Original article

A retrospective review of enteral nutrition support practices at a tertiary pediatric hospital: A comparison of prolonged nasogastric and gastrostomy tube feeding

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ARTICLE INFO

Article history:
Received 17 March 2014
Accepted 2 July 2014

Keywords:
Enteral feeding
Gastrostomy tube
Nutrition
Pediatric

SUMMARY

Background & aims: Despite the frequent use of tube-mediated enteral feeding, there is little evidence clarifying best practices pertaining to prolonged nasogastric and gastrostomy tube use in children. At the Montreal Children’s Hospital, tube feeding practices are non-standardized and highly variable, with many patients remaining on protracted nasogastric feeds. We aimed to characterize enteral nutrition practices at our institution and to compare prolonged nasogastric and gastrostomy tube use, hypothesizing that earlier gastrostomy improves outcomes, particularly the development of food refusal.

Methods: In this retrospective cohort study, we reviewed the charts of children beginning long-term (>3 months) nasogastric or gastrostomy feeds at our institution between January 2007 and December 2011, with follow-up until May 2013. Patient demographics, anthropometric parameters, swallowing assessment, tube feeding duration and complications were recorded.

Results: Among 166 patients, the median total tube feeding duration was 24.9 (3.0–75.6) months and varied with underlying disease and swallowing assessment. The median duration of nasogastric tube use was 7.8 (0.7–45.3) months. Food refusal was significantly associated with nasogastric tube exposure >3 months (RR 3.3, p < 0.001, NNT = 3) and anthropometric outcomes were superior in gastrostomy-fed patients. Rates of aspiration pneumonia were similar in both groups. Despite more initial opposition to gastrostomy and a higher complication rate, gastrostomy users appeared more satisfied with their experience, as demonstrated by a much lower discontinuation rate than observed in the nasogastric group.

Conclusions: Prolonged nasogastric feeding is common at our institution. Its association with increased food refusal and less favorable anthropometric outcomes may warrant earlier gastrostomy placement. © 2014 Elsevier Ltd and European Society for Clinical Nutrition and Metabolism. All rights reserved.

1. Introduction

Malnutrition is common in children, especially in the inpatient setting, where malnutrition prevalence has been found to range from 4 to 30%, with infants and toddlers representing a particularly vulnerable subgroup [1–8]. Malnutrition is associated with substantial morbidity and mortality [9], having been shown, for example, to prolong hospitalization when moderate or severe [1]. When malnutrition is identified, the most appropriate method of nutritional support is not always immediately apparent and depends on several factors, such as anticipated duration, underlying diagnosis, patient age, anatomic considerations, gut function, feasibility and cost [10]. Enteral nutrition support (ENS), the use of dietary foods for special medical purposes, regardless of the route of administration [11], is indicated in patients with at least partial gut function, in whom oral intake is insufficient to satisfy energy and nutrient needs. It is often delivered via nasogastric (NG) or gastrostomy (GT) tube, but tubes terminating in the small bowel rather than the stomach are sometimes used as well; these include nasoduodenal (ND) or nasojejunal (NJ) tubes, and gastrojejunostomy (GJ) tubes. Both NG and GT tubes are associated with their respective advantages and drawbacks; while NG tubes are...
easy to insert, they may be misplaced or become dislodged or obstructed and, while GT tubes offer greater stability, they are more invasive to place and may be associated with wound infection, leakage and gastrocutaneous fistula [10]. Both, in the long-term, may be associated with the development of oral feeding difficulties [10]. In fact, in a recent assessment of a rapid home-based tube feeding weaning program, all but one of the 39 children referred exhibited daily food refusal [12].

Gastrostomy tube placement is indicated when long-term ENS is anticipated, with the definition of long-term ranging from 4 to 12 weeks depending on the guideline. [10,13–16] There is little evidence comparing outcomes between prolonged NG and GT tube use in children. In adults, however, a Cochrane review addressing this question found that percutaneous gastrostomy was associated with significantly less intervention failure than NG tube (RR 0.24) with no statistically significant difference in complications [17]. At our institution, tube feeding practices are non-standardized and highly variable, with many patients remaining on protracted NG feeds, including at home. We hypothesized that earlier GT placement improves patient outcomes, particularly the development of oral feeding difficulties, as already supported by existing evidence, including the review by Avitsland et al., in which child and parent satisfaction, as well as various objective outcomes, were significantly improved after gastrostomy in a group of 58 children, 76% of whom had had a prior nasogastric tube [18].

2. Materials and methods

2.1. Study setting and participants

This single-center retrospective cohort study was conducted at the Montreal Children’s Hospital (MCH), a tertiary pediatric 100-bed center affiliated with McGill University. We included all children (<18 years) beginning long-term (defined here as >3 months) tube feeding between January 1, 2007 and December 31, 2011, whether via NG/ND/NJ or GT/GJ tube, with the latter group encompassing tubes placed by all manners of insertion, including laparoscopy (by far the most common in our population), laparotomy and percutaneous endoscopic gastrostomy, with or without fundoplication. There were no exclusion criteria. Patients were identified from a registry of children enrolled in the Home Enteral Feeding Program. Data was collected from patient charts and electronic medical records, with follow-up until May 2013. Ethics approval was obtained from the institution’s ethics committee prior to study commencement.

2.2. Variables and definitions

Baseline variables recorded were patient demographics (gender, date of birth, gestational age and birth weight), underlying disease (see below for classification), ENS route used, age and anthropometric parameters (weight and height) at baseline, duration of NG feeds prior to GT placement (if applicable), occupational therapy (OT) video fluoroscopic swallowing assessment (if available), presence or absence of gastroesophageal reflux disease (GERD) and patient/caregiver perception of tube feeding prior to intervention (if available). Outcomes assessed were total tube feeding duration, NG and/or GT feeding duration, ENS complications (device-related issues, aspiration pneumonia, food refusal) and anthropometric parameters at 6 months, 1 year and ENS termination or end of follow-up. When available, documentation of user/caregiver satisfaction was reviewed and compared between groups.

Patients were categorized into one of three intervention groups: NG only, if they did not undergo GT insertion; GT only, if they received no or very brief NG feeds (≤1 week while awaiting GT); or NG followed by GT, if they transitioned to GT after at least one week of NG feeds.

Underlying diseases were divided into the following categories: neurologic/genetic; prematurity; short gut syndrome (SGS); digestive, other than SGS (inflammatory bowel disease, dysmotility, food allergy, esophageal atresia); malignancy; upper airway anomalies; respiratory diseases; inborn errors of metabolism; renal; other (congenital diaphragmatic hernia, chylothorax, myocarditis, congenital cardiac disease, congenital hypopituitarism, immunodeficiency).

Video fluoroscopic swallowing assessment was graded on a scale from 1 to 4 as follows: 1 — normal; 2 — no aspiration, but not entirely normal (i.e. pooling, penetration.); 3 — aspiration with some, but not all, consistencies; 4 — aspiration/unsafe for oral feeding with all consistencies.

Patients were considered to have GERD at baseline if they demonstrated compatible clinical symptoms resulting in prescription of antacid treatment (H2-blockers or proton pump inhibitors) by a physician. pH probe testing was not included in the definition as it is performed infrequently at the MCH. Food refusal was defined fairly broadly, as either a documented clinically significant limitation in oral intake or oral hypersensitivity as per occupational therapy assessment. Early and late complications were defined as those occurring within and after 14 days of tube insertion, respectively. Major complications were defined as those necessitating a surgical intervention and minor complications as those requiring a hospital visit or causing substantial user or caregiver distress. Wound infection was defined by the requirement for oral antibiotics or drainage, and gastrocutaneous fistula by the need for surgical closure. Patients were deemed to have had aspiration pneumonia if the term aspiration pneumonia was documented during a hospital visit with prescription of appropriate antibiotic treatment. Patients were considered wasted if BMI-for-age (in patients older than 2 years) or weight-for-age (in patients younger than 2 years, or between 2 and 10 years if height was unavailable) was below the 3rd percentile according to standard cut-off values [19].

2.3. Statistical analysis

ENS durations and ages were expressed as medians with ranges. Complications were quantified as number of hospital visits per 1000 NG and GT days. BMI-for-age and weight-for-age percentiles were calculated with AnthroPlus (WHO, version 3.2.2, January 2011), using corrected ages for patients born prematurely (<37 weeks). ENS durations were considered both generally for the entire cohort and on a subgroup basis, according to underlying disease and video fluoroscopy swallowing assessment. Comparative statistics were calculated using the Fisher’s exact test, two-proportion Z-test or student t-test as appropriate. Results were expressed as relative risks and numbers needed to treat (NNT) with 95% confidence intervals and significance was defined as p < 0.05.

3. Results

3.1. General findings

166 children met inclusion criteria. Of these, 49 belonged to the NG only group, 28 to the GT only group and 89 to the NG followed by GT group. Overall, 138 children received nasoenteric feeds (133 NG, 5 ND/NJ) and 117 children underwent enterostomy (109 GT, 8 GJ) at some point during the study period. 29 of the gastrostomies (25%) were performed with simultaneous fundoplication. No patient underwent fundoplication subsequent to gastrostomy. The precise study population composition and losses to follow-up are indicated.
in Fig. 1. The number of patients beginning NG and GT feeds each year from 2007 to 2011 is depicted in Fig. 2.

Males and females were fairly equally represented. There were 5 deaths, all attributable to underlying disease. Fourteen patients (8%), including those who died, had incomplete follow-up for various reasons (transition to adult care, relocation, appointment non-attendance). GERD was extremely common, occurring in 98% of patients prior to intervention. The median age at tube feeding initiation was 5.3 (0–195) months, but varied considerably depending on the initial feeding route; those managed with upfront NG tubes were significantly younger than those who underwent immediate gastrostomy (Table 1). Also shown in Table 1 are total tube feeding durations, as well as NG and GT feeding durations for the entire cohort.

Figure 3 illustrates the underlying disease categories present in the study population, with the most common being neurologic/genetic, prematurity and malignancy, together accounting for 75% of the cohort. Figure 4 depicts the distribution of tube feeding modalities within each disease category.

Age at tube feeding initiation and tube feeding durations varied substantially with underlying disease (Tables 2 and 3). The longest total durations were observed in patients with respiratory diseases, short gut syndrome, inborn errors of metabolism and neurologic/genetic disorders. Table 3 also presents NG- and GT-specific tube feeding durations for each disease category.

Occupational therapists assessed 140 patients, of whom 88 underwent video fluoroscopic swallowing assessment. Those who obtained a grade of 4, the poorest grade as described above, remained on ENS far longer than those who obtained a grade of 1, 2 or 3 (Table 4).

3.2. Complications

Food refusal was documented in 65 patients (39%). The incidence was 0.49 in those exposed to NG tube for >3 months, compared to 0.15 in those on NG feeds <3 months, including those who underwent immediate GT insertion without prior NG tube (RR

![Fig. 1](image-url)

**Fig. 1.** Study patient flow. This figure illustrates the flow of patients over the study period with regard to the type of tube feeding used, including losses to follow-up, and indicates whether tube use was complete (i.e. patient entirely orally fed) or ongoing at the end of the follow-up period. NG, nasogastric; ND, nasoduodenal; NJ, nasojejunal; GT, gastrostomy; GJ, gastrojejunostomy.
3.3, \( p < 0.001 \). This represents an NNT of 3 (CI 2.1–4.7) patients managed with avoidance of prolonged NG feeds to eliminate one instance of food refusal. There were 13 cases of aspiration pneumonia in both NG and GT users, representing 9% and 11% respectively. NG-related complications, excluding food refusal and aspiration pneumonia, occurred in 64 patients (46%), including tube displacement in 29% of users, many on a recurrent basis. Other common complications were feeding intolerance, facial irritation and epistaxis. There was one case of apnea triggered by NG insertion without significant sequelae. GT-related complications, also excluding food refusal and aspiration, were extremely common, occurring in 80% of the group. Early and late major complications occurred in 6% and 13.7%, respectively, and these are shown in Table 5. The majority of the complications, however, were minor, including granulation tissue, skin irritation, leak, tube displacement and 22 cases of cellulitis, and these occurred both early and late. Complications requiring hospital visits occurred at a rate of 0.7 per 1000 NG days and 2.2 per 1000 GT days. There were no deaths attributable to either device.

There was more initial opposition from patients/caregivers to GT than NG tube (11/117 opposed to GT (9%) vs 6/138 to NG (4%), \( p = 0.14 \). 4 NG tube users entirely refused GT insertion. In contrast, once tube feeding was established, far more NG users discontinued tube feeding or opted for the alternate route due to dissatisfaction (16/138 NG users (12%) vs 1/117 GT users (1%), \( p < 0.001 \).

3.3. Anthropometric outcomes

Anthropometric parameters evolved more favorably in GT-fed than NG-fed patients. The percent of wasted children (of those with available data) decreased from 40 to 12% between the start and end of GT feeds (a 70%, statistically significant reduction), while no difference was seen in the percent of wasted children between the start and end of NG feeds (Table 6).

4. Discussion

Despite the increasing prevalence of pediatric tube feeding [20], there is sparse data comparing prolonged nasogastric and gastrostomy tube use in children. Two very small, dated articles focusing on very specific pediatric populations found no difference in complication rates or anthropometric outcomes [21,22]. Despite fairly directive guidelines pertaining to pediatric gastrostomy use,
there is tremendous variation in practice. To our knowledge, ours is the largest study comparing prolonged pediatric NG and GT tube use and the first to do so broadly, across various diseases. It is also the first to assess the development of food refusal in relation to tube feeding route.

In this review, 83% of patients began ENS with NG tube, with 64% later transitioning to gastrostomy. Upfront gastrostomy was fairly uncommon (17% of the cohort) and primarily performed in older children. GERD was extremely prevalent prior to intervention, documented and treated in 98% of patients. The effect of NG and GT tube on GERD prevalence was impossible to accurately assess given the study’s retrospective nature.

The median total tube feeding duration was 24.9 (3.0–75.6) months, but varied substantially with underlying disease. Shorter durations were observed in patients with diseases presenting a temporary need for ENS, such as malignancy and prematurity, while longer durations were observed with diseases of a more progressive nature, such as inborn errors, neurologic/genetic disorders, SGS and respiratory diseases, such as cystic fibrosis. Tube feeding duration also varied with video fluoroscopic swallowing assessment; a grade of 4, indicating aspiration with all consistencies, was associated with a much longer tube feeding duration. By extension, these two patient characteristics, underlying disease and swallowing assessment, could prove useful in identifying patients likely to necessitate prolonged tube feeds (i.e. appropriate candidates for early GT placement).

As predicted, the median duration of NG feeding was very long: 7.8 (0.7–45.3) months, which stands in stark contrast to the ESPGHAN recommendation to proceed to gastrostomy after 4–6 weeks of ENS [10]. As per Table 3, all disease categories were associated with fairly prolonged NG feeding durations, but particularly protracted courses were seen with renal, respiratory and non-SGS digestive disorders, as well as cancer, likely because these were felt to be reversible entities. However, even the neurologic/genetic patients, whose conditions are typically progressive, were exposed to a median of 7 months of NG tube use. Along the same lines, only a fifth of these patients were managed with upfront gastrostomy. The recent finding that neurologically disabled children grew better if they initiated GT feeds prior to 18 months of age is particularly relevant in this regard [23]. Although we observed that patients who eventually received a gastrostomy spent somewhat shorter periods on NG tube, the differences were not striking.

Although generally safe, NG tube use is not entirely benign, as exemplified by the 21 deaths and 79 cases of harm related to NG placement reported to the United Kingdom National Reporting System over a 5-year period [24]. Prolonged NG tube use has also been associated with increased aspiration pneumonia (25–40%), although causality has never been proven [25]. In our study, NG feeding was not associated with a higher rate of aspiration pneumonia. However, the incidence of food refusal was significantly greater in those exposed to NG tube for >3 months (RR 3.3, p < 0.001) with an NNT of only 3. This outcome is in keeping with the finding of improved oral intake after gastrostomy reported in the literature [18]. Given the tremendous ramifications of food refusal, this finding is of great importance.

The overall GT complication rate was almost double that seen with NG tube (80% vs 46%, respectively). This may partly stem from the fact that NG-related complications, particularly tube removal, are often dealt with at home, and thus less likely to be documented. However, the 3-time greater rate of hospital visits observed in GT users (2.2 vs 0.7 visits per 1000 GT and NG days, respectively) was not subject to such a bias. Our GT complication rate exceeds that of gastrocutaneous fistula 1

<table>
<thead>
<tr>
<th>Complication</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastrocutaneous fistula</td>
<td>11</td>
</tr>
<tr>
<td>Gastric perforation</td>
<td>3</td>
</tr>
<tr>
<td>GT leak requiring operative GT revision</td>
<td>3</td>
</tr>
<tr>
<td>Failure of initial GJ insertion, requiring a second surgical procedure</td>
<td>2</td>
</tr>
<tr>
<td>Early GT displacement requiring same-day operative replacement</td>
<td>1</td>
</tr>
<tr>
<td>Colostomy fistula</td>
<td>1</td>
</tr>
<tr>
<td>Penrose left in abdomen</td>
<td>1</td>
</tr>
<tr>
<td>Keloid requiring operative excision</td>
<td>1</td>
</tr>
</tbody>
</table>

GT, gastrostomy.

There were no statistically significant differences between medical and surgical specialties with regard to aspiration pneumonia rate.

NG, nasogastric; GT, gastrostomy; SGS, short gut syndrome; IEM, inborn error of metabolism.

a This includes only those patients on NG prior to GT insertion.

b Data are expressed as median with range, if not otherwise specified.

c This refers to the cumulative time spent on tube feeding, whether NG or GT.

d This includes only those patients on NG prior to GT insertion.
Anthropometric parameters in NG and GT-fed patients at various intervals.

<table>
<thead>
<tr>
<th></th>
<th>NG</th>
<th>GT</th>
<th>Number wasted (%)</th>
<th>Number without data (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>38/134 (28%)</td>
<td>42/104 (40%)</td>
<td>6/138 (3%)</td>
<td>13/117 (11%)</td>
</tr>
<tr>
<td>6 months</td>
<td>29/93 (31%)</td>
<td>22/95 (23%)</td>
<td>45/138 (33%)</td>
<td>22/117 (19%)</td>
</tr>
<tr>
<td>1 year</td>
<td>9/41 (22%)</td>
<td>15/89 (17%)</td>
<td>97/138 (70%)</td>
<td>28/117 (24%)</td>
</tr>
<tr>
<td>End of intervention/ follow-up</td>
<td>38/132 (29%)</td>
<td>13/105 (12%)</td>
<td>6/138 (4%)</td>
<td>12/117 (10%)</td>
</tr>
</tbody>
</table>

NG, nasogastric; GT, gastrostomy.

* Patients were considered wasted if BMI-for-age (in patients older than 2 years) or weight-for-age (in patients younger than 2 years, or between 2 and 10 years if height was unavailable) was below the 3rd percentile according to standard cut-off values.

b Of those with available data.

p value calculated by the two-proportion z-test.

reported by many investigators. A fairly recent review of 760 children, for example, reported early and late gastrostomy complication rates of 41% and 20%, respectively [28]. Others have observed overall complication rates of 54.7% and 44.6% in percutaneously and laparoscopically placed gastrostomies, respectively [27], and stoma-related complications in 73% [28]. Our rather high complication rate may reflect the large proportion of critically ill and neurologically impaired patients in our population. Another contributing factor may be our fairly liberal definition of complications.

It is noteworthy that, despite less initial acceptance of gastrostomy and the higher complication rate observed in GT users, NG users were twice times more likely than GT users to discontinue tube feeds or switch to the alternate route. This underscores the huge discordance that exists between patient/caregiver perception of gastrostomy prior to and after intervention, as has been highlighted by numerous studies, which have in fact found that many parents would have accepted earlier gastrostomy had they anticipated the outcome [18,23,29,30].

Another intriguing finding is that GT use more favorable influenced anthropometric outcomes; while there were 70% less wasted children at the end of GT feeds compared to the start, the percent of wasted children remained virtually unchanged at the end of NG feeds. One potential contributing factor may be less frequent feeding interruptions due to less tube displacement in GT users.

Finally, the trends over time are interesting to note. Although NG tube was twice as common as gastrostomy in 2007, rates essentially equalized by 2010. However, in 2011, while the absolute number of gastrostomies placed increased, NG tube use again was considerably more common than GT use. The reasons underlying these changes in practice are not entirely clear.

There are several limitations to this study, the first of which is its retrospective nature, which makes it particularly difficult to assess subjective outcomes. Importantly, the type and quantity of formula and mode of administration (continuous, intermittent) were not considered as this was not feasible given the frequent changes over the 5-year follow-up period. All patients, however, received standard formula, except for one who received a home preparation as per parent preference. Another significant limitation is that all patients, despite their varied underlying diseases, were considered on growth curves for the general population. Moreover, supplementary information that may have proved useful for the interpretation of such patients’ nutritional status, such as triceps skinfold thickness, was not available. Furthermore, anthropometric data was lacking in up to 10% of patients at the start and end of NG and GT use, and not all patients older than 2 years had heights available, such that weight-for-age, rather than BMI-for-age (the preferred measure), was used for assigning wasted status. In addition, it is difficult to draw any conclusions about the relationship between ENS route and aspiration pneumonia as many factors other than ENS route influence the risk of aspiration, one of the most important being neurologic impairment, which was very common in our cohort. As these patients were included in the analysis, with the last documented visit used for calculating tube feeding duration and complication rates, this may have resulted in an underestimation of both outcomes.

5. Conclusions

We found that patients at our institution remain on NG tube for prolonged periods (median 7.8 months) and showed a significantly increased risk of food refusal in children exposed to NG feeds for >3 months (RR 3.3, p < 0.001, NNT = 3). In addition, in this study, NG use did not improve anthropometric parameters while GT use led to a 70% reduction in the percent of wasted children. We found underlying diseases of a prolonged or progressive course and a failed video fluoroscopic swallowing assessment to be associated with a prolonged need for enteral nutrition support. Although GT-related complication rates were higher and individuals were initially less accepting of gastrostomy, NG tube use was far more frequently discontinued due to user dissatisfaction. Given the above, a change in practice at our institution toward early (<3 months) GT placement appears warranted, as already stipulated by various guidelines. It is essential to raise physician and patient awareness of this, across all pediatric specialties, and to address preconceived negative perceptions of gastrostomy as this is an important barrier to early GT insertion.

Statement of authorship

AR helped design the study, performed the data collection and initial analyses and drafted the initial manuscript. RB helped design the study, carried out secondary analyses, and reviewed and revised the manuscript. AS conceptualized and designed the study, and reviewed and revised the manuscript. All authors read and approved the final manuscript as submitted.

Sources of funding

None.

Conflict of interest

None.

Acknowledgments

None.

References
