

A Review of Published Studies Using Interactive Internet Tools or Mobile Devices to Improve Asthma Knowledge or Health Outcomes

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There is a growing interest in the use of information technologies to promote asthma control and improve outcomes. This article reviews published studies, identified by a search of PubMed and CINAHL, utilizing interactive Internet and mobile device platforms to improve asthma knowledge and/or asthma outcomes. Although these studies show creativity and promise, this field is still in its infancy, characterized by small pilot studies showing mixed results. Rigorous randomized, controlled trials with large sample sizes and objective assessments are in the pipeline but more are needed. This review also describes some promising ongoing studies using information technology to improve asthma management, as well as currently available mobile applications and the use of social networking for asthma. To our knowledge, there are no published studies using interactive mobile applications or social networking platforms to improve asthma self-management.

Introduction

ASTHMA IS THE most common chronic disease of childhood. In 2009, asthma affected 7.1 million children aged 0–17 years. Of these children with current asthma, 52% (4.0 million) had attacks and were at risk for poor outcomes, including emergency-room visits or hospitalization.¹ The National Heart, Lung, and Blood Institute, Expert Panel Report 3 (NHLBI EP3) Asthma Guidelines suggest that there is a potential use for information technologies to provide patients with skills to control their asthma and improve outcomes.² As the use of these information technologies are already a part of people's day-to-day activities, they have tremendous potential to be leveraged to improve asthma self-management. This review examines published studies using either the Internet or mobile device platforms to increase asthma knowledge and/or improve asthma outcomes. It provides an overview of ongoing studies as well as commercially available applications for asthma management. Finally, it explores the emerging use of social networking in asthma care.

Methods

The authors conducted a search of 2 databases, PubMed and CINAHL, from January 1, 2000, through October 1, 2011. The following search terms were used: Chronic Disease; Asthma; Self-Care; Technology; Wireless Communications; MP3; Outcome Assessment; and Treatment Outcomes. This search identified 128 abstracts: 71 from PubMed and 57 from CINAHL.

All studies not using interactive Internet and/or mobile device platforms to improve asthma knowledge and/or outcomes were excluded. Experimental as well as nonexperimental studies were included. (Nonexperimental studies are those in which participants are not randomly assigned to treatment allocation.) Although the intent of this review was to focus on pediatric asthma, as this is a newly emerging field with few published studies, both adult and pediatric studies were included. Also excluded were abstracts; nonoriginal research articles; non-English-language articles; meta-analyses; review articles; and studies describing noninteractive programs (ie, those that provided passive information only). Eight studies met criteria to be included in this review: 4 from PubMed and 4 from CINAHL. An additional 9 original research studies, published between January 1, 2000, and October 1, 2011, using interactive Internet or mobile device platforms that were referenced in these 8 studies but were not identified by the PubMed and CINAHL database searches, are also included in this review. This resulted in 17 studies included in this meta-analysis.

Ongoing studies using Internet or mobile device platforms to promote asthma self-management are discussed. Currently available mobile applications for asthma management are described and the emerging use of social networking in asthma is explored.

Interactive Internet-Based Interventions

The Internet has revolutionized people's ability to access information. It offers an instantaneous, comparatively low-

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TABLE 1. ASTHMA INTERNET-BASED STUDIES

Author (year)	Study design/duration	Population	Intervention	Outcomes measured	Results	Comments
Homer et al. (2000) ⁵	Randomized, controlled trial 3 initial visits, then monthly follow-up for 9 months	137 children aged 3–12 years old (mean age 7.4 years) with physician-diagnosed asthma	Use of an interactive educational computer program to teach children about asthma and its management versus an asthma education book and noneducational computer game	Acute health care use (emergency room and outpatient), maternal report of symptom severity, functional status, school absences, satisfaction with care, and asthma knowledge	No difference between intervention and control group except greater improvement in asthma knowledge in intervention group	Both groups showed substantial improvement in all outcomes; children enjoyed using the system
Guendelman et al. (2002) ⁶	Randomized, controlled trial 90 days	134 inner-city children and adolescents 8–16 years old (mean age 12.1 years) with physician-diagnosed asthma	Use of a web-based asthma self-management and education program to monitor symptoms and QOL and transmit this to providers; both groups received the same initial education; the control group went on to use a standard written asthma diary	Any limitation in activity, perceived asthma symptoms, school absences, yellow and red zone PFM readings, and use of health services	Intervention group had less limitation in activity, less likely to have yellow and red zone PFM readings, less urgent calls, and improved self-care behaviors	Device gave immediate feedback to participant and could transmit information to a nurse coordinator through a secure website (reviewed the next day); usage declined over time
Krishna et al. (2003) ⁷	Randomized, controlled trial 12 months	246 asthmatic children <18 years old and their caregivers (mean age not given in this study)	Use of a web-based interactive asthma management plan versus traditional printed and verbal asthma education	Asthma knowledge scores, disease outcomes (symptom days, use of quick-relief medications, activity limitations, nights with sleep disturbance, school days missed), healthcare resource utilization (urgent physician visits, ER visits, and hospitalizations)	Use of the program increased asthma knowledge, reduced asthma morbidity, and reduced emergency room costs	Users found the program easy to navigate, interesting and enjoyable; 60% would use the program again
Jan et al. (2007) ⁸	Randomized, controlled trial 12 weeks	164 asthmatic children, 6–12 years old (mean age 10.4 years)	The Intervention group received an internet-based multimedia asthma education program with an interactive asthma monitoring system and the control group received verbal and written (traditional) asthma education	Asthma symptom scores, PFM readings and variability, adherence, asthma control tests, asthma knowledge, QOL, and satisfaction	Intervention group had decreased symptoms, improved PFM readings, improved knowledge and improved QOL	Program includes symptom diaries, PFM diary, symptom support, action plan suggestions and the ability to upload information to store and share; participants reported a favorable attitude toward telemedicine
Sockrider et al. (2006) ⁹	Randomized clinical trial; a substudy of a larger asthma surveillance project 12 months	464 subjects, 1–18 years old (mean age 6.56 years) presenting to the ED for an acute asthma episode at 4 participating sites	In the ED setting, asthma educators used a computer-based program to: provide tailored asthma education to children and their families as well as and provide a customized take-home asthma action plan and educational summary	Change in confidence in their ability to self-manage asthma, subsequent healthcare utilization, school absenteeism, asthma symptoms, and quality of life	Significant improvements in confidence in intervention group at 14 days of follow-up; greater portion of subjects in intervention group reported having well visits at 9-month follow-up; patients with intermittent asthma in the intervention group had fewer ED return	The asthma educator used the computer program to create the customized patient take-home information and to guide patient education while still in the ED

(continued)

TABLE 1. (CONTINUED)

Author (year)	Study design/duration	Population	Intervention	Outcomes measured	Results	Comments
van der Meer et al. (2007) ¹⁰	Observational study followed by focus group sessions 4 weeks	Adolescents 12–17 years old, (mean age 14.4 years) with mild to moderate persistent asthma; 97 participants in monitoring portion of study; 35 participants in focus groups	Use of Internet-based or SMS to record FEV1 and peak flow values and then held focus groups to discuss barriers to asthma management	To reveal intrinsic barriers to current asthma management; explore the barriers and benefits of Internet-based self-management in patients with good and poor asthma control	Limited perceived ability to control asthma was most striking barrier in those with poor asthma control	Participants with poor asthma control were willing to incorporate the Internet-based self-management for a longer period of time; participants with good asthma control were not. Internet-based self-management should target adolescents with poor asthma control
Wyatt et al. (2008) ¹¹	One-group pretest-post-test quasi-experimental design 2 weeks	35 asthmatic children 8–11 years old (mean age 9 years)	Use of an online story and story writing techniques to teach children about asthma	Child's knowledge and attitude about asthma before and after intervention	Significant improvements in asthma knowledge and attitude scores	Developed for school nurses to use in health offices
Finkelstein et al. (2000) ¹²	Prospective observational study 3 weeks	31 asthmatic adults, 22–68 years old (mean age 41.9 years), from a low-income, inner-city area	Used an Internet-based system to record patient spirometry and symptoms in their homes	Validity of home spirometry self-testing and acceptance of system	Spirometry self-testing was valid and comparable to that obtained by medical professionals; majority of patients strongly interested in using	Successful even in a population where 71% reported no computer experience
Rasmussen et al. (2005) ¹³	Randomized, prospective parallel-group study 6 months	300 asthmatic adults 18–45 years old (mean age 29.5 years)	Assess outcome on an Internet-based management tool; 3 parallel groups: (1) treatment by an asthma specialist with Internet-based tool, (2) treatment by an asthma specialist in clinic, or (3) treatment by their general practitioner	Asthma symptoms, QOL, lung function, and airway responsiveness; medication adherence and use of action plan	Better improvement in asthma symptoms, QOL, lung function, and airway responsiveness in Internet-based group	Internet group had more unscheduled visits, higher consumption of inhaled steroids and more side effects
Anhøj and Nielsen (2004) ¹⁴	Two surveys, 2 interview rounds 9 months	85 asthma adults, 10–79 years old (mean age 36 years for females, 41 years for males) and 131 healthcare providers	Web-based asthma management system with electronic diary; healthcare providers could access patient data	Describe patients' and healthcare providers' use of system, evaluate perception of system	Users happy with system in general; helps patients manage their disease; doctors feel it helps with asthma control	Both doctors and patients stopped using over the study period (total of 3 years); stated it did not fit into their everyday lives

PFM, peak flow meter; QOL, quality of life; ER, emergency room; ED, emergency department; SMS, short message service; FEV1, forced expiratory volume in 1 s.

cost option for accessing health information anytime and mostly anywhere. Eighty percent of adult Internet users in the United States—93 million Americans—have sought health-related information online.³ Searching the Internet for healthcare information is the third most popular online activity.³ On a typical day, 7 million Americans go online for health information.⁴ However, it is difficult to monitor or assess the benefits of patient use of these passive informational-only websites. In contrast, studies using interactive patient-centered programs on the Internet may offer unique benefits and allow for measurable outcomes.

Ten of the 17 studies used interactive Internet-based interventions.^{5–14} Of these, 7 targeted the pediatric population.^{5–11} Table 1 presents a description of each study. A theme among 4 of the pediatric studies was to make Internet-based interventions an enjoyable and positive experience for the participants by having them learn about asthma self-management through games^{5,7,8} and storytelling,¹¹ and receive tailored feedback in response to their answers to questions. All 4 of these studies demonstrated significant improvements in asthma knowledge. Participants also reported enjoying the program, an improved attitude toward asthma, or an improved attitude toward the use of technology in managing their asthma. Overall, these 4 studies demonstrated improved asthma outcomes, including decreased emergency-room visits and asthma symptoms, and improved peak flow meter readings.^{5,7,8,11} In the fifth study, an asthma educator guided patients and families through a computer program to provide tailored asthma education in the emergency department, as well as to give them a customized asthma action plan and educational summary to take home. This study demonstrated increased confidence in patients' ability to self-manage their asthma at a 14-day follow-up phone call.⁹

The remaining 2 pediatric studies targeted adolescents.^{6,10} The first showed that the use of a web-based asthma self-management and education program to monitor and transmit symptoms to a case manager through a secure website for feedback could decrease activity limitation, urgent calls and poor peak flow meter readings, and improve self-care behaviors.⁶ The second, an observational study followed by focus group sessions, used the Internet or short message service to record forced expiratory volume in 1 s (FEV1) and peak flow readings and then held focus groups to discuss barriers to asthma management. The authors concluded that Internet-based self-management programs should be directed toward adolescents with poor asthma control. Teenagers with good asthma control were not willing to use the program.¹⁰

Three studies were designed for adults.^{12–14} The first study was a prospective, observational study with low-income inner-city adults to test the validity and acceptance of an Internet-based system to self-assess patient spirometry in the home.¹² Although 71% of study participants reported no prior computer experience, the spirometry results were comparable to those obtained by medical professionals and the majority of patients were strongly interested in using the system. The authors concluded that this technology was feasible, provided useful information, and well received by this disadvantaged population.¹² In a randomized, prospective, parallel-group study of adult asthmatic patients assigned to receive either an Internet-based asthma management tool or a conventional asthma treatment, the former group demonstrated greater improvement in asthma symptoms, quality of life, lung function, and airway responsiveness.¹³ A third study provided

patients with a web-based asthma management system in which they also answered electronic diary questions, and gave healthcare providers access to these data.¹⁴ Patients and providers were interviewed regarding their use and perceptions of the system. Although both groups were happy with the system overall and patients reported that it helped them to manage their disease and doctors cited that it helped patients to control their asthma, both patients and doctors stopped using the system within a short period of time.¹⁴

Mobile Device-Based Interventions

Clinical investigators are harnessing the widespread use of mobile devices to develop device-based interventions to improve asthma outcomes. With about 262 million cell phone subscribers in the United States, almost every household has at least 1 cell phone.¹⁵ Moreover, there is no evidence of disparity in ownership. Use of cell phones is as popular with persons of lower as it is with persons of higher socioeconomic status.¹⁶

Seven mobile device-based studies were identified (Table 2).^{17–23} See Table 2 for a description of each study. One study involved children only, 3 involved both children and adults, and 3 involved adults only.^{17–23} The first study gave inner-city African American adolescents cell phone MP3 players with specially written software that required them to respond to electronic asthma diary queries before being able to listen to music tracks of their choice. The intervention group received celebrity recorded asthma messages and the attention control group received general health messages between MP3 music tracks. The study did improve asthma knowledge but did not increase adherence to asthma controller medications.¹⁷

Two prospective observational studies in children and adults both explored the use of mobile phones to collect diary data, including peak flows, and evaluate patient response rates. The first study reported a high response rate in 2/3 of users; in the second study, over half of participants responded to 2/3 of the diary requests.^{18,19} The third study in both children and adults interviewed participants after use of a mobile phone-based system in which they received disease management feedback in response to entry of peak flow and asthma symptom data. Participants felt that the system facilitated disease self-management, but that it was easy to become too dependent on the system.²⁰

All 3 studies in adults were randomized, controlled trials.^{21–23} The first study showed that using daily text message reminders via mobile phone demonstrated improved adherence to asthma controller medications.²¹ The second trial, in which the active treatment group used text messaging to send peak flow readings to an asthma specialist who could adjust treatment accordingly, demonstrated improved overall asthma control (including reduced peak flow variability, better symptom control, and improved FEV1 scores).²² The last study, comparing use of a mobile phone-based interactive self-management software to a written action plan, demonstrated that the treatment group had greater improvements in quality of life, appropriate medication usage, and pulmonary function measurements.²³

Ongoing Studies

A Google search for asthma self-management technology identified currently ongoing studies. Ryan and colleagues at

TABLE 2. ASTHMA MOBILE DEVICE-BASED STUDIES

Study (year)	Type	Population	Basic concept	Outcomes measured	Results	Comments
Mosnaim et al. (2008) ¹⁷	Randomized, behavioral-controlled trial 14 weeks	28 urban African American adolescents 10–18 years old (mean age 13.5 years) with asthma	Use of the cell phone network to send messages and collect asthma diary information; while both groups received new music tracks on their study cell phone MP3 players, the treatment group received celebrity-recorded asthma messages and the control group received general health messages in between music tracks flows	Self-reported adherence to asthma controller medications and asthma knowledge using ZAP Asthma Knowledge instrument	No improvement in adherence to asthma controller medications; greater improvement in ZAP score (asthma knowledge) in intervention group	Targeted a “difficult to reach” population
Ryan et al. (2005) ¹⁸	Prospective observational study 9 months	46 asthma patients age 12–55 years old (mean age not given) on inhaled steroids	Use of mobile phone to record peak flows	Patient adherence, use of a telephone helpline; patient satisfaction	High level of adherence in 2/3 of users; 69% were satisfied or very satisfied	
Anhøj and Moldrup (2004) ¹⁹	Prospective feasibility study 2 months	12 patients with asthma, age 13–57 years (median age 38.5 years)	Use SMS (texting) for asthma diary data collection (peak flow, data on sleep loss, medication reminder, and medication dosage) through mobile phones	Response rates—number of diary inputs/diary requests	Median response rate per patient of 0.69 (more than half reported about 2/3 of the requested data); overall enthusiastic but requested fewer messages	
Pinnock et al. (2007) ²⁰	Qualitative, observational study 4 weeks	48 participants, 34 adults and teenagers with asthma, 14 asthma nurses and doctors (mean age not provided)	Used initial focus groups and then interviews of a smaller group before and after exposure to mobile phone-based monitoring of peak flows and symptoms with immediate feedback regarding: control and reminder or appropriate actions	Patient and providers were questioned about their use of the intervention	Thought the technology could facilitate guided self-management but might lead to dependence on professional supervision and undue anxiety if the technology failed	
Strandbygaard et al. (2010) ²¹	Randomized, controlled trial 12 weeks	28 subjects, 18–45 years old (mean age 32.2 years) with clinical history of asthma and positive methacholine challenge	To incorporate daily text message reminder via cell phone to improve adherence versus a control group that did not receive reminders	Mean adherence rate to treatment, reimbursement of asthma medication, change in eNO level, lung function and airway responsiveness	Daily text messaging improved adherence but not other outcomes	Overall perception was favorable
Ostojic et al. (2005) ²²	Randomized, controlled trial 16 weeks	16 asthmatic patients, 18–31 years old (mean age 24.6 years) with moderate persistent asthma	Added use of SMS (texting) to send PFM readings to an asthma specialist who could adjust treatment compared to standard treatment with asthma education and self-management plans	Office PFT, daily PFM readings, daily symptoms, medication usage, demographic data	Asthma better controlled overall (reduced PEF variability, improved FEV1, better symptoms control)	Greater number of participants needed in study to reach 80% power
Liu et al. (2011) ²³	Randomized, controlled trial 6 months	89 patients, 48–56 years old (mean age 52.3 years) with moderate to severe persistent asthma	Use of a mobile phone-based interactive self-care software compared to written action plans	Asthma control (PEFR, reliever medication usage, daily asthma symptoms), QOL, acute exacerbation, medication usage, and PFT	Intervention group had greater pulmonary function improvement, better QOL, fewer exacerbations and unscheduled visits, improved medication usage	

BD, bronchodilator; PFT, pulmonary function testing; PEF, peak expiratory flow rate; PEFR, peak expiratory flow rate; eNO, exhaled nitric oxide; ZAP, asthma knowledge instrument.

TABLE 3. IPHONE/APPLE MOBILE OPERATING SYSTEM COMPATIBLE APPLICATIONS

<i>Application</i>	<i>Device</i>	<i>Details</i>	<i>Cost</i>
Asthma Journal Pro	iPhone, iPod touch, iPad; requires iOS 2.0 or later	Journal (symptoms, peak flow measurements, medication usage); news on asthma research, prevention, and treatment	\$4.99 on iTunes
Asthma-Charter	iPhone, iPod touch, iPad; requires iOS 3.0 or later	Peak flow and medication recording application; includes a doctor reporting feature	\$0.99 on iTunes
iAsthma in Control	iPhone, iPod touch, iPad; requires iOS 4.0 or later	Includes asthma medication usage, peak flow record, school and sports forms, action plan and emergency contacts; targeting children	\$0.99 on iTunes
AsthmaMD	iPhone, iPod touch, iPad; requires iOS 3.0 or later	Asthma journal (tracks medications, peak flows and triggers), can manage multiple users, creates color graphs	Free on iTunes
AsthmaPulse	iPhone, iPod touch, iPad; requires iOS 4.2 or later	Track symptoms, peak flows, triggers and medications; browse asthma related news; personalized action plans	\$3.99 on iTunes
Asthma Tracker	iPhone, iPod touch, iPad; requires iOS 3.0 or later	Track peak flow, inhaler use, FEV1, and zone; graph data	Free on iTunes
AsthmaCheck	iPhone, iPod touch, iPad; requires iOS 3.0 or later	Track peak flow and medications; push notifications; smoking and sport tracking; e-mail transfer available	Free on iTunes
Inhaler Tracker	iPhone, iPod touch, iPad; requires iOS 2.2.1 or later	Tracks how many puffs of inhaler have been used and how many are left	\$0.99 on iTunes
Asthma Tester	iPhone, iPod touch, iPad; requires iOS 4.0 or later	Monitors asthma control	Free on iTunes
Asthma-Charter MMC	iPhone, iPod touch, iPad; requires iOS 3.1.2 or later	Peak flow and medication recording application; includes a doctor reporting feature	\$0.99 on iTunes
iAsthma GPS Tracker HD (Lite version available)	iPhone, iPod touch, iPad; requires iOS 3.0 or later	Record location of asthma attacks, temperature, time of year and other info	\$0.99 on iTunes (Lite version free)
asthmaTrack	iPhone, iPod touch, iPad; requires iOS 2.0 or later	Tracks symptoms, treatments, vital signs, and environmental conditions; can e-mail for printing	\$1.99 on iTunes
SmartinhalerLive	iPhone, iPod touch, iPad; requires iOS 4.2 or later	Stores and presents medication usage and peak flows that are manually entered thru website or use of a or digital peak flow meter	Free on iTunes

Includes English apps only.

Excludes informational-only apps.

iOS, iPhone/Apple Mobile Operating System.

the University of Aberdeen are testing whether a mobile phone-based intervention, through engaging the patient in self-monitoring with timely biofeedback, can improve asthma control compared to standard paper-based monitoring.²⁴ Seid and colleagues at Cincinnati Children's Hospital Medical Center are running a 14-month clinical trial developing and beta-testing whether a mobile phone-based platform can improve motivation and problem-solving skills in adolescents with moderate to severe asthma.²⁵ A platform called Self-Management Technology for Asthmatic Teens is using video, web, and mobile phone-based components, including e-mail, text messaging, and instant messaging, to provide adolescents with knowledge and skills to improve their asthma self-management skills.²⁶ Mosnaim and colleagues at Rush Medical College are building on their MP3-player-based intervention to improve adherence to daily asthma

controller medications by bringing participants together once a week in groups, which provide support and the opportunity to record asthma messages to each other. These messages are played between music tracks of their choice on MP3 players and make them accessible during the course of their daily routine.²⁷

Currently Available Applications

Mobile apps are application software developed for use on mobile/handheld devices such as personal digital assistants, tablets, or mobile phones. A search of iPhone and iPad applications on iTunes²⁸ revealed 13 currently available iPhone/Apple Mobile Operating System-based applications to help with asthma self-management (Table 3). A similar search found 5 available Android-based applications

TABLE 4. ANDROID-BASED APPLICATIONS

<i>Application</i>	<i>Device</i>	<i>Details</i>	<i>Cost</i>
Asthma Tracker and Log	Android 2.1 and up	Tracks symptoms, triggers and peak flow readings	Free on Android Market; Ad free version \$0.99
AsthmaCheck	Android 2.1 and up	Track peak flow and medications; push notifications; smoking and sport tracking; e-mail transfer available	Free on Android Market
Asthma Journal	Android 1.5 and up	Track symptoms, triggers and medications daily	\$4.99 on Android Market
Peakflow	Android 1.6 and up	Track peakflows	Free on Android Market
AsthmaTracker Pro	Android 1.5 and up	Track asthma triggers	\$2.99 on Android Market

Includes English apps only.

Excludes informational-only apps.

(Table 4).²⁹ Only 1 BlackBerry application, Asthma Tracker, was found on BlackBerry App World.³⁰ While most of the previously published studies used web-based management plans, technology is moving toward more mobile-based applications. Future studies need to address this newer software.

Social Networking Sites

A social-networking service is an online service, platform, or site that focuses on building and reflecting social relations among people who share interests and/or activities. Most are web-based and allow users to interact over the Internet and with mobile devices.³¹ A 2011 survey by the Pew Internet & American Life Project reported that 46% of American adults say that they use at least 1 social-networking site.³² The top 5 social network sites, as of November 2011, which made up over 82% of the market, were Facebook.com, Twitter.com, LinkedIn.com, Google Plus, and MySpace.³³

Social networks are beginning to be adopted by health-care providers. A study jointly conducted by QuantiaMD, Frost & Sullivan, and the Institute for Health Technology Transformation reported that nearly 90% of physicians use at least 1 site for personal use, and over 65% for professional purposes.³⁴ In general, physicians use social media to seek out clinical information and opinions and discuss medical points of view with other doctors; to increase their professional exposure among colleagues and the general community; and for purely social reasons—to stay in touch with family and friends.³⁵ Social media is making it easier for physicians and patients to connect outside of the examination room. About 20 percent of patients already use social media to glean healthcare information, according to an April 2011 survey by the National Research Corporation. Top sites used by patients include Facebook, YouTube, MySpace, and FourSquare.³⁶ Clinicians see the potential in online interactions with patients to improve access to and quality of care, but barriers to adoption include concerns around patient privacy, provider liability, and mechanisms of compensation for such activities.³⁴

There have been no clinical trials using social media in asthma management to our knowledge. A recently published article studied preferences of asthma patients to use of social media, text messaging, and e-mail.³⁷ Asthma patients between 12 and 40 years of age were asked to

quantify their usage of text messaging, Facebook, Twitter, MySpace, e-mail, and Internet. They were then asked about their interest in receiving information on asthma control and on communicating with their healthcare provider, through each of these technologies. Text messaging (82.5%), e-mail (77.3%), and Facebook (64.8%) were used at least once a week by the majority of participants. About 58.9% showed interest in receiving asthma information through e-mail with text messaging (34.1%) and Facebook (23.2%) showing less interest. E-mail was also the preferred method in communicating with their doctor (63.3%), followed by text messaging (33.8%) and Facebook (22.3%). When asked what type of information they would like to receive, air quality alerts (ozone alerts and pollen counts) and basic asthma information (symptoms, causes, triggers, and management tips) topped the list. Patient concerns included privacy and preferences for using these sites for social reasons rather their healthcare.³⁷ Future studies are needed to see if the use of social media can improve asthma outcomes.

Discussion

In summary, a review of published clinical trials and other studies using the Internet and mobile devices to promote asthma education and improve asthma outcomes reveals innovation and promise. The pioneers of these interventions creatively leverage technologies that are already a part of our daily lives to actively engage participants in decision-making to improve health. However, despite the appeal of technology-based asthma interventions, most of these studies are still in the early pilot stages with small sample sizes and mixed results. There were no studies found using currently commercially available asthma mobile device applications or social networking health sites.

In general, studies revealed that the technology was well received.^{5,12,8,14,19,21} Interactive asthma technology may be especially helpful in reaching populations previously considered to be difficult to reach, such as inner city populations^{17,6,12} and those with more severe or poorly controlled asthma.^{10,22,23} Patients with well-controlled asthma were less likely to use the technology.¹⁰ Most studies were short-term and those that lasted longer tended to show a decline in use over time.^{14,19}

Investigators providing participants (particularly adolescents) with mobile phones with unlimited Internet

access, as well as talking and texting features, face unique ethical challenges. Researchers struggle with whether they are responsible for monitoring all or only intervention-related web and talking/texting activity. For example, adolescents may use the mobile phones to visit websites that may expose them to topics not suitable for children. If participants know that all of their activities are being monitored, they may not want to use the study device. One approach to addressing this concern may be to incorporate language in the consent form explaining to adolescents and parents that (1) use of these features is a potential risk to participating in the study; (2) they can choose to allow the study team to set limits on Internet access; and (3) they are encouraged to take an active role and regularly monitor their child's mobile phone use.

It is controversial whether or not these information technologies will assist persons to self-manage their asthma or completely take overall decision making. If the latter occurs, participants may not be able to maintain improvements in asthma self-management skills acquired during the intervention once the study is over. Too much dependency may result in panic if there is device malfunction.

Studies relying exclusively on information technology to deliver the intervention may need additional components to maximize effectiveness. A promising approach may be to combine the use of information technology with coping peer support. In one study of urban African American adolescents, an MP3 technology-based platform alone improved asthma knowledge but not adherence to daily controller medications.¹⁷ An ongoing follow up study which combines coping peer support groups with the use of the MP3 players hopes to achieve both improved asthma knowledge and adherence to daily inhaled steroid medications.²⁷

Innovation in asthma information technology-based interventions requires a multidisciplinary approach among asthma doctors, behavior change specialists, health communication experts, and computer science sophistication.

The enthusiasm for using information technologies to promote asthma control must be supported by randomized trials to determine efficacy and cost effectiveness. Randomized, controlled trials with larger and more diverse sample sizes, objectively measured medical and behavioral outcomes, long-term follow-ups, evaluation of cost effectiveness, and assessment of the technical feasibility are undoubtedly in the near future. The results of such studies are urgently needed. The ease with which these technologies fit into our daily lives, and the importance of ongoing patient management of chronic diseases suggest that these creative and innovative approaches could prove to be a valuable adjunct to effective clinical practice.

Author Disclosure Statement

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