



Universiteit
Leiden
The Netherlands

Artificial intelligence and e-health for inflammatory bowel diseases: the quest to enhance patient experiences, outcomes and costs
Zand, A.

Citation

Zand, A. (2020, December 10). *Artificial intelligence and e-health for inflammatory bowel diseases: the quest to enhance patient experiences, outcomes and costs*. Retrieved from <https://hdl.handle.net/1887/138629>

Version: Publisher's Version

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/138629>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/138629> holds various files of this Leiden University dissertation.

Author: Zand, A.

Title: Artificial intelligence and e-health for inflammatory bowel diseases: The quest to enhance patient experiences, outcomes and costs

Issue Date: 2020-12-10



Part III: eHealth to Facilitate the Delivery of High-value Care in IBD

Part III



CHAPTER 7

Patient Experiences and Outcomes of a Telehealth Clinical Care Pathway for Postoperative Inflammatory Bowel Disease Patients

Telemedicine and e-Health. 2020 Jul;26(7):889-897

A. Zand^{1,3}, A. Nguyen¹, Z. Stokes¹, W.K. van Deen^{1,4}, A. Lightner^{2,5}, A. Platt¹, R.J. Jacobs¹, S. Reardon², E. Kane¹, J. Sack², D.W. Hommes^{1,3}

¹UCLA Center for Inflammatory Bowel Diseases, Vatche and Tamar Manoukian Division of Digestive Diseases, David Geffen School of Medicine, University of California at Los Angeles, CA, USA

²UCLA Department of Surgery, David Geffen School of Medicine, University of California at Los Angeles, CA, USA

³Leiden University Medical Center, Department of Digestive Diseases, Leiden, the Netherlands

⁴Cedars-Sinai Center for Outcomes Research and Education (CS-CORE), Division of Health Services Research, Cedars Sinai Medical Center, Los Angeles, CA

⁵Department of Colon and Rectal Surgery, Mayo Clinic, Rochester MN, USA

Abstract

Background

Despite advancements in treatment for inflammatory bowel disease (IBD), surgery remains inevitable for patients and IBD management is costly.

Introduction

Frequent postoperative monitoring is needed for early detection of both short-term complications and long-term disease recurrence. We developed a care pathway for postoperative home monitoring of IBD patients using telehealth applications.

Materials and Methods

We performed a retrospective cohort study with a matched control group to assess the efficacy of the Tight Control Surgery Scenario (TCSS), a four-week postoperative care pathway. IBD patients aged 18 or older who underwent an IBD-related intestinal operation between October 2013 and December 2015 were eligible. Enrolled participants submitted post-surgical questionnaires and wound photos via email. We measured patient satisfaction with the care pathway and assessed its impact on 30-day postoperative hospital readmission rates, emergency department (ED) visits, and GI-related office visits.

Results

64 cases were enrolled in TCSS and matched to 64 historic controls. Patients who completed the additional evaluation survey expressed overall satisfaction. Readmissions, 30-day ED rates, and GI visits were numerically higher in cases compared to controls, but this difference was not statistically significant.

Discussion: TCSS demonstrates the feasibility of implementing a telehealth care coordination platform for post-surgery IBD management. Patients with more complications may have sent in more photos due to greater concern for maintaining their health.

Conclusions

The implementation of TCSS for easy home monitoring is feasible. While we did not see reductions in ED visits, GI follow-up visits, or readmissions, patient satisfaction was high thus demonstrating its feasibility for telehealth applications.

Introduction

Despite advancements in medical pharmaceuticals for inflammatory bowel disease (IBD)¹, up to 15% of ulcerative colitis (UC) patients will undergo surgery within 20 years of diagnosis and nearly 50% of Crohn's disease (CD) patients within 10 years of diagnosis^{2,3}. Unfortunately, surgery is not always curative but rather ameliorates symptoms. Up to 30% of CD patients will require additional bowel resections within 10 years¹. Recurrence of CD post-surgical resection has also been shown to be at a rate of 55% 5 years post-surgery and 76% 7 years post-surgery⁴, demonstrating the high prevalence of disease recurrence. Additionally, postoperative morbidity remains high following intestinal surgery in CD with 30-day infectious complications and intra-abdominal sepsis as high as 30%⁵,

IBD management is also costly due to excess utilization of healthcare services. Kappelman et al. found that the mean number of excess ED visits per 100 CD patients, compared to their non-IBD controls matched by gender, age, and geographic region, is 20.1; the mean number of excess ED visits per 100 UC patients was 10.3 when compared to controls⁶. In addition, it has been shown that the frequency of IBD-related ED visits has increased by approximately 51% over the last decade⁷ and the cumulative nationwide cost of IBD-related ED visits has increased by over 200% in the past decade⁷. The most costly cases included IBD patients who had a surgical stay⁸.

Readmission after colorectal surgery is common, with rates ranging from 6-25% often due to bowel obstruction, surgical site infection, or abscesses⁹. Bliss et al. found that 14.7% of IBD patients were readmitted within 30 days after a colectomy¹⁰. Hospital readmissions after surgery are a significant driving factor of financial costs. One study found that 13% of patients readmitted after receiving a hospital resection required resources from the intensive care unit and 6% required a reoperation. The combined median direct cost was over twice as high for readmitted patients than for non-readmitted ones¹¹. High costs associated with managing IBD after surgery underscore the need for more effective postoperative care management.

Given the complexity of IBD and risk of disease progression after surgery, frequent monitoring is needed for early detection of recurrence and complications. Telemonitoring has been shown to be effective in managing chronic diseases including COPD¹², cardiovascular disease^{13,14}, and IBD¹⁵. In IBD, a study on home telemonitoring in teenagers found that telemonitoring can decrease outpatient visits and costs of care compared to

conventional follow-up¹⁶. In addition, the UC HAT home telemanagement system showed gains in quality of life for patients using UC HAT compared to those receiving the best available care¹⁷. However, no significant improvements were found in medication adherence or disease activity, suggesting the need for further research in the effectiveness of telemedicine for IBD¹⁸. While there have been some conflicting findings, electronic health (eHealth) interventions for IBD have overall been shown to improve quality of life, disease activity, and reduce healthcare costs¹⁹. To our knowledge, there has not yet been a published study conducted on telemanagement specifically for postoperative IBD care.

To address the high costs and complications of post-surgery maintenance, the University of California, Los Angeles (UCLA) Center for IBD developed a care pathway for IBD-related surgery, designed to tightly monitor patients at home after discharge using telemonitoring tools in order to improve the experience. According to the 2011 Annual exChangE on the ADvances in Inflammatory Bowel Disease (IBD Ahead) educational program, robust monitoring should involve different clinical measurements¹⁸. Our pathway included postoperative symptom assessments, including endoscopic evaluations and self-reported patient outcomes. We hypothesized that frequent and proactive monitoring of IBD patients would improve the patient experience and could reduce postoperative complications and IBD-related hospital readmissions, thus improving postoperative management.

Materials and Methods

Design & Outcomes

After institutional review board approval (IRB#16-000263), we performed a retrospective cohort study with a matched control group to assess the effects of an electronic postoperative care pathway on patient experience and resource utilization. Enrolled patients followed a 4-week reporting schedule that culminated in a follow-up visit with a gastroenterologist (GI). Participants filled out daily to weekly online questionnaires about symptoms and wound-healing and uploaded wound photos. Participants also had direct e-mail access to a specialized surgical IBD nurse for questions.

We assessed the impact of the pathway during 30-day post-discharge on 1) hospital readmission rates, 2) ED visits, and 3) GI office visits. Secondly, the number of wound photos submitted per case was measured to estimate TCSS adherence.

Population

Patients aged 18 or older, who had an IBD diagnosis confirmed by endoscopy or radiological evaluation and underwent IBD-related intestinal surgery performed by a single IBD surgeon, were eligible for study inclusion.

Between October 2013 and December 2015, a research nurse identified cases from a surgical list and explained the TCSS study to patients by phone. Participants were then consented by the research nurse at their pre-operative clinical visit. Patients that underwent surgery between that same timeframe and were not assigned to the scenario were selected as controls (**Figure 1**). We used a custom matching algorithm to make accurate, representative case-control matches based on age, gender, disease type and type of surgery.

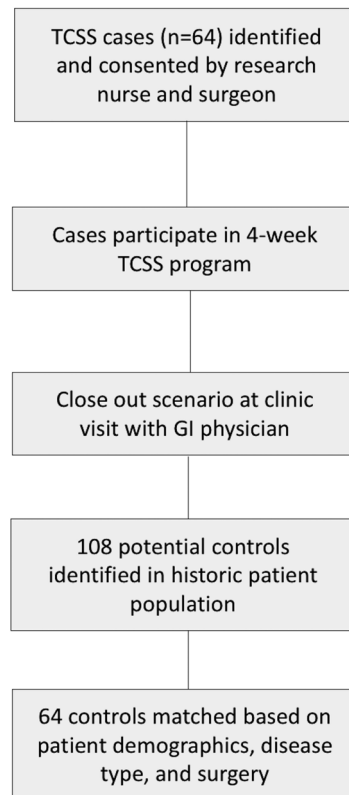


Figure 1. Flowchart of study design

The Care Pathway: Tight Control Surgery Scenario (TCSS)

TCSS is a four-week program monitoring the recovery of IBD patients after surgery. All enrolled patients filled out a post-surgery questionnaire via email for 4 weeks after discharge (Figure 2). In Week 1 they filled out the questionnaire and uploaded a picture of their abdominal surgery wound(s) every day. In Week 2 they did so on days 2, 4, and 7. In Weeks 3 and 4, patients filled out the questionnaire and uploaded a picture on day 7. A total of 12 questionnaires were collected over the course of 4 weeks. Pain was measured with a 0-10 Likert scale; wound healing was assessed through submission of wound photos; and bowel function was evaluated using ostomy output and stool frequency.

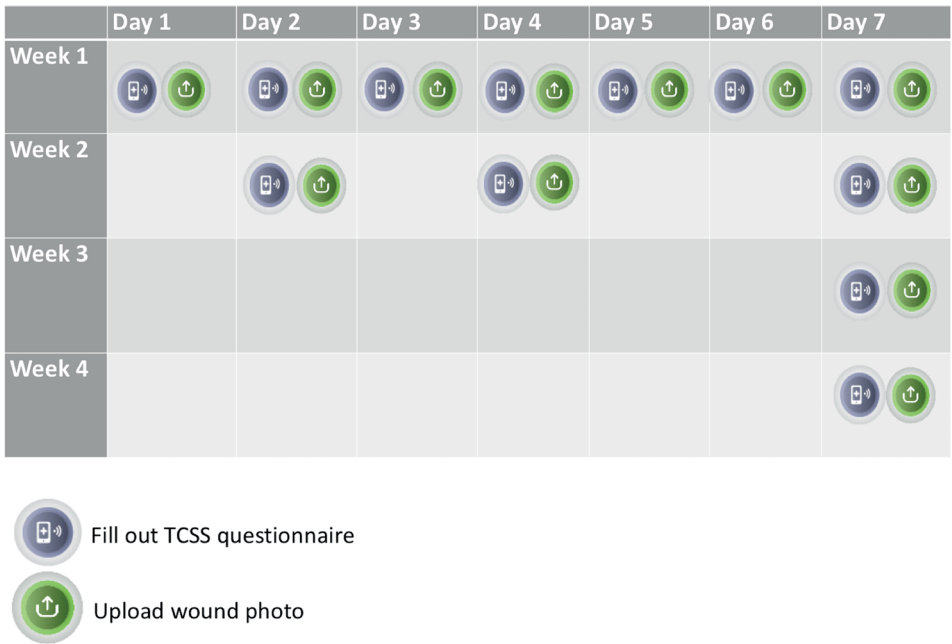


Figure 2. Calendar of four week TCSS program

All questionnaires and wound photo uploads were completed by patients and sent by email to a dedicated research nurse who also checked information and pictures daily to help monitor patients. After the four weeks, patients had a clinic visit with their gastroenterologist, who closed this surgical scenario and decided with the patient the next steps for care.

Questionnaires & Definitions

Post-Surgery TCSS Questionnaire and picture uploads

Questions in the TCSS questionnaire (Table 1) were developed to identify abnormalities and to assess pain, weight, temperature, diet, and wound information. When patients responded with certain “red-flag” answers, the surgical nurse would discuss the patient with the surgeon for appropriate actions. These red flags included certain answers that would be detected by nurses, including: fever over 100 degrees Fahrenheit; pain increase (VAS) equal to or more than 2 points in 24 hours; ileostomy output lower than 500 mL or more than 1000 mL; and bowel movements of 0 in patients without an ostomy. An optional TCSS evaluation survey was administered to all cases one week after the end of the TCSS via email. It contained questions gathering patient feedback on their experience in the TCSS.

Data collection & Statistical Analysis

Data on the three measured outcomes (GI follow-up visits, ED visits, and hospital readmission) was collected from electronic medical records (EMR) and clinic visit summaries for both cases and matched controls. Data on ostomy output, wounds, and physiological conditions (temperature, diet, etc.) were collected from patient-reported outcomes (PROs) via the TCSS for the cases only.

TCSS participants and the matched controls were compared to assess the effect of the TCSS on GI-follow-up visits, ED visits and hospital readmissions. We matched each of the 64 TCSS cases to a control patient based on patient characteristics (age, gender, disease type, type of surgery).

Cases were matched to controls by calculating the matching distance between every case and every potential control based on age, gender disease type and type of surgery. The closer the match between case and control in features (age, gender, etc.), the smaller the distance and the more appropriate the match. The algorithm matches every case to the closest control, but if a later case is found to be a closer match to a control that has already been assigned, it is subsequently assigned to the later case. This leaves some unmatched cases at the end of the first iteration. The algorithm goes through those that are still unmatched until all 64 matches are made.

For statistical purposes, we considered the matched case and control to be the same subject with two different set of outcomes, one in which they use the telemonitoring (TCSS) and

Table 1. TCSS Surgery Questionnaire Form

Question	Response
1. Pain: Rate your abdominal pain on a scale from 0 to 10, where 0 is no pain and 10 is the worst pain.	Visual analog scale
2. Weight: Weigh yourself on the indicated days. Preferably do this after getting up in the morning after going to the bathroom wearing nothing but your underwear.	Short answer in lbs or kg
3. Temperature: Measure your body temperature. (Preferably in the morning.)	Short answer in degrees F or C
4. Diet: Let us know what you eat and drink! <ul style="list-style-type: none"> • How many cups did you drink today (water, tea, coffee, etc) (#) ? • What did you eat today? <ul style="list-style-type: none"> a. Fluids (soup etc.) b. Soft foods (oatmeal, yoghurt, etc.) c. Solid food (meat, pasta, rice, potatoes, vegetables, etc.) 	Short answer Yes or no
5. Do you have an ostomy:	Yes, an ileostomy [Question 6A] Yes, a colostomy [Question 6B] No [Question 6C]
6. A) how much did your ileostomy produce this day (mL)? B) how many times did you empty your ostomy bag this day? (#) C) How many stools did you have the past 24 hours? (#)	Short answer
Now some questions regarding your wound: 7. Is your wound open or closed? 7A. does your wound drain?	open [Question 7A] closed [Question 8] yes [open drop down menu: What does the wound drain? Blood, pus, other] no [Question 8]
8. Do you have any other problems (e.g. nausea/painful urination/headaches)?	Short answer
9. Pain medication: Did you use Tylenol or Narcotics? How many pills did you take?	Yes or no Short answer indicating pill type and corresponding number of pills
10. Upload wound photo: When taking the photo of the surgical wound, make sure there is enough light to get a picture of good quality. Also make sure the entire wound is covered in the picture and it is in focus. When to upload: <ul style="list-style-type: none"> - week 1: every day - week 2: at day 7 - After that you don't have to send pictures anymore, but whenever you feel something is wrong or you want us to look at the wound, please send a picture. 	Attach photo in email to research nurse

one in which they did not. We used a McNemar test to compare proportions between cases and controls. We used a two-proportion z-test to compare outcomes between low (0-3 photos) and high (≥ 4) number of wound photos.

Results

Sample Characteristics

In total, 64 cases were enrolled in the TCSS pathway. Out of 108 historic controls identified in the patient population that did not choose to participate in the TCSS, we matched 64 with our cases based on age, diagnosis, and surgery characteristics (Table 2). Our case and control samples were both predominantly Caucasian (76.5% and 71.9%, respectively), and had never smoked (70.3% and 68.8%, respectively). Median age of cases was 35 years and 48% were male. Median age of controls was 33.5 and 60.9% were male. A greater number of cases than controls used biological therapies, antibiotics, and 5ASA. In the cases, 50% ($n=32$) of the surgeries were for CD, 44% ($n=28$) were for UC, and 6.3% ($n=4$) were for indeterminate colitis. Case surgeries included bowel resection, colectomy, ileostomy, and stomas. The 64 matched historic controls had a median age of 33.5 and 61% were male. Of the controls, 50% of surgeries were for CD ($n=32$) and 50% were for UC ($n=32$).

Mean number of wound photos sent was 3.8 (median of 3 wound photos). Average daily stool frequency was 6 in patients without ileostomy; patients with an ileostomy had an average ileostomy output of 930 mL; an initial pain score of greater than or equal to 5 was reported in 34% of patients, and an average 2-point decrease was observed during the program.

Patient Experience

16 patients (25%) enrolled in the TCSS pathway opted to complete the post-surgical care survey (Table 3). Patients expressed overall satisfaction with the program, with 81% describing their experience as “excellent” and 94% describing the amount of TCSS questions as reasonable. Patients reported that without participation in the TCSS pathway, they would most likely have used a phone call to the doctor’s office as a resource for care (94%). Additionally, 56% of patients felt their recovery would have had a different result without participation in the TCSS program.

Table 2. Patient Demographics

Variable	Subvariable	Cases (n=64)	Controls (n=64)
Mean age		37.9	38.3
Median age		34.5	33.5
Male gender		31 (48.4%)	39 (60.9%)
Diagnosis			
	UC	28 (43.8%)	29 (45.3%)
	CD	32 (50.0%)	34 (53.1%)
	Indeterminate colitis	4 (6.3%)	1 (1.6%)
Race			
	Caucasian	49 (76.5%)	46 (71.9%)
	Black	5 (7.8%)	7 (10.9%)
	Asian	5 (7.8%)	1 (1.6%)
	Other or not declared	5 (7.8%)	10 (15.6%)
Ethnicity			
	Non-Hispanic	55 (85.9%)	53 (81.5%)
	Hispanic, Mexican/ Mexican American, Chicano/a	9 (14.1%)	11 (17.2%)
Marital status			
	Married	31 (48.4%)	28 (43.8%)
	Single	30 (46.9%)	32 (50%)
	Divorced	3 (4.7%)	3 (4.7%)
	Significant other	0	1 (1.5%)
Smoking status			
	Current smoker	1 (1.5%)	2 (3.1%)
	Past smoker	18 (28.1%)	18 (28.1%)
	Never smoker	45 (70.3%)	44 (68.8%)
Insurance			
	Medicare	9 (14.1%)	12 (18.8%)
	Medicaid or Medi-Cal	0	2 (3.1%)
	Other or unknown	55 (85.9%)	50 (78.1%)
Comorbidities			
	Diabetes mellitus	4 (6.3%)	9 (14.1%)
	Chronic kidney disease	0 (0%)	1 (1.6%)
	COPD or asthma	4 (6.3%)	4 (6.3%)
	Cancer	6 (9.4%)	6 (9.4%)
	Organ transplant	1 (1.6%)	1 (1.6%)
	Congestive heart failure	1 (1.5%)	0
	HIV/AIDS	0	0
	Hypertension	4 (6.3%)	6 (9.4%)
	Hypothyroid	1 (1.6%)	3 (4.7%)

	Mental illness (depression, anxiety, etc.)	18 (28%)	29 (45.3%)
Medications			
	5ASA	5 (7.8%)	4 (6.3%)
	Corticosteroids	2 (3.1%)	4 (6.3%)
	Immunomodulators	9 (14.1%)	10 (15.6%)
	Antibiotics	13 (20.3%)	6 (9.4%)
	Biological therapies	29 (45.3%)	24 (37.5%)
Surgery Type			
	Abdominal	64 (100%)	64 (100%)
	Small bowel resection	1 (1.6%)	7 (10.9%)
	Ileocaecal or ileocolonic resection	22 (34.4%)	14 (21.9%)
	Stoma takedown	20 (31.3%)	20 (31.3%)
	Colectomy or proctectomy	22 (34.4%)	24 (37.5%)
	Non rescue stoma	19 (29.7%)	17 (26.6%)
	Rescue ileostomy	3 (4.7%)	6 (9.4%)
	Small repairs	20 (31.3%)	30 (46.9%)
	Resection	40 (62.5%)	40 (62.5%)
	Stoma	22 (34.4%)	23 (35.9%)

In the post-surgical care survey, patients were also able to provide optional comments on their experience in the TCSS program. Two (13%) patients indicated that they would not change the program when asked what they suggest could be improved. Three (19%) expressed feeling comforted that they were receiving personalized follow-up care. Five (31%) patients expressed positive satisfaction with the ease of accessibility to the care team. One patient stated, “I loved knowing that someone was always checking up on me and my recovery through the emails. It was nice knowing that I could ask any questions I had at any time. I probably would have felt a little lost, on my own, and stressed out without the program.” Another patient expressed, “I just knew I had expert help just a click away to someone who knew me.”

Other patients gave feedback on ways to improve the program. One participant suggested having a more personal follow-up process in addition to emails, such as having a care coordinator check in with phone calls. A notable comment from another participant was that they would have liked to receive feedback from staff about the wound photos patients sent in.

Table 3. Patient Experience. Questions of the post-surgical care survey with proportion of respondents (n=16) who answered. Question #5 was open-ended, allowing participants to list suggestions for change. Many opted to highlight positive aspects of the program for this question.

Question	Response Percentages n (%)
1. How was your experience participating in the post-surgery questionnaire and follow up program?	Excellent: 13 (81.3) Good: 2 (12.5) Had no effect on recovery: 1 (6.3)
2. Would you say the questions you answered were	Reasonable: 15 (93.8) Too time consuming: 1 (6.3)
3. What other resources would you have used had you not participated in this post-surgery program?	Phone call to doctor's office: 15 (93.8) Clinic visits: 6 (37.5) ER visits: 4 (25.0) Visiting nurse: 4 (25.0)
*Participants were able to choose multiple options.	
4. Do you think your recovery may have turned out differently had you not participated in the post-surgery program?	Yes: 9 (56.3) No: 7 (43.8)
5. What areas of the post-surgery program would you improve?	More feedback and interaction with staff/providers: 2 (12.5) No suggested changes: 2 (12.5) No response: 2 (12.5)
	Positive highlights Ease of access to care team: 5 (31.3) Feeling that staff cared post-surgery: 3 (18.8)

Clinical Outcomes (ED Visits, Readmissions, 30-Day GI Follow-up visit)

Readmissions, 30-day ED rates, and GI visits were numerically higher in cases compared to controls, but this difference was not statistically significant (**Table 4**). ED rates were 20% in the control group and 25% in cases ($p=0.677$); readmission rates were 22% in the control group and 22% in cases ($p=1.00$); finally, GI follow-up rates were 47% in controls and 58% in cases ($p=0.265$).

Patients who sent in 4 or more wound photos (more adherent to the care pathway) were more likely to have a 30-day GI follow-up visit (not significant; **Figure 3**). There was no difference in the number of ED visits or readmission rates between patients who submitted greater than 4 wound photos and those who submitted fewer.

Table 4. Summary of Results

	Cases	Controls	P-Value
N, IBD surgery	64	64	
ED visits n (%)	16 (25.0%)	13 (20.3%)	0.677
Readmissions n (%)	14 (21.9%)	14 (21.9%)	1.000
30-day GI follow-up visit n (%)	37 (57.8%)	30 (46.9%)	0.265
TCSS results			
Stool frequency mean (SD)	5.8 (3.7)		
Stoma output in mL mean (SD)	930 (499)		
TCSS adherence n (%)			
Wound photos n (%)			
≥1 photo	61 (95.3%)		
≥4 photos	29 (45.3%)		
Avg # photos	3.8		

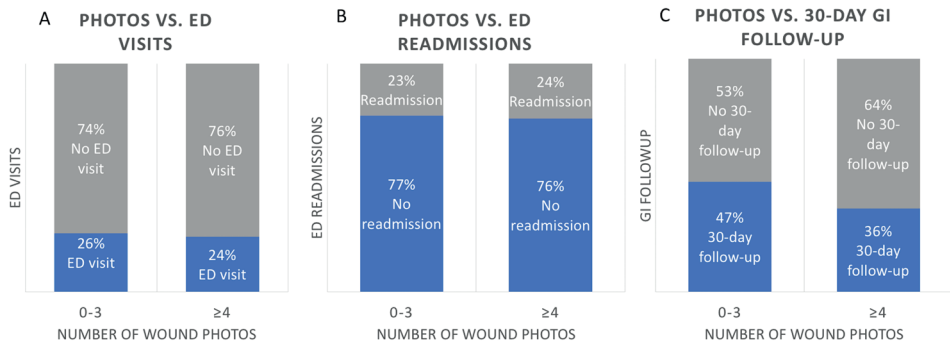


Figure 3. (A) Adherence to TCSS (measured by number of photos sent in) versus 30-day ED visits. Those with four or more wound photos sent in were less likely to visit the ED; p-value = 0.88. (B) Adherence to TCSS (measured by number of photos sent in) versus 30-day readmissions. No statistically significant difference, p-value = 0.90. (C) Adherence to TCSS (measured by number of photos sent in) versus 30-day GI follow-up. Those who sent in four or more wound photos were more likely to have a 30-day GI follow-up; p-value = 0.36. ED, emergency department; GI, gastroenterologist.

Discussion

We developed and investigated the feasibility and efficacy of a telehealth pathway in reducing 30-day readmission rates, ED rates, and GI follow-up visits. Our TCSS pathway demonstrates the feasibility of implementing a telehealth care coordination platform for post-surgery IBD management. By having patients fill out frequent questionnaires after hospital discharge, we were able to monitor patient-reported outcomes and identify complications. For instance, if a patient reported that their abdominal pain increased, the patient was called for triage by a surgical nurse who consulted with the IBD surgeon. If it was deemed necessary by the care team, the patient would be called in for a clinic visit or change of medication. The acceptability of the pathway was high, with 81% (13/16) rating their experience as “excellent”.

As indicated by our post-surgical care survey results, patients felt that they were cared for and comforted during their participation. They particularly appeared to be reassured by the ease with which they could access their care providers, suggesting the importance of increased accessibility to care teams in electronic health applications. A majority of those who responded chose to answer the open-ended question about suggested improvements with either positive feedback or no suggested changes. Those who did suggest changes seemed to call for more involvement and communication from the care team, furthering highlighting the importance of accessibility to the care team. Despite the relatively small sample size of respondents to this survey, overall patient satisfaction showcases the potential of this telehealth intervention to enhance the patient experience.

Our adherence rates also indicate that patients were active participants in the pathway. This is in line with a previous study conducted by Con et al. that found that a majority of IBD patients have internet access and feel confident entering information into a computer or phone²⁰. Despite the relatively small sample size ($n=86$), their study demonstrates the willingness of patients to participate in telehealth solutions for disease management. In addition, previous studies assessing care coordination through use of mobile technologies has shown efficacy in cancer²¹, HIV²², and diabetes²³. Such complex chronic diseases including IBD should strive to involve more patient engagement in their care.

One of the aims of the TCSS was to increase the likelihood that patients would attend a follow-up visit with a gastroenterologist to restart or optimize medical management postoperatively. Indeed, we found that numerically more TCSS patients had a postoperative

GI visit. We also found that patients who sent in 4 or more wound photos were more likely to have a GI follow-up visit. We hypothesize that patients with more complications may have sent in more photos due to greater concern for maintaining their health and seeing their GI physician more frequently. Alternatively, GI patients who sent in more photos seemed to demonstrate higher adherence to our program.

This study has some limitations. Despite our best efforts to match patients to similar controls, a selection bias might have occurred; it is possible that patients who opted in to the TCSS were at higher risk for complications compared to their matched controls. This is supported by the observation that patients included in the TCSS had a higher rate of biologic use than the control group (**Table 2**), potentially reflecting more severe disease. Our study might also suffer from measurement bias; it is possible that we observed more ED visits, hospitalizations, and complications in our TCSS group because TCSS patients were more likely to return to our hospital as we followed-up with them more closely, while controls might have been more likely to go to an outside hospital. This is consistent with findings in other telemonitoring programs such as Constant Care, in which higher relapse rates were found in the intervention group, likely due to a higher detection rate²⁴. As our sample population was predominantly Caucasian and were treated by a single surgeon, our findings may not be representative of the general IBD population based on geographical or racial identities. The relatively small sample size could have affected the significance of our results and limits the generalizability of our findings. Similarly, our small sample size of 16 respondents to the post-surgical care survey limits how representative our findings are.

Still, the use of telemedicine interventions in a postoperative setting have shown potential for enhancing clinical outcomes. Williams et al. found that complication rates for certain elective low-risk procedures were not statistically different from traditional clinical follow-ups²⁵. Clinical outcomes from telemedicine use are therefore comparable to that of traditional clinic follow-ups. Additionally, Gunter et al. conducted a systematic review of 21 articles on the use of telemedicine in post-discharge surgical care. Similar to our study, they found high patient satisfaction rates and significant patient-reported savings of time, travel, and distance; one study reported savings in the health system due to an increased availability of clinic slots for new patients²⁶. No studies have reported statistically higher complication rates in telemedicine interventions for post-surgical care compared to traditional follow-up visits^{25,26}.

Though we did not find statistical significance in the three main outcomes assessed (30-day ED visits, readmission, and GI follow-up visits), future studies should evaluate other healthcare utilization outcomes in addition to these, such as visits to walk-in clinics for pain or consultations with non-traditional providers. In addition, previous studies have demonstrated the financial burden of resource utilization and care management for IBD patients, particularly those undergoing surgery^{11,27}. While our study did not assess reduced costs associated with increased self-management through use of telemedicine, future studies should also include cost analyses to determine the optimally cost-effective method for post-surgery maintenance.

To our knowledge, this is the first study assessing a telehealth intervention involving both patient and provider aspects for post-surgery IBD management. This module aimed to make patients feel safe, prevent complications from happening, and intervene earlier in case of disease complications. TCSS is one pathway that has the potential to allow for monitoring and detection of post-surgery complications. It was well-received by enrolled patients, supporting the use and acceptability of a telehealth intervention for patient care.

References

1. Kozuch PL, Hanauer SB. Treatment of inflammatory bowel disease: a review of medical therapy. *World J Gastroenterol* 2008; 14: 354–377.
2. Targownik LE, Singh H, Nugent Z, et al. The epidemiology of colectomy in ulcerative colitis: Results from a population-based cohort. *Am J Gastroenterol* 2012; 107: 1228–1235.
3. Peyrin-Biroulet L, Loftus E V., Colombel JF, et al. The natural history of adult crohn's disease in population-based cohorts. *American Journal of Gastroenterology* 2010; 105: 289–297.
4. Achkar JP, Hanauer SB. Medical therapy to reduce postoperative Crohn's disease recurrence. *Am J Gastroenterol* 2000; 95: 1139–1146.
5. Zerbib P, Beyer-berjot L, Munoz-bongrand N, et al. Anti-TNF Therapy Is Associated With an Increased Risk of Postoperative Morbidity After Surgery for Ileocolonic Crohn Disease. 2018; 267: 221–228.
6. Kappelman MD, Porter CQ, Galanko JA, et al. Utilization of healthcare resources by U.S. children and adults with inflammatory bowel disease. *Inflamm Bowel Dis* 2011; 17: 62–68.
7. Ballou S, Hirsch W, Singh P, et al. Emergency department utilisation for inflammatory bowel disease in the United States from 2006 to 2014. *Aliment Pharmacol Ther* 2018; 47: 913–921.
8. Rutgeerts P, Geboes K, Vantrappen G, et al. Predictability of the postoperative course of Crohn's disease. *Gastroenterology* 1990; 99: 956–963.
9. Li LT, Mills WL, White DL, et al. Causes and prevalence of unplanned readmissions after colorectal surgery: A systematic review and meta-analysis. *Journal of the American Geriatrics Society* 2013; 61: 1175–1181.
10. Bliss LA, Maguire LH, Chau Z, et al. Readmission after resections of the colon and rectum: Predictors of a costly and common outcome. In: *Diseases of the Colon and Rectum*. 2015, pp. 1164–1173.
11. Damle RN, Chheng NB, Flahive JM, et al. Clinical and financial impact of hospital readmissions after colorectal resection: Predictors, outcomes, and costs. *Dis Colon Rectum* 2014; 57: 1421–1429.
12. Cruz J, Brooks D, Marques A. Home telemonitoring effectiveness in COPD: A systematic review. *International Journal of Clinical Practice* 2014; 68: 369–378.
13. Ammenwerth E, Woess S, Baumgartner C, et al. Evaluation of an Integrated Telemonitoring Surveillance System in Patients with Coronary Heart Disease. *Methods Inf Med* 2015; 54: 388–397.
14. Purcell R, McInnes S, Halcomb EJ. Telemonitoring can assist in managing cardiovascular disease in primary care: A systematic review of systematic reviews. *BMC Family Practice*; 15. Epub ahead of print 2014. DOI: 10.1186/1471-2296-15-43.
15. Peris MA, Del Hoyo J, Bebia P, et al. Telemedicine in inflammatory bowel disease: Opportunities and approaches. *Inflamm Bowel Dis* 2015; 21: 392–399.
16. Heida A, Dijkstra A, Muller Kobold A, et al. The efficacy of home telemonitoring versus conventional follow-up: a randomised controlled trial among teenagers with inflammatory bowel disease. *J Crohns Colitis*. Epub ahead of print 2017. DOI: 10.1093/ecco-jcc/jjx169.

17. Cross RK, Cheevers N, Rustgi A, et al. Randomized, controlled trial of home telemanagement in patients with ulcerative colitis (UC HAT). *Inflamm Bowel Dis* 2012; 18: 1018–1025.
18. Chang S, Malter L, Hudesman D. Disease monitoring in inflammatory bowel disease. *World J Gastroenterol* 2015; 21: 11246–11259.
19. Jackson BD, Gray K, Knowles SR, et al. EHealth Technologies in Inflammatory Bowel Disease: A Systematic Review. *J Crohns Colitis* 2016; 1–19.
20. Con D, Jackson B, Gray K, et al. eHealth for inflammatory bowel disease self-management – the patient perspective. *Scand J Gastroenterol* 2017; 1–8.
21. Kim KK, Bell JF, Bold R, et al. A personal health network for chemotherapy care coordination: Evaluation of usability among patients. In: *Studies in Health Technology and Informatics*. 2016, pp. 232–236.
22. Swendeman D, Farmer S, Mindry D, et al. HIV Care Providers' Attitudes regarding Mobile Phone Applications and Web-Based Dashboards to support Patient Self-Management and Care Coordination: Results from a Qualitative Feasibility Study. *J HIV AIDS* 2016; 2: 1310–1318.
23. Tsui I, Drexler A, Stanton AL, et al. Pilot study using mobile health to coordinate the diabetic patient, diabetologist, and ophthalmologist. *J Diabetes Sci Technol* 2014; 8: 845–849.
24. Elkjaer M, Shuhaibar M, Burisch J, et al. E-health empowers patients with ulcerative colitis: A randomised controlled trial of the web-guided 'constant-care' approach. *Gut* 2010; 59: 1652–1661.
25. Williams AM, Bhatti UF, Alam HB, et al. The role of telemedicine in postoperative care. *mHealth* 2018; 4: 11.
26. Gunter RL, Chouinard S, Fernandes-Taylor S, et al. Current Use of Telemedicine for Post-Discharge Surgical Care: A Systematic Review. *Journal of the American College of Surgeons* 2016; 222: 915–927.
27. Bernstein CN, Longobardi T, Finlayson G, et al. Direct medical cost of managing IBD patients: A Canadian population-based study. *Inflamm Bowel Dis* 2012; 18: 1498–1508.

