CME

Long-term Outcomes of Infants and Children Undergoing Percutaneous Endoscopy Gastrostomy Tube Placement

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ABSTRACT

Objectives: Little is known about long-term outcomes of patients undergoing percutaneous endoscopic gastrostomy (PEG) placement. The purpose of this study was to examine tube-related major complications in pediatric patients undergoing PEG placement during a 10-year follow-up period.

Methods: A retrospective chart review of patients undergoing PEG placement from April 1999 through December 2000 at Boston Children's Hospital was performed. Cumulative incident rates of major complications (defined by additional hospitalization, surgical or interventional radiology procedures) as well as time between PEG placement and major complications were evaluated using Kaplan-Meier survival analysis. Time to elective tube removal and patient mortality was also assessed.

Results: One hundred thirty-eight patients (59% [n = 82] boys [median age 22.5 months] [interquartile range, IQR 9–72.5], weight 9.2 kg [IQR 6.1–15.8]), underwent PEG placement during the study period and were followed at our hospital for a median of 4.98 years (IQR 1.5–8.7) years. Median time to elective tube removal was 10.2 years, with approximately half of the patients estimated to still have an indwelling enteral tube 10 years after placement. Fifteen patients (11%) had at least 1 major complication related to their gastrostomy tubes during the examined time period. The cumulative incidence of patients having a major complication was 15% (95% confidence interval 8.9–24.5) by 5.4 years.

Conclusions: Children undergoing PEG placement have a long-term high risk of morbidity related to enteral tubes. Major complications can occur many years after PEG placement. Larger prospective studies may be useful to assess risk factors for PEG-related complications in pediatrics.

Key Words: children, complication, gastrostomy, percutaneous endoscopic gastrostomy

(*JPGN* 2013;57: 663–667)

Percutaneous endoscopic gastrostomy (PEG) tube placement was originally developed in 1980 as an alternative to open gastrostomy tube placement in medically complex children (1). Placed by both pediatric gastroenterologists and general surgeons, independently or in collaboration, PEGs have become a common method for feeding tube insertion in children (2–10). Establishment of an enteral tube via PEG placement minimizes exposure to anesthesia, requires a less invasive surgical approach, may occur outside of operating room settings, and is associated with both rapid postoperative recovery times and initiation of enteral feedings (1,2,11–14). As an additional benefit, PEG stomas usually heal well if patients elect to remove them (15–17).

Published rates of complications associated with pediatric PEGs have varied widely in the literature, ranging anywhere from 4% to 44%, and may reflect different definitions (2–4,8,18). Most studies have focused on short-term complications either during the perioperative period or those within the first few months after PEG placement (2–4,8,15,18–24); other reports have focused on complications relating to stomal healing or patient feeding tolerance (2,15,23,25). To date, there has been limited literature examining long-term complication rates as well as other tube-related outcomes, including rates of elective tube removal, after PEG placement in children (8).

The aim of our study was to perform a retrospective chart review of pediatric patients who underwent PEG placement at Boston Children's Hospital 10 years ago. Our primary outcome was major complications, defined as any adverse events related to PEG tubes that were associated with additional hospitalization, surgical or interventional radiology procedures. Secondary outcomes of interest included time between PEG placement and first major complication, time to elective tube removal, and patient deaths. We were also interested in other tube-related outcomes after PEG placement, including frequency of exchange from PEG to skin-level devices, exchange to transpyloric enteral tubes (ie, gastrojejunal tube placement), and subsequent Nissen fundoplication.

METHODS

Institutional approval was granted to complete a chart review of all patients undergoing PEG placement at Boston Children's Hospital from April 1999 through December 2000. Patients were identified using CPT codes from hospital administrative data. All of the patients who received a primary PEG tube using a pull technique were included. We excluded any patient who underwent primary surgical gastrostomy tube placement, primary gastrojejunostomy (GJ) tube or jejunostomy tube, or used a 1-step PEG placement technique.

Major complications were defined as any unplanned adverse events requiring additional hospitalization, surgical, or

Received February 13, 2013; accepted June 7, 2013.

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The authors report no conflicts of interest.

DOI: 10.1097/MPG.0b013e3182a02624

interventional radiology procedures. This definition was in accordance with similar criteria used in a previously published article of complications of children undergoing PEG placement at Boston Children's Hospital between January 1988 and June 1992 (3). Fundoplication was not considered a complication but was an outcome of interest.

Per institutional protocol, Corflo PEG tubes (Corpak Inc, Wheeling, IL) were exclusively placed at our hospital during the study period. All PEG procedures were performed jointly by a gastroenterologist and a general surgeon, who worked in a coordinated fashion, in the main operating rooms with general anesthesia. The gastroenterologist was responsible for the endoscopic portions of the procedure, whereas the surgeon performed a percutaneous puncture and inserted the guidewire. All of the patients received at least 1 intraoperative dose of broad-spectrum antibiotics. In most patients, a PEG exchange to a skin-level MIC-KEY button (Kimberly Clark Inc, Dallas, TX), was performed approximately 6 months after PEG placement by the gastroenterologist. This exchange typically involved removal of the PEG via traction pull with confirmation of intragastric placement of the skin level gastrostomy tube by fluoroscopy.

Medical records were reviewed for patient age and weight at the time of tube placement. In addition, patient comorbidities were reviewed and categorized into the following categories: neurologic, metabolic/genetic, cardiac, oncologic, or oropharyngeal abnormalities, as well as any noted history of cystic fibrosis, prematurity (defined as any patient born at <37 weeks), or other disorders. Comorbidities were not considered to be mutually exclusive; therefore, some patients could have >1 comorbidity listed. Primary indications for PEG tube placement were documented and included poor weight gain, aspiration (defined as having a documented abnormal modified barium swallow before PEG placement), other feeding difficulties (excluding any patients with documented aspiration on modified barium swallow), or medication administration.

Dates for PEG placement, PEG exchange to either a skin-level gastrostomy tube or a postpyloric feeding tube (ie, GJ tubes), as well as any dates of fundoplication, were recorded. Patients' records were studied until the date of elective tube removal or recorded date of death. Patients were also noted to be lost to follow-up if they had <2 outpatient visits in our division's gastroenterology and nutrition clinic after PEG placement or no documentation of a PEG exchange or elective tube removal at our institution. Length of follow-up was defined as the time period between initial PEG placement and last recorded outpatient gastrointestinal visit.

Statistical Analysis

Patient characteristics data were described using medians (interquartile range) for continuous variables and counts (proportion) for nominal variables. Number of deaths, major complications, documented exchanges of PEG tubes to other types of enteral tubes, as well as elective tube removal during the study period were summarized using flowcharts and tables. Because of patient censoring during the follow-up period caused by death or loss to follow-up, Kaplan-Meier analyses were used to determine cumulative incidence rates of major complications and PEG retention rates during the 10-year follow-up period.

RESULTS

Patient Demographics

A total of 138 (89%) of 155 patients identified using hospital administrative data were confirmed to have undergone PEG placement at our hospital between April 1999 and December 2000 (Table 1). Median age at placement was 22.5 months and median length of patient follow-up was 4.98 years (IQR 1.5, 8.7). Seventy percent (n = 97) of patients had at least 1 comorbidity before PEG placement, with 30% (n = 41) patients having >1 comorbidity. Associated comorbidities and indications for PEG placement are noted in Table 1.

TABLE 1. Patient characteristics (N = 138)

Characteristic	
Male sex, n (%)	82 (59)
Age,* median (IQR), mo	22.5 (9–72.5)
Weight,*,† median (IQR), kg	9.2 (6.1–15.8)
Comorbidities,‡ n (%)	
Neurologic impairment	78 (56.5)
Metabolic/genetic disorder	33 (23.9)
Prematurity	20 (14.5)
Cardiac disease	17 (12.3)
Malignancy	12 (8.7)
Cystic fibrosis	5 (3.6)
Oropharyngeal abnormality	4 (2.9)
Other diagnoses§	15 (10.9)
Indications for PEG placement, n (%)	
Poor weight gain	70 (50.7)
Feeding difficulties	40 (29)
Aspiration‖	26 (18.9)
Medication administration	2 (1.4)

IQR = interquartile ratio; PEG = percutaneous endoscopic gastrostomy.
* Age and weight measurements were collected at the time of PEG placement.
† No documented weight data were available for 28 patients.
‡ Thirty percent (n = 41) of patients had >1 comorbidity.
§ Infectious process, renal disease, chronic gastrointestinal illness, and noncystic fibrosis–related pulmonary disease.
‖ Aspiration as documented by an abnormal modified barium swallow and excluding any patients with other feeding difficulties.

PEG Tube Outcomes

Initial major tube outcomes after PEG placement are presented in Figure 1. Of the 138 PEGs placed, 67% (93/138) of patients were documented at our hospital to undergo traction exchange to a skin-level gastrostomy tube. Among the 93 patients who underwent conversion from a PEG to a skin-level gastrostomy tube, an additional 28% (26/93) of patients ultimately underwent elective gastrostomy tube removal. Seventeen percent (16/93) of patients subsequently died following their exchange, with no deaths noted to be related to either the exchange procedure or their gastrostomy tube. Fourteen percent (13/93) of patients underwent conversion to a GJ tube, with 23% (3/13) receiving fundoplication within the study period. An additional 3% (3/93) of patients underwent fundoplication without previous placement of a GJ tube.

From Kaplan-Meier analysis, median time to elective tube removal was estimated to be 122.9 months (10.2 years). At 1 year after placement, an estimated 92% of patients (95% confidence interval [CI] 85–96) still had an enteral tube in place. At 5 years, approximately 65% of patients (95% CI 54–74) still had an enteral tube in place (Figure 2).

Major Complications

Fifteen patients (11%) had at least 1 major complication related to their gastrostomy tube during the follow-up period (Table 2). Ten patients developed cellulitis requiring hospitalization and antibiotics, 1 patient experienced intraoperative malpositioning

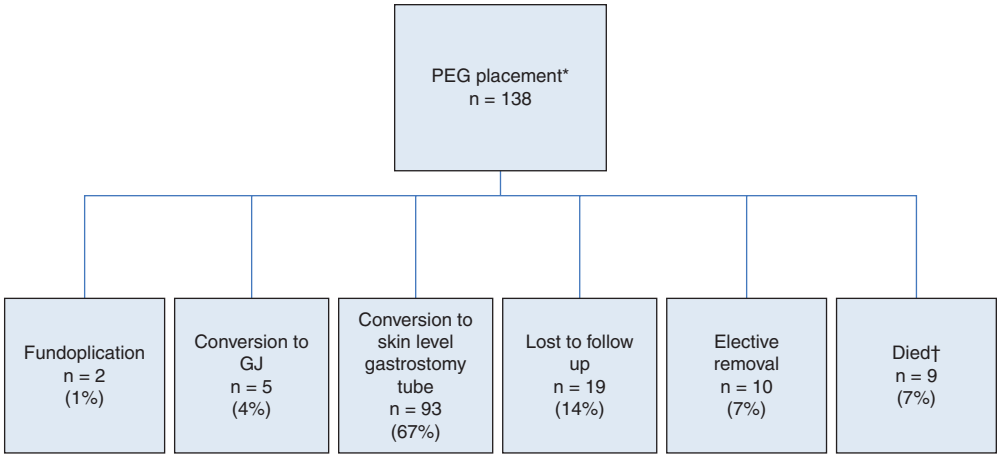

FIGURE 1. First major tube outcomes after PEG placement. *One patient with PEG placement simultaneously underwent a fundoplication procedure. †No deaths were found to be related to PEG placement. GJ = gastrojejunostomy.

of the PEG tube, 1 patient had a traumatic PEG dislodgement while at home, and 1 patient had an unanticipated dislodgement of the MIC-KEY requiring an interventional radiology procedure to salvage the stoma and replace the tube; 2 other patients needed surgical resection of granulation tissue.

Three patients (3/15) also experienced >1 major complication; all had previously been hospitalized for gastrostomy tube cellulitis. One patient required readmission approximately 2 weeks after PEG placement for treatment of severe stomal leakage and recurrent cellulitis. A second patient was diagnosed as having buried bumper syndrome approximately 3 months after previous treatment for PEG cellulitis. A third patient experienced intraperitoneal MIC-KEY migration 8 months after fundoplication, as well as intestinal perforation during a subsequent GJ tube placement, approximately 47 months after the initial PEG tube placement.

The cumulative incidence rate of patients having a major complication was 9.4% at 6 months (95% CI 5.3–16.4), 10.4% (95% CI 6–17.6) at 1 year, and 15% (95% CI 8.9–24.5) by 65 months (5.4 years; Figure 3). No patient in our cohort was observed to experience a major complication >6 years after PEG placement.

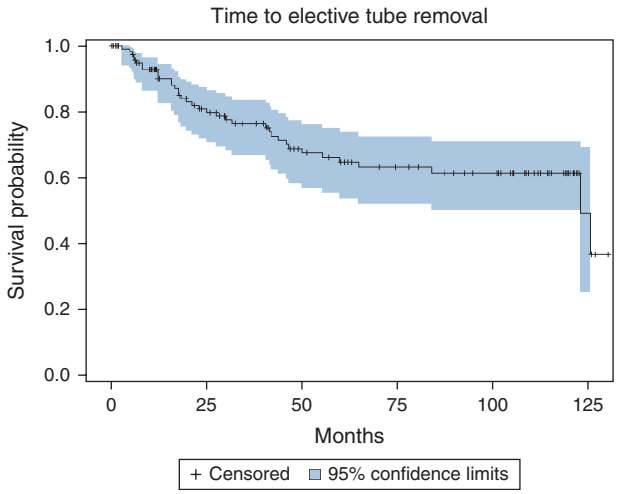

FIGURE 2. Kaplan-Meier curve (in months) estimating the probability of patients requiring ongoing enteral tube use during our 10-year follow-up period. The shaded area represents the 95% confidence interval; median time to elective tube removal was 122.9 months, or 10.2 years.

DISCUSSION

The results of our study support previously published rates of PEG-related complications in children by confirming that approximately 10% of patients will have a major complication within 6 to 12 months of initial placement (3,4,21,23). In addition, we found that although the frequency of complications decreased after the first year following PEG placement, the cumulative incidence rate of major complications associated with PEGs in children was 15% at 5 years. Major complications in our study involved additional hospitalization and surgical or interventional radiology procedures. This finding highlights the fact that significant complications related to PEGs may happen many years after the initial procedure.

Our results also demonstrate that infants and children who undergo PEG tube placement are a medically complex group of patients. Although the majority of patients in our study had some form of neurological disability, many had multiple comorbidities. The medical fragility of children who undergo PEG placement is underscored by the fact that 18% of our cohort died during the 10-year study period because of nongastrostomy-related issues. Although the frequency of deaths of patients at our institution was slightly less than has been previously reported, this is likely because of differences in patient populations, rather than different approaches to postoperative PEG care (5,18,26).

Our study found that many major complications associated with PEG placement in children can occur outside the hospital.

TABLE 2. Initial major complications recorded

First major complication	N = 15
Cellulitis requiring hospitalization	10
Surgical resection of granulation tissue	2
PEG tube dislodgement	1
MIC-KEY tube dislodgement	1
Intraoperative PEG complication	1

PEG = percutaneous endoscopic gastrostomy.

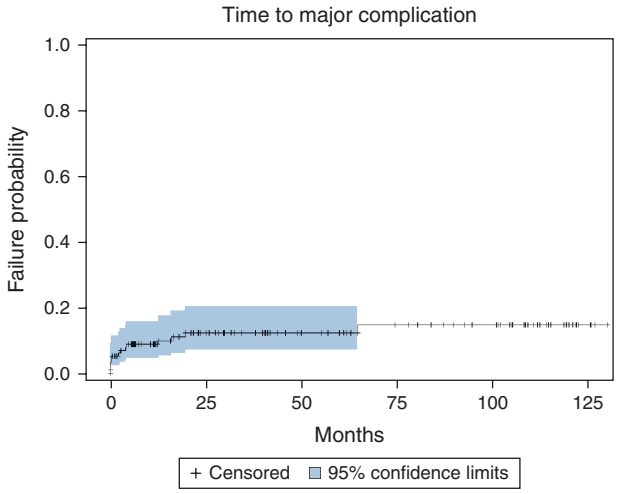

FIGURE 3. Kaplan-Meier analysis of the proportion of patients who experienced a major complication during our 10-year follow-up period. The shaded area represents the 95% confidence interval. The cumulative incidence rate of patients having a major complication was 15% (95% CI 8.9–24.5) by 65 months (5.4 years).

Cellulitis requiring hospitalization for antibiotics and wound care was the most common major adverse event. This finding is similar to previously published major complication data in pediatric patients undergoing PEG placement (3). We found it interesting that 20% of patients who experienced >1 complication associated with their enteral tubes had a history of hospitalization for peristomal cellulitis. Our study was not powered to determine whether cellulitis is a risk factor for subsequent major complications of enteral tubes, but we believe this question should be explored further (2,25,27).

Previous literature has also noted the gastrostomy tube exchange process to be a potential time for major complications to take place, including stomal disruption, bowel obstruction, or peritonitis (3,8,28). In particular, both the timing and method of this exchange have been thought to potentially affect patients' risk. No patients in our cohort were noted to have major complications associated with traction pull to a skin-level gastrostomy tube, but further research assessing risk factors for complications at this critical time point is needed.

We did note that certain patients went on to have their initial PEG exchanged for a variety of other types of tubes (ie, conversion to a gastrojejunal tube or conversion to a surgical skin-level gastrostomy tube after fundoplication). At our institution, we do not typically perform fundoplication at the time of PEG procedure. In this review, we found that 5% of patients who underwent PEGs during the study period ultimately underwent fundoplication. Further study is necessary to understand optimal screening processes for determining which patients should undergo fundoplication at the time of their initial tube placement.

We also found that approximately 50% of patients undergoing PEG placement will still have an enteral tube 10 years later. In turn, it is important for all clinicians involved in the placement of PEG tubes to recognize that patients may require long-term care, especially because our study also found that they are vulnerable to gastrostomy complications years later. Creating health care systems that provide unlimited, ongoing gastrostomy monitoring and enteral tube support for all pediatric patients who undergo this procedure may therefore be essential.

Indeed, providing preventive care for children with enteral tubes services ideally will help to mitigate risks, although we also recognize it may come at a cost. A previous study has suggested that children with gastrostomy tubes require double the home care costs of those allocated to medically complex children without gastrostomy tubes (29). In addition, a recent study of hospitalized medically complex children suggested that patients with higher readmission rates were more likely to have some form of indwelling gastrostomy tube (30). Although our study was not designed to look at the cost implications of these long-term complications, further studies are needed to assess whether gastrostomy tubes are a risk factor for rehospitalization and, if so, what is their long-term financial effect.

Our study was limited by its retrospective design and by the fact that it was conducted at a single, tertiary care pediatric hospital with a specific protocol for PEG placement in children. Another limitation was that 14% of the patients met our a priori definition of lost to follow-up, which may have led us to underestimate the frequency of complications. Finally, we chose to examine major complications and did not examine common minor complications after PEG placement, such as postprocedural pain, gastrostomy leakage, minor infections treated with topical or oral antibiotics, and granulation tissue. These well-known enteral tube issues have also been previously documented to be associated with the need for urgent medical care and patient dissatisfaction (2,23).

In conclusion, children undergoing PEG placement are medically complex and at high risk for morbidity related to their tubes. Approximately half of all children who undergo PEG placement are likely to still have an indwelling enteral tube 10 years later. Although major complications occur most frequently in the first year after PEG placement, complications may occur at any time, even in patients with well-established stomal tracts. Prospective longitudinal studies are needed to fully understand outcomes of PEG tube placement on infants and children with chronic health conditions, and to identify risk factors for complications.

Acknowledgements: The authors thank Dr Lauren Fiechtner and Dr Meenakshi Ganesh for their assistance with reviewing the charts of these patients, as well as Dennis Gotto, BA, for technical assistance with the hospital data query. Their combined efforts helped make this data analysis and review possible.

REFERENCES

1. Gauderer MW, Ponsky JL, Izant RJ Jr. Gastrostomy without laparotomy: a percutaneous endoscopic technique. *J Pediatr Surg* 1980; 15:872–5.
2. Fortunato JE, Troy AL, Cuffari C, et al. Outcome after percutaneous endoscopic gastrostomy in children and young adults. *J Pediatr Gastroenterol Nutr* 2010;50:390–3.
3. Fox VL, Abel SD, Malas S, et al. Complications following percutaneous endoscopic gastrostomy and subsequent catheter replacement in children and young adults. *Gastrointest Endosc* 1997;45:64–71.
4. van der Merwe WG, Brown RA, Ireland JD, et al. Percutaneous endoscopic gastrostomy in children–a 5-year experience. *S Afr Med J* 2003;93:781–5.
5. Catto-Smith AG, Jimenez S. Morbidity and mortality after percutaneous endoscopic gastrostomy in children with neurological disability. *J Gastroenterol Hepatol* 2006;21:734–8.
6. von Schnakenburg C, Feneberg R, Plank C, et al. Percutaneous endoscopic gastrostomy in children on peritoneal dialysis. *Perit Dial Int* 2006;26:69–77.
7. Cappell MS, Godil A. A multicenter case-controlled study of percutaneous endoscopic gastrostomy in HIV-seropositive patients. *Am J Gastroenterol* 1993;88:2059–66.

8. Segal D, Michaud L, Guimber D, et al. Late-onset complications of percutaneous endoscopic gastrostomy in children. *J Pediatr Gastroenterol Nutr* 2001;33:495–500.
9. Wilson L, Oliva-Hemker M. Percutaneous endoscopic gastrostomy in small medically complex infants. *Endoscopy* 2001;33:433–6.
10. Minar P, Garland J, Martinez A, et al. Safety of percutaneous endoscopic gastrostomy in medically complicated infants. *J Pediatr Gastroenterol Nutr* 2011;53:293–5.
11. Fortunato JE, Cuffari C. Outcomes of percutaneous endoscopic gastrostomy in children. *Curr Gastroenterol Rep* 2011;13:293–9.
12. Green A, Shepherd EG, Erdman SH. Sedated percutaneous endoscopic gastrostomy (PEG) placement in the neonate. *Gastroenterology* 2011; 140:S-687.
13. Corkins MR, Fitzgerald JF, Gupta SK. Feeding after percutaneous endoscopic gastrostomy in children: early feeding trial. *J Pediatr Gastroenterol Nutr* 2010;50:625–7.
14. Szary NM, Arif M, Matteson ML, et al. Enteral feeding within three hours after percutaneous endoscopic gastrostomy placement: a meta-analysis. *J Clin Gastroenterol* 2011;45:e34–8.
15. Sathesh-Kumar T, Rollins H, Cheslyn-Curtis S. General paediatric surgical provision of percutaneous endoscopic gastrostomy in a district general hospital–a 12-year experience. *Ann R Coll Surg Engl* 2009; 91:404–9.
16. Kobak GE, McClenathan DT, Schurman SJ. Complications of removing percutaneous endoscopic gastrostomy tubes in children. *J Pediatr Gastroenterol Nutr* 2000;30:404–7.
17. El-Rifai N, Michaud L, Mention K, et al. Persistence of gastrocutaneous fistula after removal of gastrostomy tubes in children: prevalence and associated factors. *Endoscopy* 2004;36:700–4.
18. Avitsland TL, Kristensen C, Emblem R, et al. Percutaneous endoscopic gastrostomy in children: a safe technique with major symptom relief and high parental satisfaction. *J Pediatr Gastroenterol Nutr* 2006;43:624–8.
19. Chang PF, Ni YH, Chang MH. Percutaneous endoscopic gastrostomy to set up a long-term enteral feeding route in children: an encouraging result. *Pediatr Surg Int* 2003;19:283–5.
20. Gauderer MW. Percutaneous endoscopic gastrostomy: a 10-year experience with 220 children. *J Pediatr Surg* 1991;26:288–92–94.
21. Vervloessem D, van Leersum F, Boer D, et al. Percutaneous endoscopic gastrostomy (PEG) in children is not a minor procedure: risk factors for major complications. *Semin Pediatr Surg* 2009;18:93–7.
22. Zamakhshary M, Jamal M, Blair GK, et al. Laparoscopic vs percutaneous endoscopic gastrostomy tube insertion: a new pediatric gold standard? *J Pediatr Surg* 2005;40:859–62.
23. Khattak IU, Kimber C, Kiely EM, et al. Percutaneous endoscopic gastrostomy in paediatric practice: complications and outcome. *J Pediatr Surg* 1998;33:67–72.
24. Akay B, Capizzani TR, Lee AM, et al. Gastrostomy tube placement in infants and children: is there a preferred technique? *J Pediatr Surg* 2010;45:1147–52.
25. Samuel M, Holmes K. Quantitative and qualitative analysis of gastro-esophageal reflux after percutaneous endoscopic gastrostomy. *J Pediatr Surg* 2002;37:256–61.
26. Srivastava R, Landrigan CP, Ross-Degnan D, et al. Impact of a hospitalist system on length of stay and cost for children with common conditions. *Pediatrics* 2007;120:267–74.
27. Novotny NM, Jester AL, Ladd AP. Preoperative prediction of need for fundoplication before gastrostomy tube placement in children. *J Pediatr Surg* 2009;44:173–6discussion 6–7.
28. Beres A, Bratu I, Laberge JM. Attention to small details: big deal for gastrostomies. *Semin Pediatr Surg* 2009;18:87–92.
29. Heyman MB, Harmatz P, Acree M, et al. Economic and psychologic costs for maternal caregivers of gastrostomy-dependent children. *J Pediatr* 2004;145:511–6.
30. Berry JG, Hall DE, Kuo DZ, et al. Hospital utilization and characteristics of patients experiencing recurrent readmissions within children's hospitals. *JAMA* 2011;305:682–90.