



Institution-initiated text messaging can reduce unplanned emergency department visits after appendectomy☆



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ABSTRACT

Background/Purpose: The purpose of this study was to reduce unplanned Emergency Department (ED) visits for minor complaints in children after appendectomy through proactive institution-driven communication and utilization of telehealth resources.

Methods: We developed a text messaging system to initiate communication with parents of postappendectomy patients and connect them with a telehealth visit or a phone call with a surgical provider as needed. Using descriptive statistics, chi square, and statistical process control analytics, we compared rates of postoperative ED visits for the 8 months pre- and post-implementation of the messaging system and summarized the feedback we received from patients.

Results: A total of 791 laparoscopic appendectomies were performed in two institutions (preintervention = 382, post-intervention = 409). The postoperative ED visit rate decreased from 5.8% preimplementation to 2.4% post-implementation ($p = 0.02$). Over one-fifth of families messaged (21.6%) had questions in the postoperative period. The majority expressed interest in a video visit (52.5%), while some preferred to speak with the surgeon's office (25%). Over 90% of respondents found the system helpful, and 4.9% opted out.

Conclusion: Implementation of a hospital-initiated text messaging system has the potential to reduce ED visits in the immediate postoperative period after appendectomy. This system can be scaled to include different surgeries across multiple disciplines.

Level of Evidence: III.

Type of Study: Clinical Retrospective Pre/Post Intervention Study.

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Appendectomies are the most common acute pediatric general surgical procedure performed in the United States [1]. Appendectomy is one of the procedures most commonly associated with postoperative emergency department (ED) visits in our multi-institution health care system, which is consistent with other reports [2,3]. Reviewing data from post-appendectomy patients who visited our ED showed that more than 70% of patients did not contact the system with a problem prior to ED presentation. Many of these visits were for minor complaints and hence possibly preventable. Non-urgent ED visits and ED over-

☆ How this paper will improve care: Preventable emergency department visits for minor complaints after appendectomy plague many institutions. We found that a simple texting intervention that proactively initiates contact with families and provides on-click access to video visits significantly reduces preventable emergency room visits.

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crowding leads to increased patient wait times, overburdened providers, compromised patient safety, wasted health care dollars in many cases, worse outcomes [4].

Postoperative ED visits can be classified as visits unrelated to the index procedure, postoperative complications that require admission and management, and minor complaints related to the index procedure [5]. The latter have been reported to account for over 40% of all postoperative ED visits and should be a priority for both financial and logistical reasons, particularly with changes in hospital reimbursements related to readmission penalties [5].

Parents of children who have been discharged after surgery are often unsure of how to differentiate between expected symptoms that are part of usual postoperative recovery and unanticipated adverse events that require medical attention. Several studies have documented knowledge gaps, anxiety and discontent among patients who are recovering from surgery and their parents [6–8].

Mobile applications developed for adult postoperative patients have been used to distribute educational materials [9–11], monitor medication compliance [12,13], collect data on pain medication use [14], improve patient engagement [15], send reminders to patients when it is time to pursue follow-up care [16], and monitor symptoms [17–19]. These interventions have demonstrated a decreased need for routine postoperative clinic visits [19], increased early medication adherence [13], and prevention of postoperative emergency room visits [20]. A text-messaging system is particularly relevant today, as the current generation of parents of our pediatric patients routinely use texting as a primary form of communication. This is bolstered by the fact that investigators have found that text messages and mobile applications are a feasible and acceptable way of communicating with patients and their families postoperatively that contributes to patient satisfaction [21–23].

Due to the high prevalence of preventable ED visits after appendectomies at our institution, we developed a pilot project to create and implement an institution-driven text-messaging system in conjunction with telehealth services. We hypothesized that this intervention would reduce ED visits in the immediate postoperative period after an appendectomy.

1. Methods

1.1. Development of text messaging system

The text messaging system was developed through a collaboration among surgeons, telehealth physicians, health literacy experts, and software engineers, building upon an established system that was being used to confirm appointments. The workflow is summarized in Fig. 1. Briefly, the designated caregiver was asked for cell phone contact information and a text message was sent the day of discharge. Parents were offered the option of receiving texts in English or Spanish. The message was repeated on post discharge days 2, 6, 10 and 14. Families that had questions about their child's recovery were directed to a video conference encounter with a member of our telehealth team, or if they preferred to talk to their surgeon's office, this telephone number was provided. After the final message, a simple "yes" or "no" question was asked to ascertain whether the system was helpful. In addition, parents were invited to send comments to a designated email address (Supplemental Figs. 1 and 2). The multidisciplinary team met on a monthly basis to review data on text system utilization and ED returns. Real-time modifications were made to the system including enhanced response to unrecognized texts from parents (for example, saying "Y" or "yeah" instead of "Yes"). An online dashboard was created, which enabled the team to track postoperative ED visits, and periodic chart reviews were performed to ensure validity of the dashboard and to assess whether patients who returned to the ED were utilizing the messaging system properly so that we could make real-time improvements. For example, we noted that several patients expressed interest in a telehealth visit but were not actually carrying out the visit. We designed a real-time email alert when a patient expressed interest in telehealth visit, so the telehealth team could proactively contact the parent rather than wait for the parent to initiate the visit through the link provided on the texting platform.

1.2. Telehealth team

Our healthcare system has an around-the-clock telemedicine team which began in 2015 with a group of six pediatricians who are fully dedicated to telehealth. These providers have diverse clinical backgrounds including general pediatrics, pediatric hospital medicine, pediatric urgent care and pediatric intensive care. One-third are fluent in both English and Spanish. The average number of monthly visits per telemedicine provider is 150–200. With an average of 50 appendectomies being performed per month across our system, we did not

anticipate a large proportional increase in video visit volume related to this intervention.

In preparation for go-live, one of the pediatric surgeons provided a one-hour online training session for the telehealth team, during which common post-appendectomy complaints were discussed, and criteria for referral to the ED were reviewed. Telehealth pediatricians were encouraged to contact the surgery team if questions arose about the nature of the parent's complaint and how to triage it appropriately. In advance of implementation, all surgeons and extended care providers on the surgery teams were educated about the intervention and the role of the telehealth team.

1.3. Study population

The text-messaging system was implemented on May 1, 2019. All patients who underwent a laparoscopic appendectomy (CPT 44970) at either of the institutions in our hospital system between September 1, 2018 (8 months pre-implementation) and December 31, 2019 (8 months post-implementation) were included in the study.

1.4. Statistical analysis

We compared the pre- and post-implementation appendectomy patients. We used an intention to treat analysis; therefore, all patients operated on during the post-implementation time period were analyzed as part of this group even if they were not able to receive text messages. Patient demographics, operating room time, and postoperative length of stay (LOS) were obtained from the electronic medical record. The primary outcome measure was the rate of potentially avoidable ED visits, defined as ED visits that did not result in an admission. We reviewed every ED visit during the study period and designated it as "preventable" or "non-preventable" based on whether the child required interventions that could not have been performed in the office or via telehealth (e.g., intravenous fluid resuscitation for dehydration). We compared the overall proportion of appendectomy patients who presented to the ED and were discharged home, and also compared the subset of these that were designated as "preventable" in the pre- vs post-implementation time periods. Data from the messaging system that tracks patient responses to the text messages were obtained from our dashboard.

Demographic data were described as means (normally distributed data) or medians (non-normally distributed data) for continuous variables and numbers for categorical variables. The Chi-square test was used to compare categorical variables. Student's t-test and Mann Whitney *U* were used to compare continuous variables, where appropriate. Statistical significance was defined as $p < 0.05$.

We tracked the proportion of patients with potentially preventable ED visits over time using a p-chart. Control limits were set at three-sigma limits from the mean. Standard rules were applied to determine if changes were due to common or special cause variation. QI macros 2017© software was used to create a control chart.

Our Institutional Review Board deemed the project to be quality improvement, and the need for informed consent was waived.

2. Results

There were a total of 791 laparoscopic appendectomies performed in a 16-month period between September 2018 and December 2019 at our two institutions (pre = 382, post = 409). The pre- and post-implementation populations did not vary significantly by age, sex, weight, race or preferred language. There were also no significant differences in the operating room time and postoperative LOS between the two groups, suggesting a similar distribution in the severity of appendicitis in the populations (Table 1).

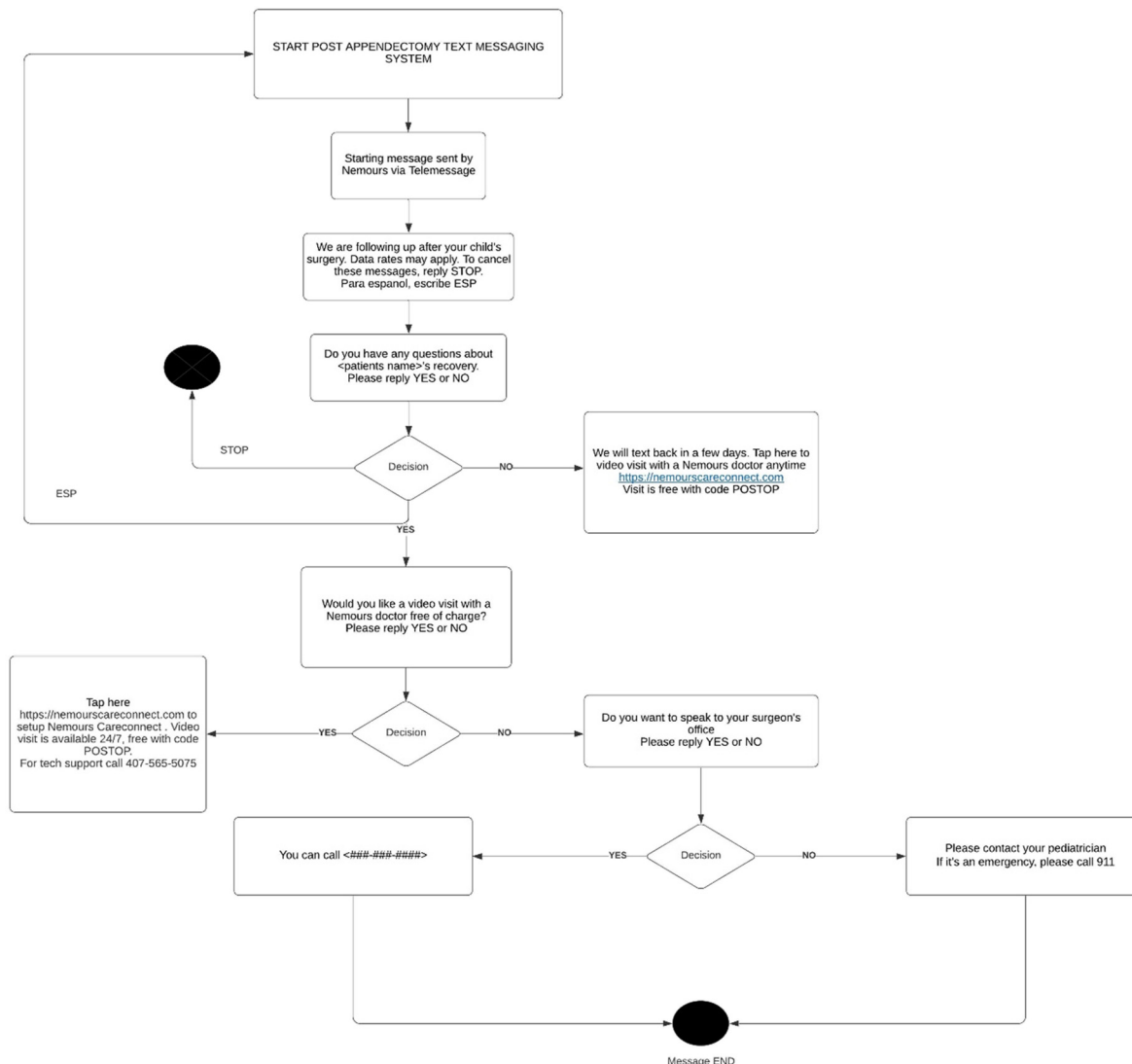


Fig. 1. Flow diagram depicting text messaging pathway.

2.1. Emergency department visits

The pre-implementation group had 22 (5.7%) postoperative ED visits within 30 days of discharge over 8 months. This was significantly higher than the post-implementation group, in which there were 10 (2.5%) postoperative ED visits in 8 months ($p = 0.02$). The decrease in the proportion of ED visits met criteria for special cause variation in April 2019, 1 month prior to implementation, with 8 points below the original mean proportion of visits (Fig. 2).

On chart review, we determined that 72.7% (16 of 22 patients) of the postoperative ED visits in the pre-implementation group were minor and did not necessitate a return to the ED and instead could have been managed by either a visit to the pediatrician or the surgeons' office. This proportion reduced to 50% of ED visits in the post-implementation group. Overall, this represents a decrease in the proportion of preventable post-operative ED visits (the type that the texting intervention would be most likely to influence) from 4.2% pre-implementation to 1.2% post-implementation ($p = 0.009$).

2.2. Messaging system performance

A total of 370 (90.5%) patients who underwent a laparoscopic appendectomy after May 1, 2019 were messaged using the system. There was a technical error after initial implementation that was

rectified by the software team, and this accounted for the majority of the 9.5% of patients who did not receive texts, with very few patients being unable to participate due to lack of cell phone. Of those who received text messages, only 4.9% opted out of the service. Approximately one in five families (21.6%) had questions about their child's recovery. Of these, 52.5% requested a video visit with a telemedicine physician and 25% wanted to speak to the surgeon's office. The remaining 22.5% were directed to contact their pediatrician with further questions.

A simple "yes" or "no" question at the end of the last text message on whether the text messages were helpful revealed that 91.8% of respondents found it helpful. No patients responded with open-ended comments.

2.3. Telehealth visits

There were 13 telehealth visits for appendectomy patients in the 8 months after implementation of the pathway. All these patients' concerns were handled at the video visit and no patients were directed to the ED. A routine component of the video visit follow-up included a form on which parents were asked, "What would you do if you did not have this telehealth visit?" There were eight parents who responded. Of these, four reported they would have either gone to the ED or an urgent care, three would have gone to the doctor's office, and the other patient would have done nothing further.

Table 1
Comparison of patient characteristics in the pre and post implementation groups.

	Pre	Post	p-Value
Age (years)			0.94
Mean	11.0	11.0	
IQR	8.0–14.0	8.0–14.0	
Weight (kg)			0.57
Mean	46.4	47.3	
IQR	30.0–59.0	30.6–60.6	
Gender (%)			0.34
Male	246 (64.4)	250 (61.1)	
Female	136 (35.6)	159 (38.9)	
Race (%)			0.27
White	250 (65.4)	238 (58.2)	
Black	27 (7.1)	31 (7.6)	
Other	100 (26.2)	137 (33.5)	
Unavailable	5 (1.3)	3 (0.7)	
Language (%)			0.10
English	321 (84.0)	334 (81.7)	
Spanish	51 (13.4)	71 (17.4)	
Other	10 (2.6)	4 (0.9)	
Operating room time (minutes)			0.11
median	89.0	91.0	
IQR	79.0–104.0	79.0–107.0	
Post op length of stay (hours)			0.17
median	10.0	6.2	
IQR	2.1–33.1	1.8–45.0	

3. Discussion

The postoperative period is a stressful time for parents. When parents are overwhelmed with taking care of their recovering child, they may not think to contact the health system prior to showing up in the ED. In a world that is growing more and more digitally connected, people rely less on traditional phone calls and in-person encounters and more on tools like texting to communicate. Millennials in particular, who comprise an increasing proportion of our parent population, embody this culture of

digital connectivity, and are likely to embrace the texting platform as a way to communicate concerns about their child's recovery.

Text messaging as a method to confirm appointments is fairly ubiquitous in healthcare today, with most institutions utilizing some form of automated system. We developed our texting pathway based on the existing platform at our institution that is used for appointment reminders. Limiting the responses to a simple “yes” and “no” promotes convenience and avoids overwhelming families, which can hinder utilization. It also assists in data tracking. It is also important to understand the demographic of patients that are being treated, particularly with regard to language. A significant number of our patients are Spanish-speaking, which is why enabled the system to send and receive messages in Spanish, and ensured access to Spanish-speaking telehealth providers.

Families that have low health literacy may be especially vulnerable to unnecessary utilization of the health care system [24]. Health literacy encompasses the ability of caregivers to access, comprehend and process basic health information to make adequately informed decisions [25]. An estimated 30–35% of adults have low health literacy [26,27]. Low health literacy has also been consistently associated with more hospital admissions [28]. Understanding the difference between the normal postoperative course and deviations from that course can be challenging even for medical professionals if it is outside their specialty. Health care providers and hospitals must therefore take steps to address this problem and take initiatives to assist families in the stressful postoperative period. We are in the process of developing a web page that will educate caregivers about the expected postoperative course after an appendectomy, and will be directly accessible through the texting platform.

Efforts that improve health literacy by improving patient education have shown the most benefit so far [29]. A “universal precautions approach” to health literacy [30] (communicate as if all families have low health literacy) has been advocated, but many times this is not enough. In 2011, the World Health Organization (WHO) identified communication problems between patients and providers as a risk factor for preventable patient harm and introduced the term “eHealth” to the medical lexicon to describe the use of information and communication technologies (ICT) for health. The WHO also defined “mobile health” or “mHealth” as the “medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, per-

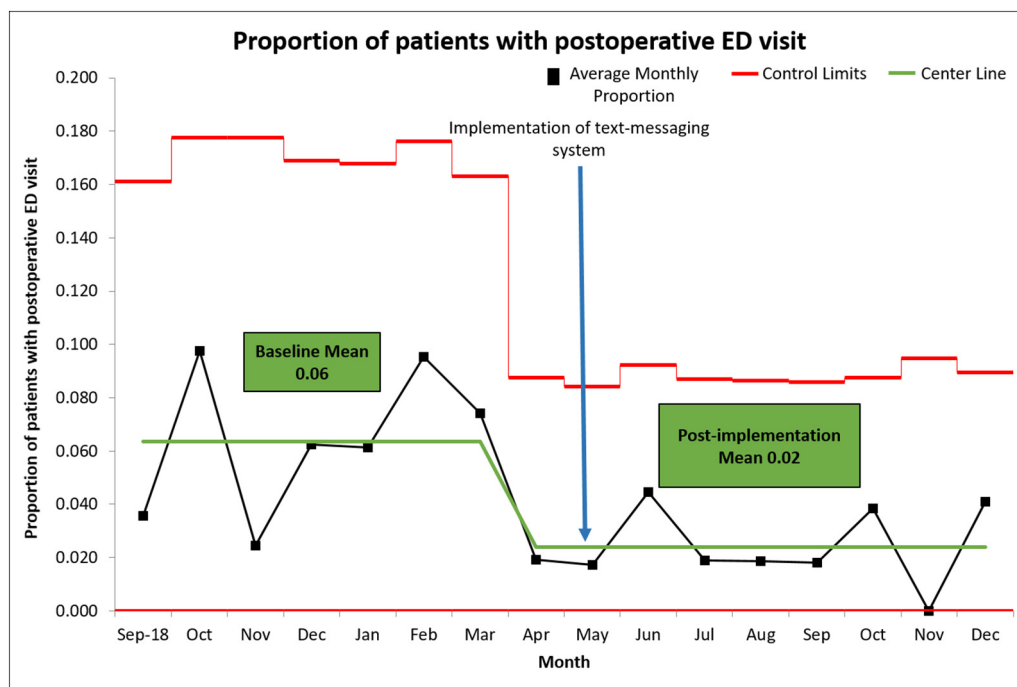


Fig. 2. p-chart depicting decrease in proportion of patients that had a postoperative ED visit within 30 days of discharge before and after implementation of the text messaging system.

sonal digital assistants (PDAs) and other wireless devices [31].” Our text messaging intervention is an innovative example of mHealth, and it appears to be effective in preventing unnecessary postoperative ED visits.

ED visits related to minor postoperative complications are a significant contributor to the overall number of patients that return to the ED postoperatively. Complaints may include pain, superficial wound complaints and constipation. The use of mobile pictures or video visits can be very useful in delineating which wound complaints require prompt ED evaluation or close monitoring with an earlier office visit. Our healthcare system was already equipped with a robust team of telehealth physicians, which enabled us to undertake this project and provide around-the-clock assistance as needed. Of note, we did time the texts so none would be delivered in evenings, on holidays or weekends in order to encourage system utilization during full-time staffing hours. It is important to note that only 13 telehealth visits occurred in 8 months, so this did not come close to overwhelming the system.

Many patient complaints after surgery are unrelated to the surgery, or are minor complaints related to the surgery. A short presentation by the surgery team to our telehealth physicians outlined the expected postoperative course in order to help them appropriately triage these patients. A template was created to standardize reporting of these visits and assist data tracking. The benefits of the video visit include the ability to observe the patients and to utilize the family as an assistant to better examine the patient. The fact that no patients were sent to the ED after their telehealth visit suggests that non-surgeon telehealth physicians are very comfortable caring for postoperative patients on a virtual platform. Although only 13 telehealth visits occurred in the 8 months post-implementation, we believe there is a high likelihood these patients would have come the ED if they had not had access to telehealth. We believe the success of the intervention can, in large part, be attributed to the accessibility and expertise of the telehealth team.

The response from families to our text-messaging system was largely positive, with over 90% of respondents finding it helpful. In addition, only a small minority of parents were unable to participate in the intervention due to lack of access to a cell phone. This strengthens our belief that text messaging has great potential to decrease miscommunication, improve patient care, and decrease unnecessary postoperative ED visits among pediatric appendectomy patients.

Limitations of our study include the potential lack of generalizability, as we understand that many institutions do not have access to telehealth physicians and resources to set up a text messaging system. In addition, we note that the reduction in postoperative ED visits may not be attributable to the texting intervention, as other unmeasured variables may have changed over the time frame of the study that could have affected ED visits. We met criteria for special cause variation 1 month prior to implementation of the text message system. This might be explained by the fact that education for surgical teams was being rolled out during this time frame, and surgeons might have been more attentive to the concept of preventing postoperative ED visits. Since the decrease in ED visits was sustained over the entire post-implementation period, we believe that the text intervention is the most likely explanation for the change.

In conclusion, an institution initiated text-messaging system can reduce postoperative ED visits related to minor postoperative complications and complaints that may be unrelated to the surgery. Video visits conducted by pediatricians can effectively address many patient and parent concerns. A major advantage of this system, unlike other institution-initiated processes (for example, routine postoperative phone calls), is that it can be implemented with relatively low human resource investment through an automated system using similar technology to what many health systems already use for appointment reminders. It has the potential to be scaled to include different procedures that are associated with high postoperative ED visit rates in any surgical subspecialty. There is also potential to use this system for other medical conditions associated with frequent ED visits after discharge.

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