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Experience in Bedside Placement, Clinical Validity, and Cost-Efficacy of a Self-Propelled Nasojejunal Feeding Tube

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Abstract

Background: The procedures needed to insert nasojejunal tubes (NJTs) are often invasive or uncomfortable for the patient and require hospital resources. The objectives of this study were to describe our experience in inserting a self-propelling NJT with distal pigtail end and evaluate clinical validity and cost efficacy of this enteral nutrition (EN) approach compared with parenteral nutrition (PN). *Materials and Methods:* Prospective study from July 2009 to December 2010, including hospitalized noncritical patients who required short-term jejunal EN. The tubes were inserted at bedside, using intravenous erythromycin as a prokinetic drug. Positioning was considered correct when the distal end was beyond the ligament of Treitz. Migration failure was considered when the tube was not positioned into the jejunum within 48 hours postinsertion. *Results:* Fifty-six insertions were recorded in 47 patients, most frequently in severe acute pancreatitis (69.6%). The migration rates at 18 and 48 hours postinsertion were 73.2% and 82.1%, respectively. There was migration failure in 8.9% of cases, and 8.9% were classified null (the tube was no longer in the gastrointestinal tract at 18 hours). There were no reported or observed complications. The mean duration of the EN was 12 ± 10.8 days. Five different types of EN formula were used. The total study cost was 53.9% lower compared with using PN in all patients. *Conclusions:* Our study demonstrated that bedside insertion of a self-propelling NJT is a safe, cost-effective, and successful technique for postpyloric enteral feeding in at least 73% of the patients, and only 18% of patients could eventually need other placement techniques. It can avoid the need for more aggressive or expensive placement techniques or even PN if we cannot achieve enteral access. (*Nutr Clin Pract*. 2015;30:815-823)

Keywords

enteral nutrition; parenteral nutrition; nutritional support; cost analysis

Enteral nutrition (EN) by nasogastric tube is the most common method for short-term nutrition support.[1] There are, however, certain situations in which despite a functioning digestive tract, intragastric nutrition is not recommended.[2–4] So, EN via nasojejunal tube (NJT) is indicated in the following:

1. Severe gastroesophageal reflux, gastric atony, or gastroparesis with high risk of broncho-aspiration
2. Slowed gastric emptying, for example, as defined by Canadian Critical Care Nutrition Guidelines (in patients receiving EN via nasogastric tube, causing 2 episodes of gastric retention >250–500 mL in 4 hours,[5] despite prokinetic treatment)
3. Intolerance to oral diet or gastric feeding, due to gastroduodenal inflammation, postprandial pain, or problems with passage of food as a consequence of inflammation or external compression of the duodenum secondary to pancreatitis or cancer
4. Fistula in the proximal small intestine (in the duodenum or first part of jejunum)

In this scenario, postpyloric EN is a valuable alternative to parenteral nutrition (PN) due to the clinical benefits of preserving the intestinal barrier and its associated immune functions,[6] reducing the incidence of sepsis[7] and other infectious complications,[8,9] and is cost-effective.[10] PN should therefore be reserved only for patients with motility and/or intestinal absorption failure[11] or demonstrated intolerance to postpyloric EN.

It is important to consider the specific location of the termination of the postpyloric tube to provide safe and effective EN. Postpyloric tubes are technically difficult to maintain due to duodenum antiperistalsis movements. For this reason, nasoduodenal tubes can migrate back into the stomach (specially with weighted tubes[12]), and therefore they would not be a useful alternative to intragastric nutrition.

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With regard to the effects of the point of entry of EN on pancreatic stimulation, the same secretory response was observed for lipase, trypsin, and amylase with the oral administration of a polymeric formula as for via tube, both at the level of the ampulla of Vater[13] and at the ligament of Treitz[14] in healthy volunteers. In contrast, an absence of pancreatic response was observed when infusing a tube feed of the same characteristics 40–120 cm beyond the ligament of Treitz.[15]

Both in terms of avoiding the reflux of the tube feed into the stomach and reducing the pancreatic stimulation, the end of the tube should be distal to the ligament of Treitz.

The insertion of a tube into the jejunum is not an easy task. Only around 30% of conventional tubes, whether weighted or unweighted, spontaneously pass through the pylorus at 24 hours.[12,16] Apart from providing no additional benefits in terms of duodenal migration, the weighted tubes are more likely to return to the stomach.[12]

A number of different methods have been described for facilitating the passage of tubes through the pylorus. Salasidis et al[17] used the insufflation of 500 mL of air into a tube inserted in the stomach, with 78% successful migration at 24 hours. Welch[18] achieved an 83% successful migration rate by administering air through the tube while it is being gently advanced toward the pylorus. Thurlow[19] reported an 87% success rate introducing the tube while applying "corkscrew" rotation movements. The technique described by Ugo et al[20] uses weighted tubes, achieving 83% tube migration with the patient lying in the right lateral position with simultaneous insufflation of air into the stomach. With the aid of metoclopramide as a prokinetic drug, Lord et al[21] achieved an 86% success rate at 24 hours with unweighted tubes but only 48% with weighted ones. These success rates do make NJT insertion appear easy, but success requires practice and familiarity with a particular technique.[22]

Precisely because it is complicated, devices have been developed to aid the passage of the tube through the pylorus and into the jejunum. However, the costs of these devices vary greatly, and they require training to familiarize oneself with their use. One such device is a magnet that attracts the magnetized end of a specially designed tube, allowing it to be guided from the outside, which achieved a 95% success rate in a group of 20 patients.[23] Another alternative is a tube with an electromagnetic transmitter (Cortrak; CORPAK MedSystems, Buffalo Grove, IL) that conveys an image of its trajectory on a monitor at the patient's side, which allows for guiding insertion toward the small intestine with a wide range of success depending on the training, from 70% in untrained staff to 98% in a trained team.[24]

Other more complicated procedures that help guide the passage of the tube are abdominal ultrasound, with an 84.6% success rate,[25] and gastric electrocardiogram, where a change in polarity of the QRS complex indicates the passage of the tube through the pylorus with an 88% success rate.[26]

The endoscopic and radiological techniques are without doubt the most effective for inserting an NJT and are often used when the other methods fail. A number of different possible procedures exist with success rates of >90%.[27,28] However, they are expensive, the availability of the necessary facilities and equipment is often limited, and they require specialists trained in the technique, which at times is laborious and time-consuming.

For many years now, noncritical adult patients admitted to our hospital with the indications for an NJT have had a single-lumen, self-propelling model of tube with a pigtail distal end inserted at the bedside, with very good results.

Apart from the higher risk of complications associated with PN, there are a lot of advantages using the gastrointestinal (GI) tract, such as reduced mortality, multiple organ failure, systemic infections, and the need for operative interventions, seen in patients with acute severe pancreatitis.[29] Furthermore, it is important to compare, through cost-effectiveness analysis, PN with jejunal EN, using different insertion methods.

The aim of this study is to describe our experience in inserting an autopropelled NJT in hospitalized non–critically ill patients requiring postpyloric enteral feeding, to evaluate its effectiveness in the administration of EN adapted to the patient's condition, and to make a cost-efficacy analysis of its use.

Methods

This was a prospective study from July 2009 to December 2010 including noncritical, nonsurgical adult patients admitted to Vall d'Hebron University Hospital, Barcelona, Spain, who, due to their condition, required short-term jejunal administration of EN. The only criterion for exclusion was hypersensitivity to erythromycin.

The Flocare Bengmark NJT (Nutricia, Amsterdam, The Netherlands) was used in all cases. This is a 10-Fr (3.3-mm) external diameter, 145-cm-long, radio-opaque polyurethane tube. The distal end forms 2.5 spirals, 3 cm in diameter and 23 cm long, which are straightened by an interior guidewire, introduced to facilitate the insertion of the tube as far as the stomach and then removed so that the tube regains shape. The presence of the spirals facilitates its advance to the jejunum. The tip is coated with a hydromer compound that lubricates the tube when immersed in water and in contact with fluids.

The tubes were inserted at the bedside by nursing staff from the nutrition support unit following the manufacturer's instructions[30] summarized below. After explaining the procedure in detail to the patient, and once the guidewire was fully inserted into the tube, with the spirals straightened out, the length of tube to be inserted was determined by measuring from the xiphisternum to behind the earlobe and earlobe to the tip of the patient's nose and marking the tube at that point. Two further marks were then made on the tube, one at 25 cm and one at 50 cm from the first mark toward the proximal end. After lubricating the distal end of the tube by immersing in water, the tube was inserted into one of the nostrils and advanced slowly as far as the first mark. If there was no contraindication, the passage

of the tube into the esophagus could be facilitated by gently pushing it while the patient swallowed a sip of water. The correct position of the tube in the stomach could be confirmed by aspirating gastric fluid or by auscultation over the epigastrium for the gurgling sound of air insufflated through the tube if aspiration was unproductive. If any doubt, a plain X-ray was performed for confirmation before continuing the placement procedure. The tube was then flushed with 10–20 mL of water and the guidewire was removed by 25 cm to allow the formation of the spirals, advancing the tube until the second mark was reached. Last, the guidewire was removed completely and the tube secured to the earlobe, leaving sufficient slack to allow it to easily advance as far as the third mark.

All the patients received the prokinetic treatment that is part of our hospital's nasojejunal insertion protocol, consisting of 3 bolus injections of 3 mg/kg body weight of intravenous (IV) erythromycin over 30 minutes. This was administered simultaneously with the insertion of the tube and every 6 subsequent hours. The position of the tube was confirmed radiologically at 18 hours postinsertion. The tube was considered in the correct position when the distal end had passed beyond the ligament of Treitz (defined on a plain abdominal X-ray as the point to the left of the left border of the vertebrae at which the descending tip of the tube was observed, having passed in an ascending direction through the fourth part of the duodenum[31]). In the event of insufficient migration, the erythromycin regime continued and a repeat X-ray was performed 24 hours later. Migration was considered a failure when the distal end of the tube had not reached the jejunum within 48 hours postinsertion. In such a case, the options were endoscopy-guided insertion or PN, depending on the patient's clinical condition.

Due to their medical condition, all the patients were kept nil by mouth from the moment of tube insertion, and we did not use the tube until X-ray confirmation that the distal end of the tube was in the jejunum, at which point the patients were started on a progressive EN regimen with the objective of providing 80%–100% of their nutrition requirements in 3 days. A nutripump was used to infuse the tube feed. Each patient received the most appropriate type of formula for his or her particular clinical condition.

This procedure was standard of care in our hospital. Institutional review board approval to collect patient's data was obtained.

Figure 1 shows the model of an NJT used in the study, and Figure 2 shows an X-ray of the tube having passed beyond the ligament of Treitz.

Categorical variables were compared with Pearson's χ^2 test using SPSS software, version 11 (SPSS, Inc, an IBM Company, Chicago, IL).

To conduct the cost-effectiveness analysis, we calculated the average cost in our hospital of the nutrition treatment per patient when NJT migration was successful as well as the average cost associated with NJT migration failure (see Table 1). In the case of migration success, we calculated the total nutrition cost by adding the cost of the NJT, the erythromycin doses, the X-ray controls, the EN for 12 days (the average EN duration in our study), and the laboratory tests. To calculate the average cost of nutrition treatment in case of migration failure, we took into consideration the 3 different alternative interventions, their associated costs per patient, and the frequency with which each intervention was used, based on the results of this study. Included in this computation were costs associated with NJTs, erythromycin doses, X-rays, endoscopic technique, central catheter, EN and PN for 12 days, and laboratory tests. To simplify the cost estimate, we extrapolated our data to a 100-patient sample.

Figure 1. Flocare Bengmark (Nutricia, Amsterdam, The Netherlands) nasojejunal tube used in the study. Image used with permission from Nutricia.

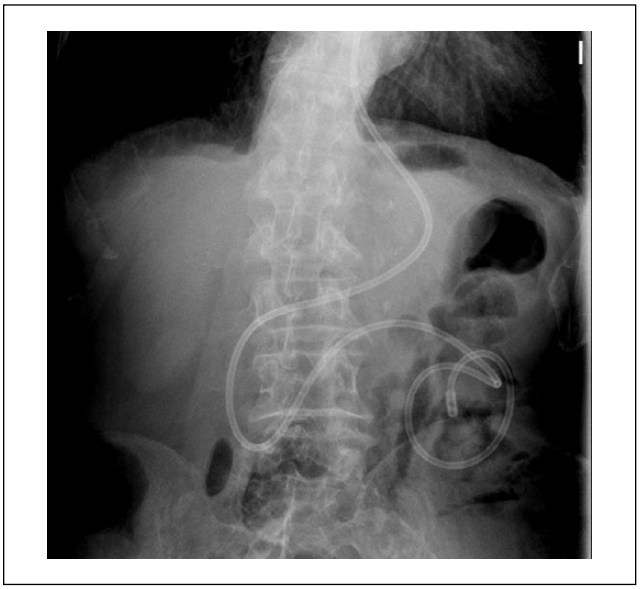

Figure 2. X-ray confirming nasojejunal tube position. Image used with permission from Nutritional Support Unit, University Hospital Vall d'Hebron, Barcelona, Spain.

Table 1. Average Costs in Study Hospital per Treatment Type.

Calculations	Cost (€)[a]
NJT migration success	
Average cost of EN (100% of cases)	
NJT tube cost + erythromycin + X-ray + laboratory tests + EN (12 days) =	$335.01
Average cost of NJT migration success	**$335.01**
NJT migration failure (according to data from Figure 3)	
Average cost of endoscopic NJT placement and EN (49.7% of cases)	
NJT tube cost + erythromycin + X-ray + endoscopic procedure + laboratory tests + EN (12 days) =	$615.91
Average cost of NJT second attempt and EN (10.1% of cases)	
NJT tube cost × 2 + erythromycin + X-ray + laboratory tests + EN (12 days) =	$368.31
Average cost of PN (40.2% of cases)	
NJT tube cost + X-ray + laboratory tests + central catheter + PN (12 days) =	$896.13
Average cost of NJT migration failure	
(49.7% × 466.29) + (10.1% × 278.84) + (40.2% × 678.44) =	**$703.55**

EN, enteral nutrition; NJT, nasojejunal tube; PN, parenteral nutrition.
[a]All monetary values were originally in Euros and have been converted using the 12-month average (November 2012–November 2013) Euro (€)/US dollar ($) ratio = 1.320871.

To isolate and illustrate the effect on cost-effectiveness of implementing a placement procedure that allows for a migration success rate of 82.1%, we calculated the theoretical costs in our hospital of attaining the success rates that previously have been described in the literature. One of those studies[32] used the same tube model, applying an endoscopic procedure whenever the tube did not migrate; if this also failed, the patient received PN. The other study[33] used a weighted NJT, feeding the patient via a parenteral route whenever the tube did not migrate. Studies with surgical patients were disregarded, since the procedure to insert NJTs in the operating theater is radically different from ours. Finally, and for comparison, we also calculated the theoretical costs of treating all patients with PN.

Results

During the study period, 56 NJT insertion attempts were made in 47 patients: 3 had to have new tubes inserted after the first came out accidentally, another 3 had 2 flare-ups of pancreatitis during the study period, 2 patients required new tubes after the first had become obstructed, and 1 patient required reinsertion after the tube was removed for a digestive tract endoscopy.

The average age of the patients (30 men and 17 women) was 56 ± 16.9 (range, 18–81) years. The diagnoses that made jejunal tube insertion necessary in the 56 cases were as follows: 39 cases of severe acute pancreatitis, Balthazar grade C, D, or E (70.9% of the total); 4 cases of gastroparesis (7.3%); 4 pancreatic pseudocysts (7.3%); 3 ampullary carcinomas (5.4%); 2 stomach cancers (3.6%); 1 intra-abdominal abscess; 1 broncho-oesophageal fistula; 1 gastric fistula; and 1 rumination syndrome (1.8% each) (see Table 2).

Migration of the Tube

There were few complications related to the tube insertion procedure. In 1 patient diagnosed with bronchoesophageal fistula, we observed an episode of pharyngeal bleeding, resulting in the procedure being stopped. In the remaining 55 insertion attempts, the tubes were passed into the stomach without difficulty. Three patients diagnosed with severe acute pancreatitis experienced vomiting episodes shortly after insertion and displaced the tube. In another patient, the tube came out accidentally shortly after insertion. In total, there were 5 cases (8.9%) in which the tube was not in the stomach long enough to do the X-ray verification. Of the 51 cases in which the tube remained in place, in 41 (80.4%) the tube had migrated at 18 hours, in 5 (9.8%) at 36–48 hours, and in the remaining 5 (9.8%), the tube was still in the stomach or duodenum after 48 hours. In the subgroup of patients with acute pancreatitis, a clear correlation was found between severity of the pancreatitis and a lower percentage of tubes passing into the jejunum (100% in grade C, 75% in D, and 65% in E; $P < .05$).

Table 2 shows tube migration according to disease, and Figure 3 displays the scheme for follow-up of the tubes.

EN

Of the 46 cases in which the tube migrated to the jejunum, enteral feeding was not started in 1 patient, due to the need for a GI endoscopy, during which the tube was removed. This patient went on to receive PN. EN was started in the remaining 45. Of these, a polymeric high-protein formula was used in 35 cases (77.8%), a peptide-based formula was used in 5 cases (11.1%), a standard polymeric formula was used in 3 cases (6.7%), and in

Table 2. Cases and Outcome With the Tube According to Disease.[a]

Disease	Cases	Migration				Problems Before the 18-h Postinsertion
		18 h	36–48 h	Migration Total %	No Migration	
Total	56 (100)	41 (73.2)	5 (8.9)	82.1	5 (8.9)	5 (8.9)
Acute pancreatitis						
Balthazar grade C	15 (26.8)	14	1	100	0	0
Balthazar grade D	4 (7.1)	2	1	75[b]	1	0
Balthazar grade E	20 (35.7)	12	1	65	3	4
Gastroparesis	4 (7.1)	3	0	75	1	0
Pancreatic pseudocyst	4 (7.1)	4	0	100	0	0
Ampullary carcinoma	3 (5.4)	2	1	100	0	0
Stomach cancer	2 (3.6)	1	1	100	0	0
Intra-abdominal abscess	1 (1.7)	1	0	100	0	0
Broncho-mediastinal fistula	1 (1.7)	0	0	0	0	1
Gastric fistula	1 (1.7)	1	0	100	0	0
Rumination syndrome	1 (1.7)	1	0	100	0	0

[a]Values are presented as number or number (%) unless otherwise indicated.
[b]$P < .05$ (between Balthazar C and D and between Balthazar C and E).

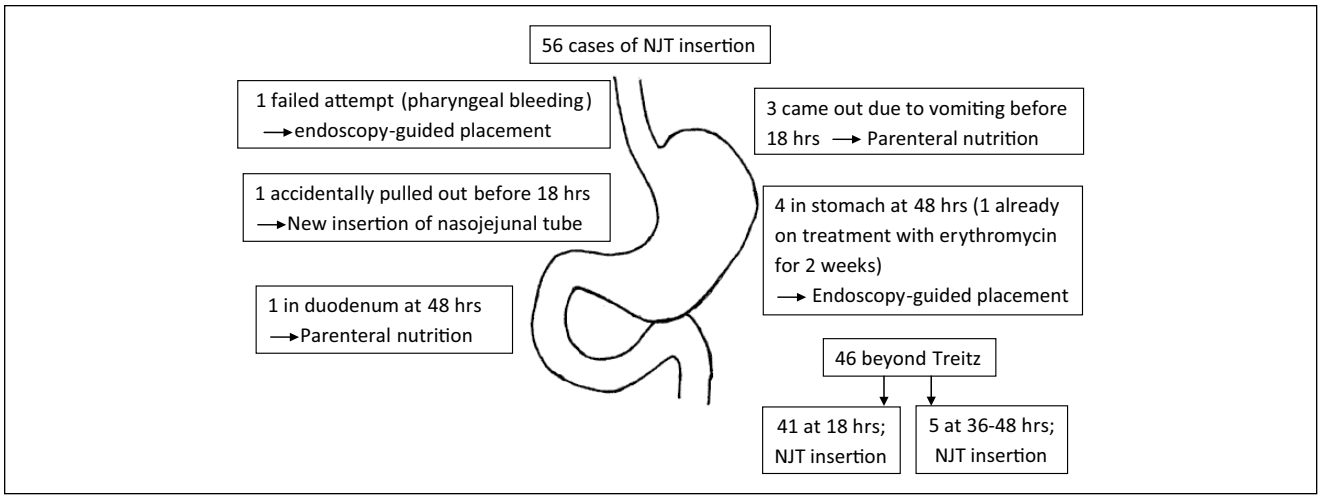

Figure 3. Follow-up of the nasojejunal tubes (NJTs).

the remaining 2 cases, a polymeric hypercaloric formula (2.2%) and a diabetes-specific formula were used (2.2%) (Table 3).

The average duration of the nutrition was 12 ± 10.8 days (range, 2–40 days), and between 80% and 100% of patients' caloric needs were delivered from day 3. There were 4 cases of mechanical complications with the tube: 2 cases (4.4%) of obstruction that could not be solved and another 2 (4.4%) in which the tube came out accidentally. In none of the cases was the tube used for medication.

The reasons for discontinuing EN in the 45 cases were as follows: introduction of oral diet in 32 cases (71.1%), change to PN in 3 cases (6.7%), death of the patient in 2 cases (4.4%), surgery in 2 cases (4.4%), spontaneous removal of the tube in 2 cases (4.4%), tube obstruction in 2 cases (4.4%), removal of the tube to perform GI endoscopy in 1 case (2.2%), and transfer to another hospital in 1 case (2.2%).

Cost Efficacy Analysis

Figure 4 shows the costs associated with the procedures and migration success rates seen in our study (Figure 4A). It also contains a comparison with the theoretical costs that would be incurred in our hospital if we were to use PN in all patients or if our migration success rates were lower and identical to those of 2 previously published studies (Figure 4B–D). In one of these studies,[32] the type of tube was identical to the one used in the present study, whereas in the second study,[33] a weighted tube was used. In this theoretical cost model, to isolate the effect of improving

Table 3. Types of Formula Used and Duration of Enteral Nutrition (EN).

EN Formula	Cases of EN by Diagnoses	No. (%)	Days of EN, Mean ± SD
Polymeric hyperprotein	Acute pancreatitis (Balthazar C)	15 (33.3)	6.3 ± 3.6
	Acute pancreatitis (Balthazar D)	3 (6.7)	11.7 ± 1.5
	Acute pancreatitis (Balthazar E)	10 (22.2)	11.2 ± 9.3
	Pancreatic pseudocyst	3 (6.7)	27.3 ± 18.6
	Ampullary carcinoma	1 (2.2)	20
	Stomach cancer	2 (4.4)	22.0 ± 21.2
	TOTAL	35 (77.8)	12.1 ± 11.1
Peptide based	Acute pancreatitis (Balthazar E)	3 (6.7)	16.7 ± 17.7
	Ampullary carcinoma	1 (2.2)	11
	Intra-abdominal abscess	1 (2.2)	4
	TOTAL	5 (11.1)	13.0 ± 13.7
Standard polymeric	Gastroparesis	3 (6.7)	6.0 ± 1.7
Polymeric hypercaloric	Rumination syndrome	1 (2.2)	7
Diabetic	Gastric fistula	1 (2.2)	9
TOTAL		45 (100)	12 ± 10.8

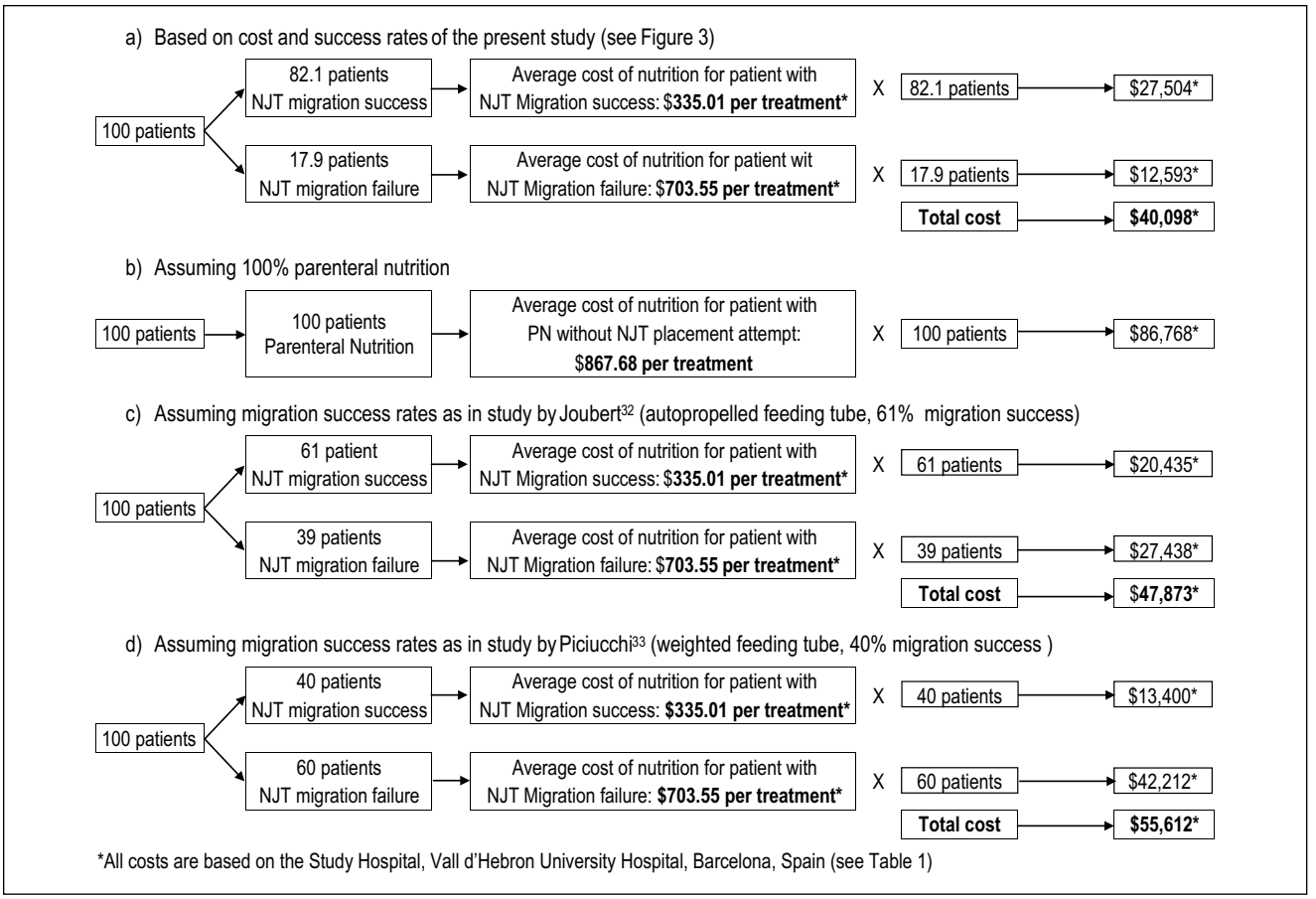

Figure 4. Nasojejunal tube (NJT) cost-effectivity analysis.

migration success rates, the average cost of providing nutrition treatment to patients with migration success and migration failure respectively is assumed to be fixed and equal to the costs in our hospital. In this model, achieving a migration success rate of 82.1% means a cost reduction of 53.9% compared with only using PN and a cost reduction of 16.2% and 27.9%, respectively, compared with achieving the migration success rates of 61% and 40% seen in the mentioned studies.

Discussion

Our study demonstrates a high rate of jejunal migration with this NJT model (82% at 42–48 hours postinsertion) in noncritical patients, with the tube having passed through in the majority at 18 hours (73.2% of total). It also shows the reliability of this type of tube in administering postpyloric feeding in different patient groups.

In a previous study, a similar type of tube was used in the preoperative preparation of patients with normal GI motility and no local anatomical abnormalities, and maintained oral intake was made.[34] The design of this tube facilitated its rapid passage through the pylorus and into the jejunum in most of the above patients likely due to the waves of phase III of the migrating motor complex.[35] Gastroparesis could negatively affect the success rate of migration of this tube. Most patients with postpyloric EN indication have gastroparesis, so we use prokinetic treatment in all to aid the tube in passing the pylorus.

The migration success rate we obtained with this tube is higher than that seen with several other types of tubes[12,16,33] and slightly higher than that found in other studies that used the same type of self-propelled tube: 57% and 78% at 24 hours in noncritical patients with a variety of different diseases with or without altered gastric emptying,[31] 49% at 72 hours in critical patients,[36] and 75% at 96 hours,[37] 61% at 72 hours,[32] and 56% at 48 hours[38] in noncritical patients with acute pancreatitis.

As was observed in other studies, [31,34,37,38] tube migration occurred within the first few hours in most patients. In a number of patients of this study, the tube could already be seen to be entering before the second dose of the prokinetic drug. Nonetheless, all continued to receive the prokinetic drug regime and had the confirmation X-ray as per protocol. However, as a result of the study, we have discontinued the second dose of erythromycin, and the confirmation X-ray is done as soon as we see that the tube has advanced to the third mark. In some cases, we were surprised to find that the tube had reached the ligament of Treiz at 18 hours, even though there were no external signs that the tube had moved.

The most common diagnosis in our patients was acute pancreatitis. The relation between the degree of severity and the lower rate for passage of the tube into the jejunum has also been observed in other studies, both with the same type of tube[32,37] and with a weighted tube.[33] As suggested in one of these studies, [32] in acute pancreatitis, migration through the pylorus may be reduced due to altered motility and the duodenal edema often associated with this condition.

A prokinetic drug is often administered to facilitate the passage of an NJT through the pylorus. The most commonly used is metoclopramide, and in some studies,[31–33] it was used with variable dosage. However, a Cochrane review[39] found no clear benefit from metoclopramide and advises against using it for this purpose.

Since the medical conditions that lead to the need for NJTs are very often accompanied by altered GI motility, our protocol included the administration to all patients of at least 3 doses of erythromycin as a prokinetic.

At a dose of 3 mg/kg, erythromycin is a motilin agonist capable of considerably speeding up gastric emptying in both individuals with normal GI motility and gastroparesis.[40–42] Motilin is a polypeptide hormone secreted by M cells in the small intestine under the stimulus of the acid pH of the duodenum. Its peak plasma concentration coincides with anterograde GI contractions, which make up phase III of the migrating motor complex.[43] Due to tachyphylaxis, the prokinetic erythromycin response cannot be sustained,[44] and a marked reduction in its effects is observed in approximately 60% of critical patients at 7 days.[45] Different doses of erythromycin have been used to facilitate the passage of nasoenteral tubes in various studies with conflicting results. Although in 2 of these studies, a clear benefit was found in both observed active[46] and passive[47] positioning of straight tubes, another 2 studies[38,48] found no difference from the placebo.

Interestingly, in the van den Bosch et al[38] study, with a design similar to the present study and using the same type of self-propelling tube, 40 patients with acute pancreatitis underwent almost identical erythromycin regimes and administration times, yet only 50% of these advanced to the jejunum in the erythromycin group. That study does not specify the degree of severity of the pancreatitis with tomography criteria. Nor does it specify the number of days between hospital admission and tube insertion, which we, in line with the Karsenti et al[37] study, believe was one of the keys to our success in these patients. In all our patients diagnosed with acute pancreatitis, the tube was inserted within 48 hours of hospital admission.

There were no instances of the tube being regurgitated into the stomach, despite 2 patients with severe acute pancreatitis having nausea and 1 episode of vomiting in which EN had to be discontinued and changed to PN. We believe this was most likely due to the anchor effect of double helix of the tube in the intestine. There were only 2 (4.4%) cases of accidental tube ejection in patients who had started EN. In both cases, this was due to the accidental pulling on the tube by the patient or a relative. This rate is much lower than the 36%[49] or 63%[50] of accidental extractions reported with unweighted, straight-ended NJTs or 54%[51] with nasogastric tubes. Patient care and a good system for securing the tube to the nose or cheek are, without doubt, key to success.

Tube occlusion, which was recently classified as fourth on the list of 10 quality indicators in nutrition therapy,[52] occurred in 4.4% of the cases but was not related to the type of formula administered. This rate is slightly lower than the 6.8% in an earlier study carried out with 3 models of nasogastric tubes,[53] but it is high considering that no medication was administered via the tube, this being one of the main causes of obstruction.[54] The 2 cases of obstruction occurred at the beginning of the study, and the frequency for flushing the tube was increased as a result (from every 6 hours to every 4 hours).

EN was well tolerated in all but 3 patients with severe acute pancreatitis (Balthazar grade E) who had to be changed to PN as a result of persisting abdominal pain or nausea.

In addition to its beneficial effects on the intestinal barrier and its immune functions,[6] as well as decreased incidences of

sepsis incidence[7] and infectious complications,[8,9] jejunal EN also has a lower cost compared with PN.[10,54]

Focusing on noncritical, nonsurgical patients who require short-term nutrition support, for whom the alternative to jejunal EN is PN, the group of patients most frequently studied in the literature are those with acute pancreatitis. In this group, unlike PN, EN significantly reduced oxidative stress,[55] mortality,[56] multiple organ failure,[54,55] systemic infections,[54,55] the need for operative interventions,[55] and the length of hospital stay,[54,55] and ultimately it accelerated resolution of the disease process.[54] In this group of patients, enteral jejunal nutrition, apart from being a safe and adequate nutrition source, is also a cost-effective technique. Several studies in patients with acute severe pancreatitis[57–61] have calculated the real cost of both kinds of nutrition support, showing that EN may represent a cost-saving potential, ranging from 47.3%[57] to 81.5%.[60] Comparing results across different studies is difficult because nutrition support costs are measured differently in the various studies. In addition, in all but 1 study,[61] the lower costs observed in the EN groups were also due to the shorter duration of nutrition support.

According to our calculations, the cost associated with our protocol is 16.2% lower than the cost in the study by Joubert et al[32] study (same tube model with different insertion protocol, accruing 61% of success), 27.9% lower than the cost in the study by Piciucchi et al[33] study (10-Fr weighted tube, accruing 40% of migration success), and 53.9% lower than the cost of using PN for all patients. The latter percentage is consistent with the range of saving rate computed for Louie et al[57] (47.3%) and Gupta et al[60] (81.5%).

We are aware that with our NJT insertion method, EN starts at least 18 hours after tube placement and that this delay could lead to the potential detrimental effects related to delayed nutrition intervention. This, in turn, could increase the length of hospital stay. However, we have to consider that other nutrition support techniques, in our setting, fare no better. Although PN was not indicated in our study patients, when necessary, it is accompanied by increased morbidity and related longer hospital stays. In addition, when starting PN in noncritical areas of our hospital, the protocol could last 12–24 hours (to insert and to check a central venous catheter and to prepare the PN formula). In addition, as the endoscopic and radiologic units in our hospital are very overworked departments, it can take more than 24 hours for a tube to be placed by these departments once the tube placement is ordered.

In conclusion, bedside insertion of this model of self-propelling NJTs appears to be safe, cost-effective, and effective in non–critically ill patients requiring EN into the jejunum. Furthermore, it can be implemented by nursing staff accustomed to inserting conventional nasogastric tubes, without the need for special training. In many cases, this type of tube obviates the need for more aggressive or more expensive NJT insertion techniques. It also allows a wide range of EN formulas to be administered.

Statement of Authorship

C. Puiggròs and R. Burgos contributed to the conception or design of the research; C. Puiggròs, R. Molinos, M. D. Ortiz, M. Ribas, C. Romero, C. Vázquez, H. Segurola, and R. Burgos contributed to the acquisition, analysis, or interpretation of the data; C. Puiggròs drafted the manuscript; R. Molinos, M. D. Ortiz, M. Ribas, C. Romero, C. Vázquez, H. Segurola, and R. Burgos critically revised the manuscript; and C. Puiggròs, R. Molinos, M. D. Ortiz, M. Ribas, C. Romero, C. Vázquez, H. Segurola, and R. Burgos agree to be fully accountable for ensuring the integrity and accuracy of the work. All authors read and approved the final manuscript.

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