

**Implementation of a hospital-wide standardized feeding tube pathway is
associated with a reduction in health care utilization**

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Abstract

Implementation of a hospital-wide standardized feeding tube pathway is associated with a reduction in health care utilization

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Background

Relatively recent medical advances such as percutaneous endoscopic, image-guided, laparoscopic and even robotic gastrostomy tube (GT) placement have become common among pediatric patients. These minimally invasive approaches may be quick to perform and simple to complete, but they are not without subsequent complications such as infection, leakage, device malfunction, dislodgement, hemorrhage and intra-abdominal organ injury. In addition, many of the procedures require planned interventions such as tube exchanges or conversions from gastrostomy to gastrojejunostomy. We hypothesized that implementation of a hospital-wide clinical standardized work (CSW) feeding tube pathway would be associated with a reduction in hospital resource utilization.

Methods

We performed a retrospective cohort study comparing all children undergoing GT or gastrojejunostomy tube (GJ) placement following implementation of the hospital-wide clinical standardized work pathway (CSW) from June 1, 2013 – July 31, 2014 to those placed in a previous time period (January 1, 2010 – December 31, 2011). We limited follow up time to 365 days in both groups. Our primary outcome was the change in the rate of hospital resource utilization, defined as 1) GT/GJ-related emergency department visits, 2) planned events, or 3) unplanned events before and after implementation using adjusted Poisson regression. We also compared the time to first event between cohorts using adjusted Cox regression to understand the relative number of children requiring repeat utilization ($p < 0.05$). Adjustment factors included age, ASA class, gender, insurance, race, comorbidities and GT/GJ at initial placement.

Results

Prior to CSW implementation, 145 (48.7%) devices were placed surgically, 113 (37.9%) endoscopically, and 40 (13.4%) with an image-guided technique. After implementation, 105 (73.4%) were placed surgically, 23 (16.1%) endoscopically, and 15 (10.5%) with an image-guided technique. Prior to implementation, 174/298 (58.4%) patients required additional hospital utilization compared to 58/143 (40.6%) after implementation. Poisson regression demonstrated that following implementation, the rate of resource utilization decreased by over 50% (Incidence Rate Ratio: 0.45; 95%CI 0.36-0.57; $p < 0.001$). The risk of at least one additional feeding tube related intervention or emergency department visit was reduced by over 30% based on Cox regression (Hazard Ratio: 0.62; 95%CI 0.45-0.85; $p = 0.005$). This demonstrated that fewer children required at least one repeat GT/GJ-related hospital utilization event after algorithm implementation.

Conclusions

Care of this complex and heterogeneous patient population is currently spread among multiple providers and specialties leading to variability in the pre-operative workup, intra-operative technique, and post operative care. Our study shows an association between a standardized approach to GT/GJ placement and decreased hospital resource utilization.

Introduction:

Children requiring gastrostomy/gastrojejunostomy tubes (GT/GJ) represent a heterogeneous and complex patient population with high resource utilization. Every pediatrician, specialist and subspecialist cares for patients requiring nutritional support. Multiple services place operative feeding tubes with significant practice variability. This has led to a complex system in which physician ownership for patients with feeding tubes is rare.

Despite the fact that GT/GJ placement is a relatively simple procedure, complications and subsequent hospital utilization is frequent. Fascetti-Leon et al. found a cumulative incidence rate of complications after pediatric percutaneous endoscopic gastrostomy tube (PEG) placement of 47.7% within 24 months of follow-up.¹ After surgical placement, Correa et al. found that 20% of patients presented to the emergency department.² Clinic visit utilization, both planned and unplanned are likely even higher.² Major complications include infection, bowel perforation, hemorrhage, esophageal tear and may occur in as many as 5-17% of cases.³ Minor complications including granulation tissue, minor infection and tube dysfunction, which may occur in more than 50% of cases.³

Beyond the risk of complications, GT/GJ placement is associated with a significant burden on the health care system. Clinic follow-up for wound care and device management, planned tube exchanges or conversions are some of the many indications for routine follow-up in this patient population. Current literature

focuses either on a particular technique for tube placement such as endoscopic or fluoroscopic, or on a certain patient population such as children with cystic fibrosis or neurologic anomalies. There has been no report of a hospital-wide approach to this complex patient population.

In response to these challenges, a standardized clinical work pathway was established at Seattle Children's Hospital to help decrease variability in the preoperative workup, intraoperative technique and postoperative care of patients requiring operative feeding tube support. The goal of this study is to evaluate and report the success of this program.

Methods:

We performed a retrospective cohort study of consecutive GT/GJs placed at Seattle Children's Hospital comparing before and after implementation of a hospital-wide clinical standardized work (CSW) gastrostomy tube pathway for the preoperative workup, intraoperative technique and postoperative care of patients requiring feeding tubes (Figure 1). Prior to pathway implementation the process for gastrostomy placement was unstandardized. Almost any physician involved in a child's care would make the decision for gastrostomy placement with variable preoperative workup and frequently without input from physicians involved in the child's long-term care. Both in the outpatient clinic and as an inpatient consult, the services placing the feeding tubes (surgeons, gastroenterologists, or interventional radiologists) rarely participated in determining the appropriateness for feeding

tube placement, if they considered it at all. Coordination of care was time consuming with little patient ownership throughout the process.

In May of 2013, we implemented a clinical standardized pathway created jointly by all three proceduralist teams with input from referring pediatric services. A key item of the implemented pathway was a preoperative gastrostomy readiness checklist that included, 1) identification of a “Medical Home” physician-partner that oversees a dietician and therapist and ensures ongoing support of each child’s unique and complex medical needs, and 2) family and patient preparation with a nasogastric feeding trial. The feeding trial serves three purposes: it confirms gastrostomy-feeding tolerance, initiates Home Health service engagement, and verifies parent comfort with the equipment and that a feeding plan well in advance of tube placement and hospital discharge. Intra-operatively proceduralists were encouraged to use the same size and type of device at placement and to standardize the location of placement on the abdominal wall. Additionally, a post-operative pathway was instated, which allowed for medications to be used through the device after 6 hours and feeds to be resumed 24 hours after placement.

The unexposed cohort (298 patients, 67.6%) included all consecutive patients with surgical, endoscopic or fluoroscopic GT/GJ placement from January 1, 2010 – December 31, 2012. The exposed cohort (140 patients, 32.0%) included all consecutive patients receiving GT/GJ placement beginning after the algorithm’s implementation from June 1, 2012 – July 31, 2013. For the post-algorithm

implementation period, success of implementation was verified by examining the number of patients with pathway activation. Pathway activation was defined as initiation of the gastrostomy readiness order set in the electronic medical record.

All patients from birth to 22 years of age receiving an initial GT/GJ during both periods were identified using internal billing data and information was collected using extensive chart review. Patients were excluded if they had a concurrent fundoplication since those patients require a separate workup and preoperative evaluation. Additionally patients were excluded if they had a feeding device placed previously. Data abstraction was completed by a medical professional and a trained medical abstractor and included demographic information such as age, race, insurance status and comorbidities, operative characteristics, which included the specialty and location of initial device placement and post-implementation hospital utilization. Hospital utilization included feeding device-related emergency visits, device-related operations, endoscopic procedures or fluoroscopic studies and interventions that occurred within 365 days of the initial device placement in both cohorts. All such encounters were recorded. Patient follow-up data was limited to either the end of the study period or to a limit of 365 days. Those with limited follow-up time were censored in the analyses and exact time at risk was used. Examples of device-related emergency visits included inadvertent removal, leakage or infection. Examples of device-related operations include gastrostomy revisions and both planned and unplanned gastrocutaneous fistula closures. Endoscopic

procedures include planned and unplanned device changes or revisions. Examples of fluoroscopic procedures included device checks or replacements.

The primary outcome of interest was the incidence rate ratio of hospital resource utilization. Hospital resource utilization was defined as any feeding tube-related emergency department visit or a planned or unplanned operative, endoscopic or fluoroscopic intervention or imaging procedure for devices placed after pathway implementation relative to those placed before implementation.

Our secondary outcome of interest was the hazard ratio of at least one additional encounter after tube placement comparing those after implementation to those prior to pathway implementation. GT related clinic visits and patient phone calls were not assessed because the medical record does not clearly indicate if the visit was feeding tube-related. Additionally, patient phone calls are not consistently documented in the chart.

Confounding factors were determined a priori and included gender, age, insurance status, race, American Society of Anesthesiologists (ASA) Class, and patient comorbidities. Insurance status was defined as private, public or uninsured. Race was defined as White/Caucasian, Black/African American, Asian/Native Hawaiian/Pacific Islander or Other/Multiple. Patient comorbidities were obtained through chart review with identification of CPT codes and grouped into six categories and included gastrointestinal disorders such as inflammatory bowel

disease or gastroesophageal reflux requiring nutritional augmentation, genetic anomalies that led to failure to thrive requiring nutritional support, cardiac malformations, pulmonary disease and renal disorders. Univariate analysis was performed using Chi² and Student's t-tests for categorical and continuous variables, respectively. Incidence rate ratios were estimated using an adjusted Poisson regression and hazard ratios were obtained using adjusted Cox regressions. Statistical significance was set to p<0.05. The Seattle Children's Hospital Internal Review Board approved the study (IRB# 14816). Analysis was completed using Stata version 12.1 (StataCorp. 2011. *Stata Statistical Software: Release 12*. College Station, TX: StataCorp LP).

Results:

The 298 patients in the pre-intervention group and the 140 patients in the post-intervention group had similar distributions with respect to age, gender, race, and insurance type (Table 1). The post-implementation group had a slightly higher percentage of comorbidities and more were ASA Class III (Table 1). With respect to GT/GJ placements, in the pre-intervention group 145 (48.7%) devices were placed surgically, 113 (37.9%) devices were placed endoscopically, and 40 (13.4%) devices were placed with an image-guided technique. In contrast, in the post-intervention group 102 (72.9%) of patients that their GT/GJ placed surgically, 23 (16.4%) underwent endoscopic placement, and 15 (10.7%) had image-guided placement. The mean time at risk for the cohort that received their devices before implementation was 149.2 (SD: 126.6) days. The mean follow-up time for those who

received their device after implementation was 158 (SD 132.3) days. There was no statistically significant difference in mean follow-up time between the two groups ($p=0.5$).

Compared to patients before implementation of CSW pathway, the rate of additional hospital utilization was 55% lower for children who had devices placed after implementation after adjusting for the patients' age, gender, race, insurance status, comorbidities and ASA class (IRR: 0.45, 95% CI: 0.36-0.57). The reduction varied in magnitude according to the method for initial placement with a reduced rate of utilization of 73% for those placed using an image-guided technique and 40% for those placed surgically (IRR 0.27, 95% CI: 0.13-0.56; IRR 0.60, 95% CI: 0.42-0.86, respectively (Table 2). The number of procedures per patient was reduced after CSW implementation relative to before implementation (Figure 2).

In addition to a reduced rate of hospital utilization, after adjusting for the patients' age, gender, race, insurance status, comorbidities and ASA Class, the risk of at least one additional encounter was also significantly reduced (HR: 0.62, 95% CI: 0.45-0.85) (Table 2). After CSW implementation, there was a decrease in the proportion of children who required at least one additional encounter following device placement relative to those before implementation (Figure 3).

The reduced rate of utilization and risk of an additional encounter remained statistically significant among patients who had a gastrostomy at initial placement

(IRR: 0.54, 95% CI: 0.42-0.70; HR: 0.65, 95% CI: 0.46-0.91). The reduced risks were also noted among high and low ASA Class and when comparing infants to older children (Table 2).

In order to capture the risk of a specific type of hospital utilization, the risk of at least one additional encounter was measured separately for emergency visits, as well as operative, endoscopic and image-guided encounters. The risk of an endoscopic intervention was significantly reduced both overall and for patients with endoscopic method of initial placement (HR: 0.13, 95% CI: 0.06-0.31; HR: 0.50, 95% CI: 0.31-0.80, respectively). Image-guided events were also significantly reduced. (Table 2)

Discussion:

Our study demonstrates that initiation of a hospital-wide feeding tube pathway was associated with a significant decrease in the amount of device-related hospital utilization. The decrease is noted in the rate of additional encounters and the increased risk of at least one additional encounter. These associations were consistent across our stratified analysis of specifically gastrostomy devices, ASA class and age. There was a shift toward a higher number of surgical devices placed post-implementation and a lower rate of GI or IR interventions between the two groups. The reason for the higher number of surgical devices was likely related to

the principles of the pathway including minimizing radiation and exposures to additional anesthetics.

Although there have been reports in the literature of attempts to reduce post gastrostomy placement hospital resource utilization², there has been no description of a comprehensive, hospital-wide program for the management of this complex patient population. Gastrostomy-related utilization goes beyond the emergency room as children often required confirmatory imaging studies following tube replacement⁴, they require device exchanges, replacements and conversions.

In order to estimate a more accurate assessment of gastrostomy-related hospital resource utilization, we examined not just complications, but a broader definition of hospital resource utilization. This was to estimate better the amount of contact this patient population had with the hospital after placement. Although the exchange of a percutaneous endoscopic gastrostomy tube for a button may be a quick outpatient procedure, there may be consequences to such a planned procedure such as the use of general anesthesia and time missed from work for the caregivers relative to a clinic visit.

The algorithm that was implemented at our institution was an evidence-based and expert generated pathway that was based on core tenants of gastrostomy placement including optimizing patient safety, which included minimizing radiation and anesthetic exposure, reducing the cost and lengths of stay, and ensuring proper

anatomic placement. Our study indicates that implementation of a gastrostomy placement algorithm is associated with decreased hospital resource utilization. The rate of hospital resource utilization was 40% lower after implementation of the pathway.

Additionally, the number of children who required further hospital utilization was significantly lower after implementation. The hazard of having at least one additional encounter was over 30% lower after implementation. This effect may be explained by a reduction in both planned and unplanned visits. By following the principles agreed upon by all services, we performed more surgical tubes and fewer endoscopic and interventional tubes in order to decrease additional anesthetics and radiation exposure. At the same time, we were also able to decrease unplanned encounters, which we believe are due to standardization in education provided by all of the procedural services.

Our stratified analysis demonstrated that the reduction in the rate of hospital resource utilization and the risk of at least one repeat encounter was lower for children with ASA Class 1 or 2 and for those with ASA Class 3 or 4. We also stratified by age ≤ 1 year and > 1 year and again the decreased rate of utilization and risk of additional encounters was again seen. When we restricted to gastrostomy tubes only, the rate reduction and decreased hazard of additional visits for the post-implementation group compared to the pre-implementation group was sustained. The fact that stratification by ASA Class and age shows a consistently lower rate of

additional resource utilization indicates that the success of the intervention impacted children despite age differences or the severity of their condition. Moreover, the intervention reduced the rate of utilization among a more homogeneous group of children who just received a gastrostomy indicating that the improvements were not simply related to a change in the gastrojejunostomy procedure. When we restricted our analysis to ER visits only as a secondary outcome, our results were not significant, likely related to the fact that our study was underpowered to detect a relatively rare outcome.

This study is limited in that it is retrospective, non-randomized and single institutional so there is likely residual confounding in our estimates. We were unable to assess feeding tube related clinic visits or patient phone calls so we have likely underestimated the overall resource burden. Clinic visits and phone calls were not assessed for either the pre- or post-intervention time frame so it is unlikely that this accounted for the changes seen. In addition, they were not obtained for any of the specialties that place feeding tubes, thus this difference is consisted for all methods of initial placement. Since our study includes planned tube changes or conversions we are able to better estimate total resource utilization than if we had examined complications alone. Although pathway activation is documented, some portions of the pathway such as nasogastric feeding tube trial are not clearly documented in the medical record so it is difficult to understand which components of the pathway are central to its success.

Pathway implementation was most challenged by the need to overcome institutional memory. The practice and referral patterns of individual providers must be shifted to allow for a more objective evaluation and review of patient data to choose the optimal specialty for device placement. Additionally, the need for a single team to see the patient through the complex process from beginning to end requires a level of patient ownership that is often not yet integral in the system. Many of the resources required for the preoperative planning phases of our CSW pathway were necessary prior to implementation, but the pathway standardized the approach and allowed for patient and family preparation prior to device placement. Finally, in order to ensure the ongoing success of such a pathway, an administrative manager must champion the effort and follow the population over time with measurable predefined quality outcomes. This ensures maintenance of clinician commitment to the program.

Conclusion:

Our study demonstrates that a hospital-wide pathway for surgical feeding tube placement is possible and is associated with decreased hospital resource utilization. The rate of repeat encounters was lower in the post-implementation group relative to the pre-implementation group. Additionally the risk of at least one additional encounter was significantly lower after implementation. These differences were sustained when stratified by ASA class, gastrostomy tube placement only and age. It

is our hypothesis that decreased variability in care was associated with the decreased hospital utilization seen after pathway implementation.

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Table 1: Demographic and health characteristics of the study population before and after implementation of a clinical standardized work pathway for feeding device placement.

	Before CSW ¹	After CSW
	N (%)	N (%)
Demographic Characteristics		
Age, years [mean, SD]	2.96 (4.34)	2.59 (4.02)
Male	152 (51.0)	69 (49.3)
Race		
White/ Caucasian	164 (55.0)	77 (55.0)
Black/ African American	12 (4.0)	10 (7.1)
Asian/ Native Hawaiian/ Pacific Islander	19 (6.4)	13 (9.3)
Other/ Multiple	103 (34.6)	40 (28.6)
Insurance status		
Private	128 (43.0)	63 (45.0)
Public	166 (55.7)	76 (54.3)
Uninsured	4 (1.3)	1 (0.7)
Health Characteristics		
Comorbidities ²		
Neurodevelopmental	262 (87.9)	126 (90.0)
Heme Onc/Transplant	41 (13.8)	25 (17.9)
Cardiac	107 (35.9)	58 (41.4)
Pulmonary	125 (41.9)	75 (53.6)
Renal	34 (11.4)	25 (17.9)
Gastrointestinal	177 (59.4)	119 (85.0)
ASA Class ³		
I	4 (1.3)	1 (0.7)
II	82 (27.5)	36 (25.7)
III	174 (58.4)	94 (67.1)
IV	38 (12.8)	9 (6.4)

¹ CSW, clinical standardized work

² Comorbidities were based on CPT codes found in the patients' charts and were grouped into six categories: neurodevelopmental anomalies, hematology/oncology/transplant comorbid conditions, cardiac anomalies, pulmonary disease, renal disease and gastrointestinal disorders. Some patients were classified as having multiple categories of comorbidities.

³ American Society of Anesthesiologist (ASA) physical status classification system: ASA Class I, healthy person; ASA Class II, mild systemic disease; ASA Class III, severe systemic disease; ASA Class IV, severe systemic disease with a constant threat to life.