

Can Smartphones Help Deliver Smarter Care for Patients With Inflammatory Bowel Disease?

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The addition of smartphone applications to the armamentarium of tools to help manage patients with inflammatory bowel disease (IBD) has the potential to improve care in multiple ways, including enhanced disease understanding, improved adherence to medications, accessible support networks, and earlier interventions by medical professionals when problems arise. However, at present, for patients with IBD, the development of such mobile applications is still in its infancy. We conducted a review of the literature and online resources including phone application stores (Apple and Android app stores) to assess the current availability of mobile health applications for IBD patients and opportunities to increase patient engagement. We also addressed the limitations and challenges of patient and provider adoption of mobile-based technologies for IBD self-management and remote monitoring.

Key Words: inflammatory bowel disease, smartphones, mobile apps

INTRODUCTION

The ubiquity of mobile devices and smartphones has empowered today's patients, including those with inflammatory bowel disease (IBD), to turn to the Internet and mobile applications (apps) to meet their health needs.¹⁻³ The addition of mobile apps (ie, apps on a handheld device like a smartphone or tablet) to the armamentarium of tools to help manage patients with IBD has the potential to improve care in multiple ways, including enhanced disease understanding, improved adherence to medications, accessible support networks, and earlier interventions by medical professionals when problems arise. Self-management of other chronic diseases, including chronic heart failure and diabetes, utilizing mobile apps has been promising. However, at present, the development of such apps for patients with IBD is still in its infancy.⁴

As payment models continue to transition to value-based reimbursement, physicians will need to devise and implement methods to encourage patients to engage in their own health to minimize health care utilization and improve outcomes. Tools that provide patients with chronic gastrointestinal disorders with evidence-based information about their disease and

incorporate remote self-monitoring will likely become an integral part of gastroenterology practice. In addition to improving health care utilization, remote patient monitoring using mobile apps may lead to improved adherence, personalized medicine,⁵ better quality of life,⁶⁻⁸ and improved outcomes.

We conducted a review of the literature and online resources including phone app stores (Apple and Android app stores) to assess the current availability of mobile health (mHealth) apps for IBD patients and opportunities to increase patient engagement.⁹ We also address the limitations and challenges of patient and provider adoption of mobile-based technologies for IBD self-management and remote monitoring.

THE AVAILABILITY AND POTENTIAL VALUE OF INTERNET AND SMARTPHONE USE BY IBD PATIENTS

It is generally known that patients with chronic diseases go to the Internet to assist with the management of their disease. According to a Pew 2013 survey, more than 70% of American Internet users have searched for health-related information within the past year.¹⁰ A survey among individuals presenting to an IBD clinic at a tertiary care center found that younger patients and those with higher education levels were most likely to use the Internet to gather IBD-related information.² Despite marked variation in the quality of websites, patients continue to seek out information on IBD from the web.^{1,11} Searches include information on treatment options and their side effects, available and new diagnostic procedures, support groups, complementary and alternative therapies, nutrition recommendations, and guidelines from scientific societies.¹ Not surprisingly, these patients also prefer to communicate with their physician by web-based secure messaging platforms.¹²

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Increasingly, beyond simply searching the Internet, individuals are turning to mobile apps and web-connected devices to manage their health. Two-thirds of Americans report interest in using mobile apps to manage health-related issues.¹³ The smartphone market has grown rapidly over the last several years, with 68% of Americans owning smartphones in 2015 compared with 35% in 2011. Among adults aged 18–29 and 30–49 years, smartphone ownership is estimated at 86% and 83%, respectively. Moreover, nearly half of US adults own a tablet.¹⁴

The widespread availability of smartphones, tablets, and web-connected devices has fueled the rapid proliferation of consumer-facing, mHealth apps available for Android and iOS devices. There are more than 165,000 mHealth apps available, with the vast majority targeting fitness, wellness, medical reference, and nutrition. However, less than 10% of mHealth apps focus on providing diagnostic tools, remote consultation, and chronic disease management.¹⁵ Even fewer apps allow for real-time transmission of data or interaction between the patient and provider.¹⁶

Mobile applications represent a substantial opportunity for increasing health literacy, patient engagement, and compliance (Table 1), particularly among patients with inflammatory bowel disease given the young age of onset, usually 20s and 30s.^{17–19} These younger patients are well versed in using smartphones and have demonstrated their willingness to explore alternative methods of self-management.⁴

CURRENT USE OF MOBILE APPS FOR IBD SELF-MANAGEMENT

Two mobile app stores dominate the marketplace, Google Play for Android and Apple's iTunes App Store, with more than 5 million apps available for download between the 2 of them (Statistica.com; <https://www.statista.com/topics/1002/mobile-app-usage/>). We searched the Apple iTunes (iOS) and Google Play (Android) stores to assess the availability of mHealth apps targeting IBD patients as of June 19, 2017. The

TABLE 1: Potential Benefits of Smartphone Use in Caring for Patients With Inflammatory Bowel Disease

Patient education on disease and management
Remote disease monitoring
Symptom tracking
Medication adherence tracking
Dietary logs
Earlier interventions based on tracked data
Alerts to medical team if symptoms not on track
Improved adherence (alarms/reminders)
Improved self-management/patient empowerment
Online support network

terms used for the search included “Crohn's disease,” “Crohns,” “UC,” “ulcerative colitis,” “colitis,” “IBD,” and “inflammatory bowel disease(s)”. Electronic medical record–sponsored patient portals were not reviewed and are beyond the scope of this paper.

Between the 2 platforms, our search yielded 56 IBD-related apps (25 Android apps, 15 iOS apps, and 16 Android/iOS apps) for English-speaking audiences (Table 2). The functionality and authorship of each app was assessed by their descriptions and developer websites. Similar to apps for other chronic conditions, common features include providing disease-related information (36%), symptom diaries (57%), nutrition diaries (36%), weight tracking (16%), physical activity tracking (16%), medication administration logs and reminders (36%), personal health records (14%), and remote monitoring/surveying (14%). More IBD-specific functionalities include geo-location to find restroom facilities (7%) and social media for IBD patients (9%). Although there is significant interest in using mobile apps for IBD self-management, only 6% of smartphone users in a recent study reported using mobile apps to manage their IBD.¹⁹ Moreover, currently available apps are primarily designed as an end-user product, without the capability to transmit data or reports to providers.

The majority of mHealth apps commercially available in the app stores are not evidenced based, lack clinical validation, and have limited professional medical involvement, similar to findings from prior studies.^{4,20,21} Nine out of the 56 apps (16%) were developed by gastrointestinal (GI) or IBD patients alone. Also, social media use among IBD patients is widespread despite the variable quality of content and lack of moderation by health professionals. Three out of the top 4 most downloaded and frequently reviewed Android apps incorporate social media or a community forum for IBD patients. A recent survey of IBD patients by Reich et al. found that 55% of respondents were interested in obtaining IBD-related education through social media.¹⁹ Only 46% of app descriptions or websites assessed in this review document physician involvement in the app design and/or implementation.

POPULAR IBD-RELATED APPS FOR PATIENTS

GI Monitor, the most downloaded app (100,000–500,000 installs on Android devices) for self-management of IBD, allows individuals to log symptoms, pain, bowel movements, diet, and medications. The app, developed by a patient with ulcerative colitis (UC) in conjunction with a physician, also can generate a report that can be printed out and provided to their physician and includes a quality of life (QoL) score that is automatically calculated based on patient-reported outcomes.⁴ Apart from functionality to track certain self-reported parameters, GI Monitor incorporates an online forum for users to hear from and interact with other IBD patients. There are 987 reviews, with an average rating of 3.8/5 stars in the Google Play store and 3.5/5 stars from 7 reviewers on Apple iTunes.

TABLE 2: Currently Available Apps Related to Inflammatory Bowel Disease

App Name	Publisher/Developer	Device
GI Monitor	Vertical Health	Android/iOS
GI Buddy	Crohn's and Colitis Foundation	Android/iOS
WC ASAPP	Cole Street BV	Android/iOS
Crohn's and Colitis Support	MyHealthTeams	Android/iOS
BathroomMap	BathroomMap	Android
IBD (Crohn's, colitis)	Socaplaya21	Android
GoHere: Washroom Locator	Crohn's and Colitis Canada	Android/iOS
Poop Tracker-Toilet Log	Appstronaut Studios	Android
Gi BodyGuard from the CDHF	Canadian Digestive Health Foundation	Android/iOS
Poocount Lite	tobik(a)-Tobias Kausch	Android
IBD Warriors	The Real BB staff	Android
Gut check	Janssen Biotech, Inc.	Android/iOS
Crohns Food Tracker	Austin Hunter	Android
Poop Happened	Health and Fitness Logs	Android
IBD diary	Alfred Brandtner	Android/iOS
Bowelle-The IBS Tracker	Cane Media Ltd.	iOS
Pentasa Timer	Ushio Shugo	Android
Cara-Food, Mood, Poop Tracker-IBS Symptom Tracker	HiDoc Technologies UG	iOS
My Crohn's Diary	3 ACORN Technologies, LLC	Android
Stomach Problems	Expert Health Studio	Android
IBD	Focus Medica India Pvt. Ltd	Android/iOS
IBD Assistant	Leber László	Android
Colitis Diary	cellHigh LLC	Android/iOS
SugarSweet	Christopher Jarvis	Android/iOS
myGI	Children's Hospital Los Angeles	Android
Visit Planner	CCHMC Mobile App Dev	Android
Gut Health Storylines	Health Storylines	Android/iOS
UCLA eIBD	Mindstream Design	Android/iOS
Crohn's Disease	Droid Clinic	Android
Ulcerative Colitis Causes	Revolxa Inc	Android
Stool-Your Poop Tracker for IBS and IBD	Karate Health, Inc	iOS
Crohn's Disease	Personal Remedies LLC	Android/iOS
IBD Circle	Brigham and Women's Hospital	Android
IBD	Alexey Manannikov	iOS
MyGIHealth	My Total Health, Inc	iOS
Stool Log-Your Bowel Movement Journal	Digitalisrump GmbH	iOS
Poocount	tobik(a)-Tobias Kausch	Android
cliexa-IBD	CN4CE, Inc	Android/iOS
Connect2 CCUK	Sheena Jawanda	Android
Crohn's Disease	MMI	Android
myIBD+	The Hospital for Sick Children	Android/iOS
Toilet diary	Tillie	Android
Crohns Disease Symptoms	Medical Apps Studio	Android
CrohnsTracker Pro	ToTheHand, LLC	Android
Stomach Problems Tips	stay healthy	Android
Care4Today Crohn's (powered by bepatient) (unreleased)	BEPATIENT	Android
IBD Fighter (unreleased)	Wootera LLC	Android
Colitis Tracker	Bit3 Computing	iOS
IBData	Takeda Pharmaceuticals	iOS
IBDeciding	Blair Ventures LLC	iOS
IBDWatch-Crohn's and Colitis News	Brandon Wuerth	iOS
KCH-IBD	Apppli Limited	iOS
Lisa's Diet	Daniel Fong	iOS
Plop Chart your Crohn's	Sasha Zanjani	iOS
Tummy Lab-Diary for IBS, IBD, and stomach issues	Tummy Lab AB	iOS
you...track	Dr Falk Pharma UK Ltd	iOS

The Crohn's and Colitis Foundation created the next most popular IBD mobile app, GI Buddy (10,000–50,000 installs on Android devices). The app features many of the same logging capabilities, including symptom and nutrition diaries and medication reminders that can be graphically trended over time. There is also access to a community forum within the application. GI Buddy has an average rating of 3/5 stars from 99 reviewers and 2.5/5 stars from 8 reviewers on the Google Play and Apple iTunes stores, respectively. The biggest criticisms of the application are a difficult-to-use interface and unstable functionality. The last published update was in 2015.

MyCrohnsAndColitisTeam is the only free social network dedicated to IBD and the third most popular mobile app for Crohn's disease (CD) and UC patients. The application focuses on helping IBD patients find psychosocial support and answers to questions from others with Crohn's and colitis. Interestingly, patients can reveal their identity, post photos, find others with IBD nearby, and share diagnoses. Despite the lack of anonymity and ability to log symptoms and other patient-reported outcomes, users rate the application highly, with 4.2/5 stars in the Google Play store.

RESEARCH-VALIDATED IBD MOBILE APPS

Although assessing the number of times an app is downloaded is one way to measure success, it is likely a much less accurate way to do so. There are several other apps, available only to patients in various health care systems, missed by such search strategies, that are being used and studied, with building literature to back their validity and use. We performed a search of the literature to identify such apps.

Investigators at the UCLA Center for IBD validated two 4-question, patient-reported outcome questionnaires that are currently being used in the UCLA eIBD mobile app to remotely monitor disease activity and alert providers when certain thresholds are met. Van Deen et al. were able to demonstrate that patient-reported disease activity was an independent predictor of clinical disease activity in a multicenter, prospective observational study among Crohn's disease and ulcerative colitis patients.¹⁶ In the ulcerative colitis cohort, there was also high correlation between clinical disease activity and endoscopy findings.

Current disease monitoring tools for IBD are cumbersome, complex, and impractical for use in patient-targeted mHealth apps. The Crohn's Disease Activity Index (CDAI) was developed in the 1970s and is one of the most widely used tools to evaluate clinical disease activity; however, it can be cumbersome to use. Kim et al. devised a mobile-friendly, self-reporting diary app using the Harvey-Bradshaw Index, accessible at www.cdsd.or.kr, which correlates well with CDAI, with a positive predictive value and negative predictive value for clinical remission of 91.7% and 88.5%, respectively.²² To our knowledge, this app is only available for download from their website. These studies demonstrate that remote monitoring tools can be

devised and deployed on smartphones to provide continuous outpatient monitoring of IBD patients.

Moreover, a group in Denmark recently published a randomized controlled trial of a telemedicine system that included a patient-facing app called myIBDcoach. The app monitors disease activity, medication use and adherence, and quality of life via questionnaires. Outcomes data were compared between a group of patients treated using myIBDcoach and standard care. Over 12 months of follow-up, they found that patients randomized to using myIBDcoach had reduced outpatient visits (1.5 vs 2.3, $P < 0.0001$) and hospital admissions (0.05 vs 0.10, $P = 0.046$) compared with standard care, although there were no differences in quality of life, steroid use, emergency room visits, flares, or surgeries between the 2 groups.²³

Mount Sinai has an ongoing phase III, single-center, pragmatic randomized controlled trial using the Mobile HealthPromise App to evaluate if a patient-centric self-monitoring and collaborative decision support platform will lead to sustainable improvement in overall quality of life for patients with IBD.²⁴ Preliminary results of this study, presented at a recent national meeting, included enrollment of 320 patients, with those randomized to the mobile health app arm having significantly higher quality of life (quality of life score, 30.0 vs 25.2; $P < 0.001$) and quality of care (as based on the quality of care indicators recommended by the American Gastroenterological Association) scores than those randomized to the control arm.

OPPORTUNITIES TO IMPROVE PATIENT ENGAGEMENT USING MOBILE APPS

Similar to other chronic illnesses, nonadherence to medications and treatment recommendations is rampant in IBD.^{25–27} Unlike other chronic diseases such as hypertension and diabetes that are slowly progressive or indolent, exacerbations of inflammatory bowel disease can occur rapidly and require emergency room visits and hospitalization to control symptoms.⁹ A recent study identified several factors, including psychiatric illness, use of steroids, use of narcotics, anemia, and a high number of IBD-related hospitalizations, that were associated with high health care utilization.²⁸ Increasing adherence to treatment recommendations and health literacy among patients may curb health care utilization among these high-risk patients.

Patient education with health- and disease-specific information has been shown to improve compliance with therapy, shared decision-making capacity, and overall satisfaction with care.^{29,30} Nonetheless, Bernstein et al. found that nearly a quarter of patients newly diagnosed with IBD were dissatisfied with the information they were given at the time of their diagnosis. The vast majority of patients were amenable to using supplementary online materials as an adjunct to physician-patient consultations.³¹ Unlike static websites, mobile apps are easily accessible and can be tailored to a patient's characteristics (ie, cognitive factors, beliefs and attitudes, and skills) to provide relevant content or address specific problems.³² Messages

or push notifications through mobile applications can provide reminders or prompts that will motivate patients to participate in behavioral change. These prompts can be personalized to a user's specific needs identified by the clinician or predetermined using algorithms. Some apps are even able to increase or decrease the frequency of monitoring based on the current control of that patient's symptoms. Previous studies have shown that behavioral prescriptions, such as automated reminders or instructions, increase desired behavior change.³³ Other content delivery methods that have been shown to increase patient engagement include audio, video, and interactivity.³²

Patients with IBD often minimize their symptoms and delay care, which leads to complications necessitating escalating medical and surgical interventions. Angelucci et al. found that the use of the Internet to gather IBD-related information increased significantly with the increase of disease activity and severity. A statistically significant increase in the number of visits per year, need for steroids, immunosuppressive drugs, and biologic use was observed among Internet users who searched for IBD-related information compared with those who did not.¹ IBD patients with active disease are more likely to search for content on the web to assist with self-management to control symptoms. Implementation of analytics that track mHealth app usage may help clinicians identify patients who are failing medical therapies. Future studies are needed to assess whether mobile app usage also increases with disease activity and severity.

The benefits of remote monitoring can also be seen in mild to moderate disease. A recent study found that a greater number of outpatient visits serves as a significant protective factor for IBD-related hospitalization in the subsequent year.²⁸ The use of mHealth apps for chronic disease management could help eliminate the need for some office visits and has clear environmental and economical benefits.³⁴ Incorporating remote monitoring and self-management tools can reduce barriers to in-person treatment, including missed time from work/school, scheduling appointments, commute and treatment time, and cost.³² A European study that randomized patients with ulcerative colitis on 5-aminosalicylate therapies to either a web group receiving education and self-treatment resources or a control group continuing usual care for 12 months found a significant increase in QoL, knowledge, and 4-week adherence, and a reduction in acute and routine outpatient clinic visits. The decreased utilization of outpatient visits resulted in a cost savings of 189 euros/patient/y.^{6,8}

Another study assessing the feasibility and acceptance of a remote monitoring system for IBD found a significant improvement in patient knowledge and 90% self-reported adherence with medications and self-testing at 6-month follow-up. Patients were given a scale and laptop computer and asked to weigh themselves and answer questions grading symptoms and medication side effects over the past week. Responses and clinical alerts were generated and transmitted to the

physician based on how a patient answered the questions. At the completion of the study, 91% of patients said they would consider using remote monitoring in the future.³⁵ This study further illustrates patient readiness and willingness to participate in interventions involving remote monitoring. Advances in technology since this study was published will enable us to condense these monitoring systems into easy-to-use apps running on smartphones, which can transmit data wirelessly from any location.

SOCIAL MEDIA

Social media plays an integral part in dissemination of IBD-related information, self-management, psychosocial support, and patient empowerment.^{19, 36} The social network Facebook is arguably the most frequented mobile app worldwide and hosts dozens of support groups for patients with CD and UC with memberships that easily outnumber the majority of IBD-related mobile apps. Other IBD-specific social media websites including the Crohn's and Colitis Foundation, MyCrohnsandColitisTeam.com, and IBDsupport.org are also popular among IBD patients. A survey of IBD patients at 2 tertiary care centers conducted by Reich et al. found that high-frequency social media users (>2 hours per day) were 3 times more likely to believe social media was useful in IBD management compared with low-frequency users. Moreover, 54% of respondents expressed interest in receiving IBD information from their gastroenterologist via social media.¹⁹ Provider presence and participation in social media may help facilitate the delivery and improve the quality of IBD-related information and commentary on these platforms.

LIMITATIONS AND CHALLENGES

There are significant challenges and barriers to using mobile health technologies that will need to be addressed before mHealth apps become universal in IBD management.

Concerns over privacy and confidentiality are a major barrier to patient-provider communication. The majority of mHealth apps currently available are not integrated into electronic medical records that can be made accessible to providers and lack HIPAA-compliant messaging capabilities. However, groups such as Xcertia are in the process of developing collaborative industry guidelines for safe and effective mobile health apps and are focused on topics including privacy, security, usability, content, and adaptability to clinical practice. With time, groups such as this can certify apps as meeting certain minimum standards and increase the safety and ease of use of these apps.

Until recently, there has been a lack of medical involvement in the design of mHealth apps, and the validity and accuracy of content within many of these apps are questionable. Current rating tools, descriptions, popularity, and reviews are subjective and potentially biased. They do not reflect the content quality within the mHealth app.²¹ NODEHealth is a

consortium of health systems that are collaborating to promote evidence-based digital medicine. By including academics, industry, and entrepreneurs, this initiative is working to build collaboration between health care systems and developers and grow ongoing studies of digital health apps. Moreover, delivery platforms for apps, such as RX Universe (Mount Sinai), are being pioneered to allow providers to “prescribe” various apps for patients after the apps have been vetted as meeting certain standards. With time, apps such as this will be able to rank mobile health apps based on these predescribed standards.

The frequency of mobile app usage by IBD patients may not follow disease activity. Patients who are nonadherent to medical treatment with or without active disease may or may not subscribe to using an app for self-management. Further, there will likely be a group of patients who will not use mobile health apps or technology for any reason regardless of their disease activity or adherence to treatment. Conversely, other patients whose IBD is well controlled may not feel the need to log symptoms, document medication use, or participate in support groups.

Lastly, there may be a concordance gap between the mobile apps and digital tools promoted by gastroenterologists and patient preference. Physicians may not endorse tools that patients use, and patients may not find it necessary or beneficial to complete symptom and nutrition diaries or fill out symptom diaries.³⁷ Moreover, even if patients are actively engaged in mobile health app use, their physician must similarly be engaged in using the app. Otherwise, not only will there be a missed opportunity to gather additional data about a patient's current disease status, but critical information regarding a patient's health may go ignored, causing possible harm to the patient. Further, this raises medical-legal concerns over what information the physician is responsible for and in what sort of timely fashion the data must be addressed. Careful attention to the details will be paramount.

CONCLUSION

It is clear that the role of mobile apps for IBD self-management will continue to increase as health policy makers and other stakeholders continue to seek more efficient, effective ways to deliver quality care at reduced costs, and as patients find apps to self-manage their IBD. It is critical that effectiveness studies be incorporated into existing and new mobile app interventions. Future studies are needed to develop validated tools for mobile applications that increase compliance, decrease unnecessary services and cost of care, and improve health outcomes. It is imperative that health care providers be at the forefront of this research, guiding developers to build and launch mHealth apps that will ultimately improve outcomes.

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