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Implementation of a gastrostomy care bundle reduces dislodgements and length of stay☆

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ABSTRACT

Purpose: Pediatric gastrostomy tubes (G-tubes) are associated with considerable utilization of healthcare resources. G-tube dislodgement can result in tract disruption and abdominal sepsis. We aimed to reduce early G-tube dislodgement by 25%.
Methods: An interdisciplinary team convened to identify key drivers of G-tube dislodgement and implement initiatives to reduce this complication. A G-tube care bundle was implemented in 2018. Rates of early G-tube dislodgement (within 90 days of insertion) were tracked. 15 months of cases after bundle implementation were compared to 20 months of cases before implementation. Length of stay (LOS, balancing measure) and bundle compliance (process measure) were tracked.
Results: G-tube dislodgements decreased 47% after bundle implementation. Overall, dislodgements after G-tube insertion decreased from 43% to 19% dislodgements per tube inserted, $p = 0.004$. Reductions were observed for dislodgements occurring in both the inpatient (14% vs. 1.5%) and outpatient (29% vs. 18%) settings. Median LOS was reduced from 15.3 to 7.1 days following implementation, $p = 0.004$. Process measures demonstrated 75% or greater compliance one year after implementation.
Conclusion: An interdisciplinary team using quality improvement science methodology can significantly reduce G-tube dislodgement and improve value after pediatric gastrostomy tube insertion.
Type of study: Longitudinal cohort study.
Level of evidence: III.

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Gastrostomy tube (G-tube) placement is one of the most common procedures performed in the United States, and, in children, is the third most common noncardiac procedure following only appendectomy and circumcision [1]. G-tubes serve as vital lines for nutrition, hydration, and administration of medicine. However, in children G-tubes have been associated with high rates of complications resulting in the need for additional healthcare utilization [2–4]. Minor complications include excessive granulation tissue around the site, tube dysfunction, and the inability to replace a tube owing to lack of supplies. More serious complications include G-tube dislodgement in an immature gastrostomy tract, which can result in peritoneal soilage, subsequent need for procedural intervention or operative exploration, and potentially death from sepsis. Fifteen percent of patients will present to the emergency department (ED) within 90 days of insertion with a G-tube related complaint, highlighting the often complex care requirements in this population [5].

Comprehensive process standardization has been shown to be effective in improving the care of children by reducing catheter associated infections, preventable medical harm, and morbidity in intensive care units [6–8]. Similar efforts to increase value via quality improvement initiatives remain an active approach in managing the high healthcare utilization following G-tube placement [2,9]. Implementation of a hospital-wide feeding tube placement pathway has been demonstrated to significantly decrease subsequent healthcare utilization, including complications requiring interventions in the operating room or interventional radiology [9,10]. Further, patient-specific variables, including the presence of three or more comorbidities, have been shown to correlate with increased ED utilization [1]. These data highlight the complex interplay between patient and provider factors which underpin subsequent G-tube related complications.

While previous work has focused on resource utilization *after* discharge from the index hospitalization, data remain scarce regarding G-

☆ How this paper will improve care: Pediatric gastrostomy is associated with vexing complications such as premature tube dislodgement. Utilizing quality improvement methodology, a multidisciplinary team has refined a rubic for standardizing care and guardian education, yielding improved postoperative care.

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tube complications, including dislodgement during inpatient care. At our institution, we implemented a quality improvement initiative to address high rates of G-tube dislodgement, in particular, early dislodgement (those occurring within the first 90 days from placement). Our aim was to reduce early G tube dislodgements by 25%. We hypothesized that by standardizing the delivery of care and implementing broad based G-tube best practice education, we could decrease dislodgements. Here we present findings from this multidisciplinary effort.

1. Methods

1.1. Interventional methodology

In January of 2018 a multidisciplinary team of physicians, advanced practice providers, nurses, care coordinators, and hospital quality improvement specialists was formed to address G-tube related healthcare utilization driven by G-tube dislodgements. In order to maximize buy-in

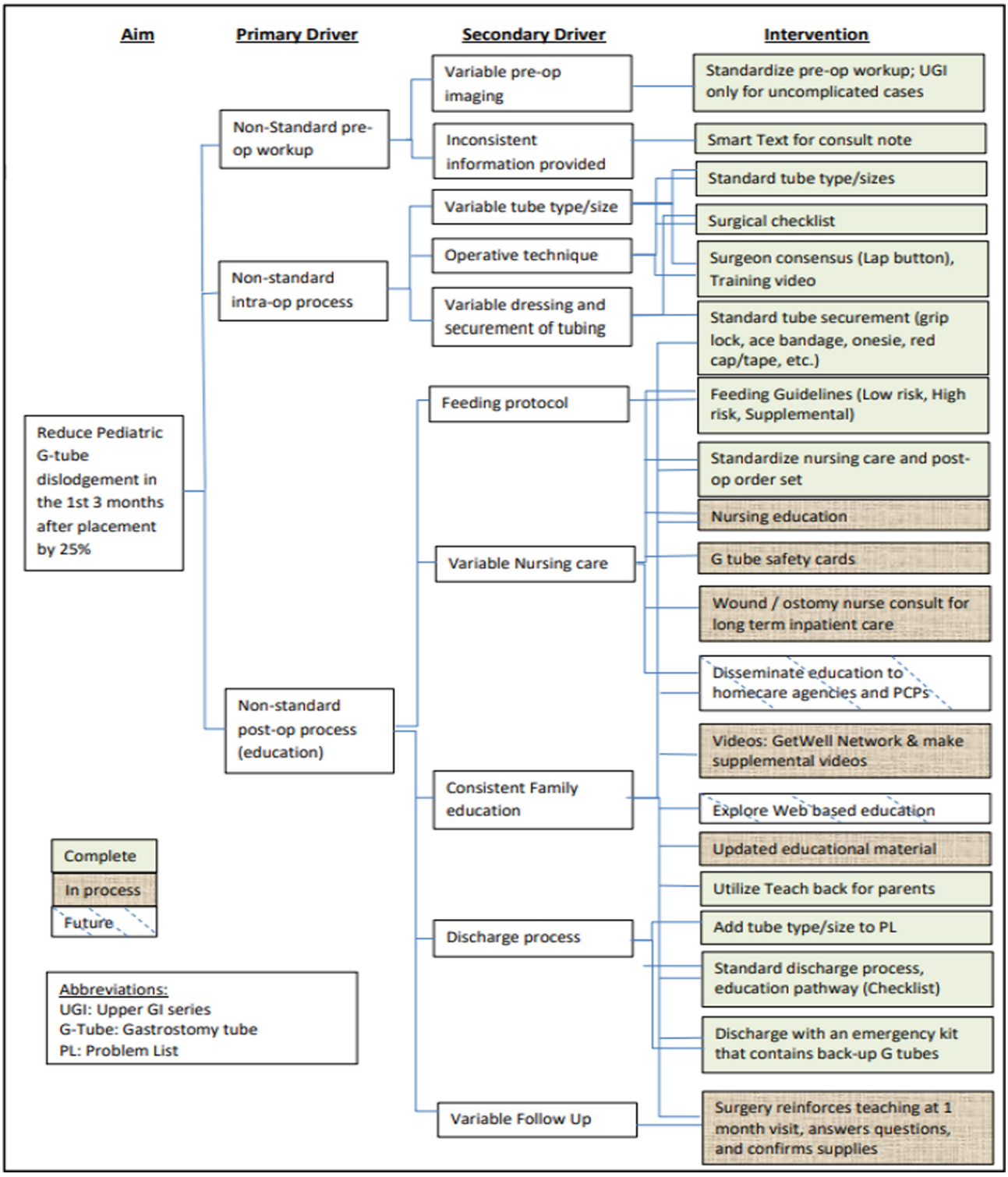

Fig. 1. A key driver diagram of primary and secondary drivers believed to contribute to early gastrostomy dislodgement. We also include interventions thought to ameliorate the problem and the team's progress implementing these ideas of change.

institutionally, the working group was made as inclusive as possible, and crossed all hospital units/departments involved in the care of patients with G-tubes; team members represented pediatric general surgery, gastroenterology, emergency medicine, neonatal and pediatric intensive care, and interventional radiology. Retrospective and prospective data on G-tube dislodgement occurring in the inpatient and outpatient setting were collected and curated along with standard American College of Surgeons National Surgical Quality Improvement Program-Pediatric (NSQIP-P) outcomes.

In order to standardize care institutionally and improve caretaker knowledge and confidence around management of G-tubes in children, a holistic approach was undertaken focused on preoperative, intraoperative, postoperative, and postdischarge key drivers of G-tube dislodgement (Fig. 1). We created and implemented a preoperative consultation checklist to demystify and expedite the consultative process, standardized intraoperative processes, including an intraoperative training video (Fig. 2), and formed consensus postoperative feeding pathways. In order to enhance provider, nursing, and caretaker education regarding best-practices for feeding, cleaning, and tube maintenance, policies and nursing bundles were created to emphasize disconnecting feeding lines when not actively in use, and vigilant application of physical deterrents to dislodgement including discouraging balloon-port access and mechanical securement devices. A timeline of serial plan–do–study–act (PDSA) cycles is shown in Fig. 3. Educational documents and process pathways are available at the American Pediatric Surgical Association (APSA) Quality and Safety Toolkit (https://sites.google.com/view/apsaqsc/home; > Gastrostomy > Gastrostomy QI Projects > University of Rochester).

1.2. QI methodology

In order to assess the efficacy of our initiative in improving the quality of care for patients with G-tubes, we set our "smart" aim on reducing the number of G-tube dislodgements occurring within the first 90 days from placement by 25%. The principal outcome measure was any G-tube dislodgement after implementation and the balancing measure was the length of stay (LOS) during this time frame. Given the implementation of multiple new pathways and processes, we measured compliance with the nursing bundle, teaching for families, and G-tube securement devices; audits of these process measures occurred approximately every six months. Finally, to assess the global impact on quality in this patient cohort, NSQIP-P adverse events were compared between the year prior to implementation and the year after complete implementation of most facets of the initiative (2017 outcomes were compared to 2019 outcomes).

Patient demographics, clinicopathologic factors, and operative characteristics were abstracted from the electronic medical record or were collected from the NSQIP-P institutional dataset. Postoperative outcomes such as LOS (date of surgery to date of discharge), G-tube dislodgement within 90 days of placement, nursing bundle pathway utilization, and readmission within 30 days were collected.

1.3. Statistical methodology

For univariate statistical analyses, continuous variables were tested for normality via the Shapiro–Wilk test. Normally distributed variables were tested for comparisons of means with one or two sided Student's T tests, and are reported as means and standard deviations. Nonnormal continuous variables were tested for comparisons with the Mann–Whitney *U* or Wilcoxon signed T-test where appropriate, and are reported as medians and ranges. Categorical variables were compared between groups utilizing one or two sided Fisher's exact tests, and are reported as proportions. Statistical significance was set at a p-value of 0.05. Statistical analyses were conducted with JMP Pro 13 (© SAS Institute Inc) and Prism 8 (© GraphPad Software, LLC). The institutional review board granted exemption status for this work as a quality improvement effort undertaken during routine care.

2. Results

Between January 2017 and January 2020 147 children underwent primary gastrostomy tube placement at a single tertiary care children's hospital; of these 130 had complete 90-day follow-up at time of analysis (Table 1). The principal intervention (implementation of a comprehensive care bundle) began in September of 2018, and this date is used to delineate analyses before and after the intervention. The G-tube population between these two time periods was similar with respect to clinicopathologic factors (Table 1), notably similar age, race, and sex. However, there was a statistically significant increase in the use of laparoscopic approach in the postintervention cohort (63% vs. 90%, $p = 0.003$).

During the study period, 40 G-tube dislodgements occurred within the first 90 days after insertion. The majority of these events (30/40, 75%) occurred after hospital discharge, in the outpatient setting. Following implementation of a comprehensive care bundle, a **47%** reduction in the rate of G-tube dislodgements-per-case performed was achieved. This was driven by a decrease in the number of dislodgements occurring both within the hospital and following discharge (Fig. 4). Further, the mean number of days between inpatient dislodgements increased six-fold over the study period (Fig. 5). Overall, the rate of G-tube dislodge-

Fig. 2. The quick response (QR) code (left) for accessing a training video (right) for enhancing trainee and staff preparedness prior to laparoscopic gastrostomy insertion.

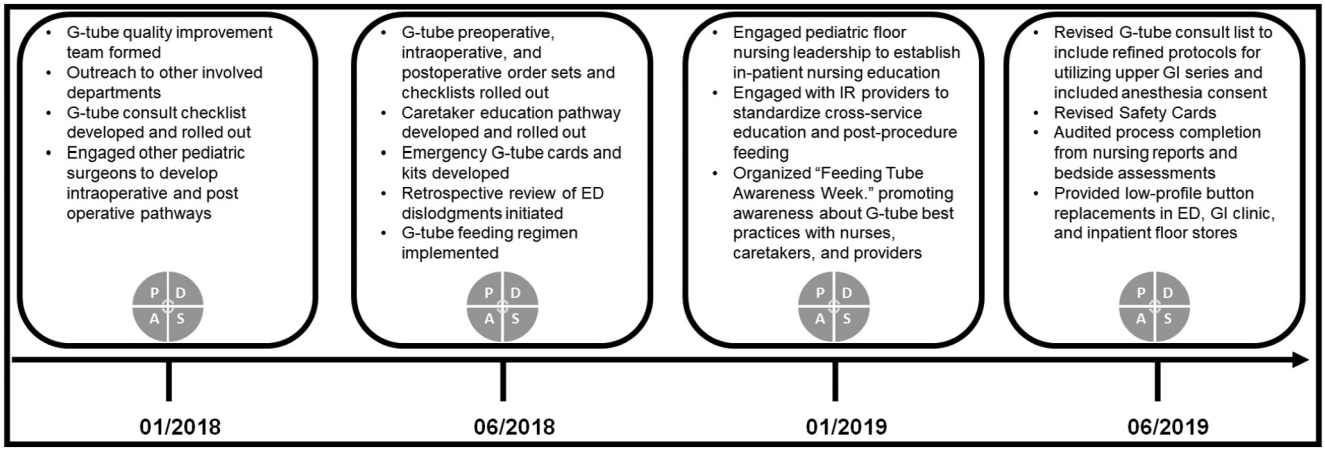

Fig. 3. Timeline of serial plan, do, study, act (PDSA) cycles from formation of our quality improvement team to present; G = gastrostomy, ED = emergency department, IR = interventional radiology, GI = gastrointestinal or gastroenterology.

ments between these two time periods decreased from 0.43 to 0.19 dislodgement per G-tube placed ($p = 0.004$). We observed one dislodgement requiring a return to the operating room during the preintervention cohort compared to zero event in the postintervention cohort.

In order to assess potential secondary deleterious effects of our interventions, we evaluated the LOS for patients before and after implementation as a balancing measure. Following implementation, we observed a reduction in median LOS from 15.3 days per patient to 7.1 days per patient, $p = 0.004$ (Fig. 6). A 42% increase in the number of G-tubes placed per month following implementation was observed (mean cases per month 3.15 vs. 4.5, $p = 0.02$).

One year following implementation of the comprehensive care bundle, postoperative nursing G-tube assessment audits for process compliance were performed (June 2019). We observed a 75% or greater completion rate across all aspects of the postoperative care bundle (Table 2).

An exploratory aim of the project was to assess the frequency and type of postoperative NSQIP-P adverse events following implementation of the comprehensive care bundle. Owing to the sequential implementation of various aspects of the program throughout 2018 (Fig. 3), a comparison between 2017 and 2019 was performed. We observed fewer NSQIP-P reported complications in the G-tube population after PDSA cycles in 2018 (27.3% vs. 24.6% respectively), driven by decreased superficial incisional surgical site infections (3% vs. 1.8%), postoperative systemic sepsis (9.1% vs. 1.8%), and 30-day readmissions (18.2% vs. 15.8%).

Table 1
Patient characteristics before and after implementation of a comprehensive G-tube care bundle.

Patient demographics ($n = 130$)			
Variable	Preimplementation	Postimplementation	p-value
	$N = 63$	$N = 67$	
Age (age)	0.38 (0.06–14.6)	0.48 (0.07–15.9)	0.09
Sex (female)	33 (52%)	30 (49%)	0.71
Race (Caucasian)	49 (78%)	42 (69%)	0.38
ASA class			0.11
2	10 (16%)	11 (17%)	
3	34 (54%)	44 (66%)	
4	19 (30%)	12 (18%)	
Premature birth	24 (40%)	35 (42%)	0.79
Laparoscopic approach	40 (63%)	55 (90%)	**0.003**
Cardiac intervention	24 (38%)	15 (25%)	0.06
Congenital malformation	21 (33%)	22 (33%)	0.58
Payer			0.24
Government	41 (65%)	49 (73%)	
Private	18 (29%)	16 (24%)	
Other	4 (6%)	2 (3%)	

ASA = American Society of Anesthesiologists.

3. Discussion

Herein, we demonstrate that significant improvements in care for children with G-tubes can be achieved using quality improvement science methodology. Specifically, we were able to reduce G-tube dislodgements within the first 3 months of insertion, a particularly vulnerable time as the tract is not mature and dislodgement can result in increased morbidity. Further, we also witnessed reduced LOS and NSQIP-P tracked complications such as surgical site infection, sepsis, and readmission. Despite additional effort needed to complete postoperative nursing assessments, we achieved 75% or greater compliance across all aspects of the postoperative care bundle on audits of these process measures one year after implementation, suggesting effective retention of these pathways to date.

Overall, we observed a dramatic decrease in dislodgement events occurring both within the hospital and after discharge following implementation of a comprehensive G-tube care bundle. We attribute the success of our quality improvement project to standardization of care, nursing and caretaker education, and the interdepartmental and interprofessional nature of the initiative. We were able to recruit champions and generate buy-in from all departments involved in the care of these children. Standardization occurred across all phases of perioperative care, including preoperative consultation, intraoperative practices, and application of securement devices at the completion of operative cases. Meticulous care of G-tubes by nursing staff required a culture shift towards vigilant avoidance of deflating the retention balloon, as well as diligent disconnection of the extension tubing when not utilized for infusion. Early involvement of relevant stakeholders on the quality improvement team enhanced buy-in of initiatives.

Standardization of care makes the job of nurses, residents, and surgeons easier [11,12]. Despite requiring additional tasks for nurses to complete during assessments of children with G-tubes, they reported more facility with the care of this population because they felt they could be more confident following the pathway: there is no second-guessing of provider preferences of feeding advancement plans or surgical site care. Thus, we observed *improved* LOS over the intervention period, and a high rate of compliance with process measures; these assessments have become integral to the care of these patients, not superfluous documentation. Furthermore, engagement across healthcare providers to tackle common challenges facilitates each team member to practice at the apex of their degree, promoting buy-in and job satisfaction [11].

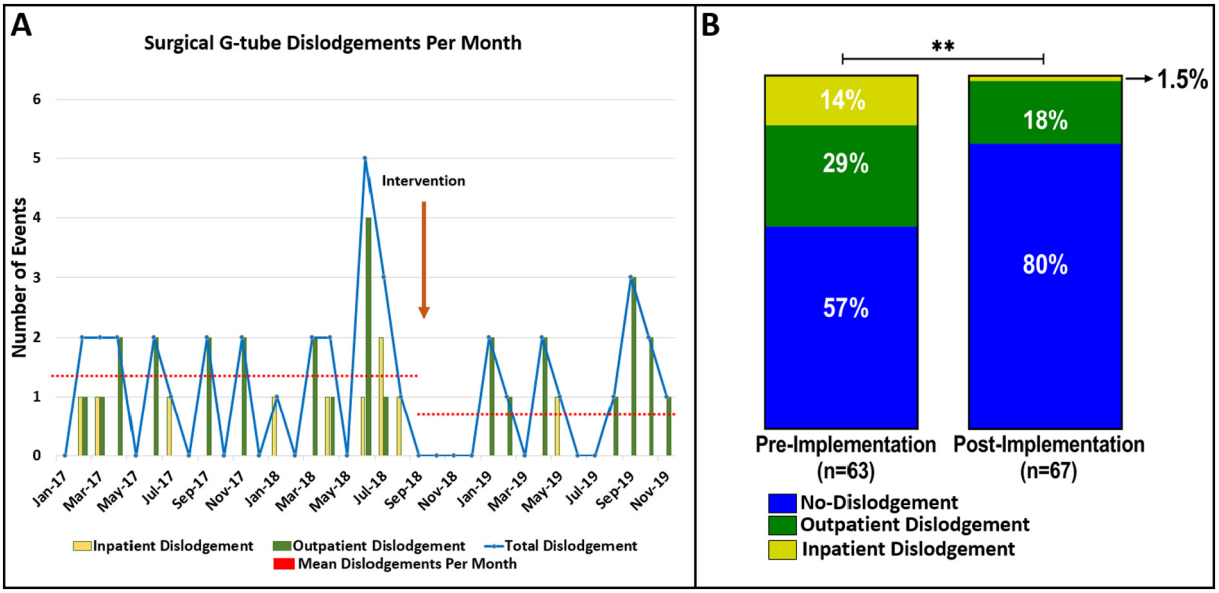

Fig. 4. Run chart of dislodgement events demonstrating a reduction in events, driven by fewer inpatient and outpatient dislodgements (A). Statistical comparison of pre and postimplementation events demonstrates a statistically significant reduction in dislodgements (B), P = 0.004; G = gastrostomy.

To date, few reports have codified the incidence of G-tube dislodgement in the inpatient setting. A report by Fernandez-Pineda et al. demonstrated a 20% perioperative complication rate including one dislodgement out of 181 procedures (0.5%). However, this was in a considerably older pediatric population (mean age 7 years) [13]. In the seminal report of the U-stitch technique for laparoscopic G-tube insertion in children popularized by Georgeson and Barnhart, 1.5% of children (7/461) required reoperation owing to early tube dislodgement [14]. These events, while often reviewed in morbidity and mortality conferences, are likely a product of the environment of care of the child, as opposed to surgical technique, approach, or feeding advancement protocols. Thus, cross departmental collaborations to educate allied health workers are necessary to address the systematic risk factors to dislodgement.

We have found that many G-tube dislodgements occur while the device is accessed with a connecting feeding line. Usually, the tubing becomes entangled and places the gastrostomy tube at risk of tensile force resulting in dislodgement. Thus, deterrents to prevent mechanical forces to the tube are valuable in reducing dislodgement events. We implemented a bundle which included placing a deterrent to inadvertently accessing the balloon port, a grip lock device (hook and loop style restraint) to bolster the extension tubing to the patient by absorbing tensile forces before being transmitted to the gastrostomy device, and a covering garment to prevent patients from grabbing the G-tube (see APSA Quality and Safety Toolkit for more details).

For most of the intervention period, a Luer lock red cap was utilized to cover the balloon port. Though this event never occurred, there has been some concern recently that the red cap could be a choking hazard for young children. We have transitioned to applying liquid resistant rubber tape to cover the balloon port. To date, this tape has performed similarly. We are aware that the vendor of the low profile G-tube we use advocates that the volume of water in the balloon be tested weekly, a practice that requires deflating and reinflating the balloon [15]. The authors would advise against this practice while the tract is immature, as we believe deflating the balloon at this time places the tube at risk for dislodgement, perhaps unknowingly, with subsequent peritoneal soilage.

Finally, we believe mechanical barriers are particularly important deterrents to G-tube dislodgement as they were a major component of the bundle implemented in September 2018, after which dislodgements declined. In our experience, dislodgements occur when the extension tubing is connected. For this reason, our most recent PDSA cycle stresses that caregivers disconnect the extension tubing to minimize tube length whenever the patient is not feeding. We hope this will help further reduce outpatient dislodgements.

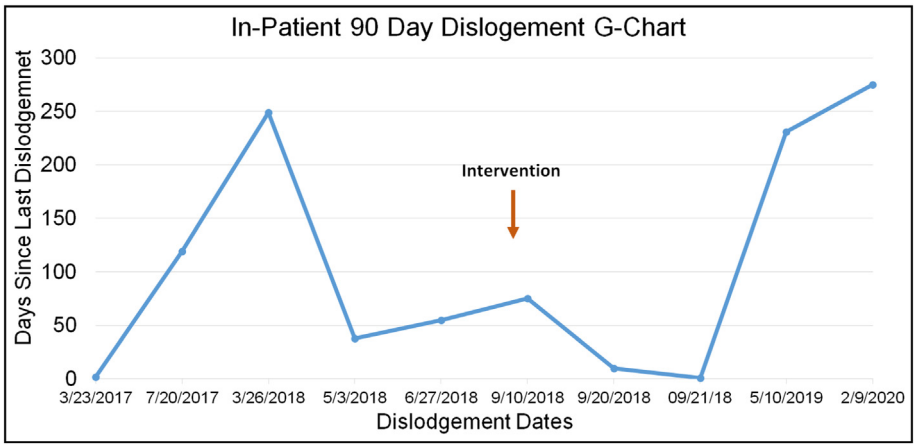

Fig. 5. Geometric (G) chart demonstrating increase in number of days between in-patient dislodgement events following implementation of a care bundle in 2018.

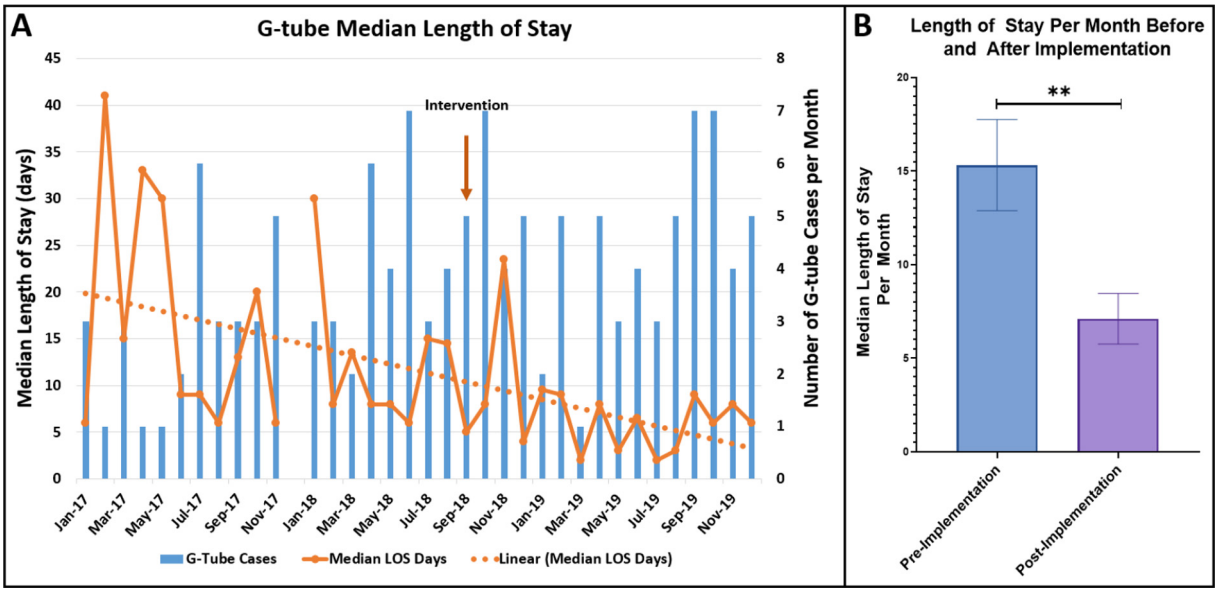

Fig. 6. Run chart (A) of the balancing measure (length of stay) over the initiative. We observed a statistically significant reduction in monthly median LOS following implementation of the comprehensive G-tube care bundle. Bar graph (B) demonstrating a 50% reduction in LOS after G-tube insertion (15.3 days vs. 7.1 days, p = 0.004); G = gastrostomy, LOS = length of stay.

Our study has limitations which are important to consider. These results are from a single institution and the unique cross-departmental/professional relationships which facilitated this endeavor may not be the same at other centers. Secondly, our comparison of prospectively and retrospectively collected patient data carries with it the risk of bias given the nature of the collection of data. Owing to the nature of the quality improvement project, multiple interventions were implemented serially over time as PDSA cycles; thus, we cannot be certain as to which interventions influenced change over time. Given the relationship between institutional volume and outcomes after gastrostomy, it is possible that our outcomes improved owing to some other factor (s) associated with placing more G-tubes in the postintervention period. We did note an increase in laparoscopic approach associated with standardizing intraoperative care after our intervention. It is possible that some of the witnessed improvements were related to the surgical approach or type of tube placed by the surgeon. As is often the case in quality improvement efforts, it is difficult to pinpoint the exact bundle element that resulted in change. Nevertheless, given the reduction in dislodgements over the study period, shortened hospital stay, and positive feedback from caretakers and providers, we are encouraged by the outcomes observed. Finally, outpatient dislodgements remain a pernicious occurrence, and future PDSA cycles will focus on preventing dislodgement events in this cohort following discharge.

Table 2
Audit of process measures one year after implementation of comprehensive care bundle demonstrates high retention of process elements.

Process measures audit June 2019				
Process	Percent complete	Complete	Not complete	NA
Patient assessment				
Grip lock present?	92%	11	0	1
Balloon port deterrent present?	75%	9	3	0
Ace wrap/belt?	75%	9	3	0
Bedside/pathway				
Emergency kit at bedside?	92%	11	0	1
G-tube pathway in use?	83%	10	0	2
Documentation				
Daily clean	75%	9	3	0
Daily dressing change	83%	10	2	0
Patient education record (pathway)	92%	11	0	1
Video module	92%	11	0	1

NA = not applicable.

4. Summary

Quality improvement initiatives which engage cross-departmental/professional stakeholders have the opportunity to improve the care of children with G-tubes by reducing the incidence of inpatient complications, principally inadvertent G-tube dislodgement. Furthermore, standardization of preoperative, intraoperative, and postoperative care in conjunction with comprehensive caretaker training has the potential to reduce length of stay and increase confidence around the caretaker management of common G-tube complaints.

Acknowledgments

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