogastric Tube/
43. post-pyloric feeding.ab,ti.
44. postpyloric feeding.ab,ti.
45. Enteric Feeding/
46. trans-pyloric feeding.ab,ti.
47. nasoduodenal tube.ab,ti
48. exp Endoscopy, Gastrointestinal/ or exp Endoscopy, Digestive System/
49. endoscop$.ab,ti.
50. Endoscopic Surgical Procedure$.mp.
51. Gastrostom$.mp.
52. exp Gastrostomy/
53. percutaneous endoscopic gastrostomy.mp.
54. or/31-53
55. (16 or 30) and 54
56. 7 and 5

Appendix 4. LILACS search strategy

1. pt ensaio controlado aleatorio
2. pt ensaio clinico controlado
3. mh ensaios controlados aleatorios
4. mh distribuicao aleatoria
5. mh método duplo-cego
6. mh método simples-cego
7. pt estudo multicentrico
8. #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7
9. tw ensaio
10. tw ensayo
11. tw trial
12. #9 OR #10 OR #11
13. tw azar
14. tw acaso
15. tw placebo
16. tw control$
17. tw aleat$
18. tw random$
19. #13 OR #14 OR #15 OR #16 OR #17 OR #18
20. tw duplo
21. tw cego
22. #20 AND #21
23. tw doble
24. tw ciego
25. #23 AND #24
26. tw double
27. tw blind
28. #26 AND #27
29. #19 OR #22 OR #25 OR #28
30. tw clinic$

31. #12 AND #29 AND #30
32. #8 OR #31

WHAT'S NEW

Last assessed as up-to-date: 30 September 2011.

Date	Event	Description
15 December 2011	New search has been performed	Literature searches rerun. No new studies identified and conclusions unchanged
15 December 2011	New citation required but conclusions have not changed	No new studies identified and conclusions unchanged.

HISTORY

Protocol first published: Issue 4, 2009

Review first published: Issue 11, 2010

Date	Event	Description
14 June 2011	Amended	Information about number of studies were amended in the Summary of Findings table and risk of bias terminology updated with no change to overall assessments

CONTRIBUTIONS OF AUTHORS

Conceiving the review: CG, JW and DM

Co-ordinating the review: CG

Screening search results: CG and SL

Organising retrieval of papers: CG and DRW

Screening retrieved papers against inclusion criteria: CG, SL, DM and JW

Apraising quality of papers: CG, SL, RBA and DRW

Extracting data from papers: CG, DRW, SL and RBA

Writing to authors of papers for additional information: CG

Providing additional data about papers: CG

Obtaining and screening data on unpublished studies: CG and DRW

Data management for the review: CG and SL

Entering data into Review Manager (RevMan 5.0): CG and RBA

Other statistical analysis not using RevMan: RBA

Interpretation of data: CG,DM, SL,RBA and JW

Statistical inferences: CG, RBA and SL

Writing the review: CG

Person responsible for reading and checking review before submission: CG, DM, JW and SL

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- CAPES - Ministry of Education for the postgraduate scholarship, Brazil.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

Previous criteria to evaluate the risk of bias are indicated below. The criteria were modified according to the new *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011)

Selection bias

- Was the allocation sequence adequately generated?
- Was allocation adequately concealed?
- Were there systematic differences between the baseline characteristics of the groups that were compared?

Attrition bias

Were there systematic differences between groups in withdrawals from a study?

Detection bias

Were there systematic differences between groups in how outcomes were determined?

INDEX TERMS

Medical Subject Headings (MeSH)

Deglutition Disorders [*complications]; Enteral Nutrition [*methods; mortality]; Gastrostomy [adverse effects; *methods; mortality]; Intubation, Gastrointestinal [adverse effects; *methods; mortality]; Malnutrition [etiology; *therapy]; Pneumonia [etiology]; Randomized Controlled Trials as Topic; Treatment Failure

MeSH check words

Adult; Humans