Clinical Pharmacy and the Impact of Providing Smartphones to Patients to Manage Chronic Diseases: A Systematic Review

Natalie Weltman, Mehdi Namil, Jason Trinh, Annesha White, Katrina Dsouza, Stephanie Jacob, Cassidy Loving, Chloe Dang, Pamela Carter
University of North Texas Health Science Center, System College of Pharmacy, 3500 Camp Bowie Blvd, Fort Worth, Texas-76107

BACKGROUND

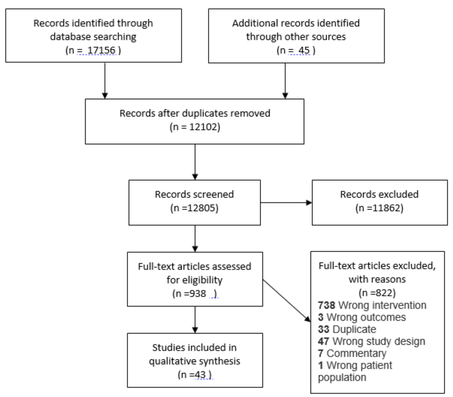
- Approximately 60% of Americans own a smartphone and 15% prefer using it to go online.
- Imperative to find solutions to combat growing healthcare expenditures and increased life expectancy
- An entire continuum of healthcare needs, such as chronic disease management, can be addressed via smartphones and mobile health devices. Integration of this type of technology improves quality of care while reducing costs.

OBJECTIVE

The objective of this study was to explore literature from the last decade to identify examples of patient use of of smartphones to improve health outcomes.

METHODS

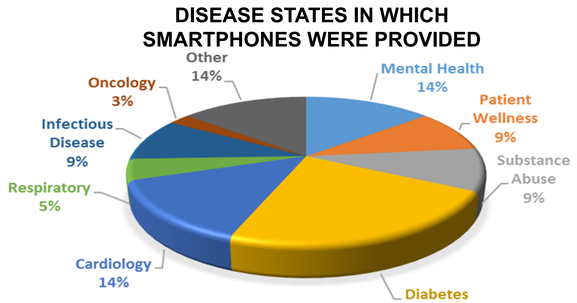
- A systematic review was conducted using Pubmed, Medline, Cinahl Plus, Cochrane Library, Scopus, Trip and PsychInfo to identify studies between 2005-2015.
- Key search terms included “mhealth”, “telehealth”, “smartphone”, “mobile applications”, “cost savings”, and “patient health outcomes”.
- Abstracts were screened against inclusion criteria and selected based upon relevance and quality.
- The most significant eligibility criteria required was that a smartphone must have been provided to the patient.
- Risk of bias was assessed using the Cochrane Risk of Bias Tool. Use of Covidence facilitated the summary of selected articles.



RESULTS

Studies	Health Topic	Type of Smartphone Provided	Purpose of Study	Sample Characteristics	Intervention Components	Results (Primary Endpoint only)
Alessi 2013	Alcohol Recovery	Motorola	To assess the efficacy of cell phone based contingency maintenance for drinking, which was further assessed by proportion of negative breath tests	N=30	Reminder texts sent to participants 1-3 times daily to indicate a breath test (BrAC) video was due within the hour. If the video was not received within 30 minutes, a reminder text repeated the deadline. Prompts occurred 8 am to 11 pm, but were clustered during evenings and weekends. Each video was reviewed for quality and a thank you text was sent communicating earnings. Compensation for adherence was $1 per valid on-time video.	Contingency management participants submitted a higher percent of negative breath test (87.1% vs. 66.9%; P=0.00) and achieved a longer duration of negative BrAC days than the control group
Carter 2013	Weight loss	HTC Desire with MMM (My Meal Mate) app pre-downloaded	To collect acceptability and feasibility outcomes of self-monitoring weight management intervention delivered by smartphone app compared to a website and paper diary.	N = 128	Weight Management intervention delivered by smartphone application, website, or paper diary	Adherence was statistically significantly higher in the smartphone group with a mean of 92 days (SD 67) of dietary recording compared with 35 days (SD 44) in the website group and 29 days (SD 39) in the diary group (P < 0.001). Mean weight change at 6 months was -4.6 kg in the smartphone app group, -2.9 kg in the diary group, and -1.3 kg in the wbsite group. BMI change at 6 months was -1.6 kg/m^2 in the smartphone group, -1.0 kg/m^2 in the diary group, and -0.5 kg/m^2 in the website group. Change in body fat was -1.3% in the smartphone group, -0.9% in the diary group, and -0.5% in the website group.
Charpentier 2011	Type 1 Diabetes	Smartphone loaded with Diabeo software	To demonstrate that Diabeo software enabling individualized insulin dose adjustments combined with telemedicine support significantly improved A1c in poorly controlled T1DM patients.	N=173	Adult patients with T1DM (>1 year) on a basal-bolus insulin regimen (6 months), with HgA1c >8%, were randomized to usual quarterly follow-up (G1), home use of a smartphone recommending insulin doses with quarterly visits (G2), or use of the smartphone with short teleconsultations every 2 weeks with no visit until endpoint (G3).	Six month mean HbA1c in G3 was lower than in G1 (8.41 ± 1.04% vs. 9.10 ± 1.16%; P = 0.0019). G2 displayed intermediate results (8.63 ± 1.07%). The Diabeo system gave a 0.91% (0.60; 1.21) improvement in HbA1c over controls and a 0.67% (0.35; 0.99) reduction when used without teleconsultation.
Fukuoka 2015	Diabetes prevention	iPhone	To assist adults to achieve moderate weight reduction over a 5 month study period to prevent or delay onset of type 2 diabetes	N = 61	Intervention lasted 5 months and consisted of 2 delivery modes: in person and through mobile app. Two trained non-medical research staff members delivered core curriculum consisting of 6 in-person sessions at randomization and at 0.5, 1, 2, 3, and 4 month visits. The application supplemented the in-person sessions and included electronic diaries for self-monitoring of weight, activity, and caloric intake with daily reminders to enter this information. The mobile application also delivered interactive intervention content through daily messages, video clips, and quizzes.	Primary outcomes were percentage change in weight and BMI from baseline to 5 month follow up. The change in percentage weight from baseline to 5 months were as follows: control: 0.3 +/- 3.0 and intervention: -6.8+/-5.4, p<0.001. The change in percentage BMI from baseline to 5 months were as follows: control: 0.3+/-3.0 and intervention: -6.6+/-5.7, p<0.001.
Kristoffer 2015	Inflammatory Bowel Disease	Samsung	To evaluate CalproSmart, a new rapid test for fecal calprotectin performed by patients themselves at home, and compare it to gold standard ELISA	N = 221	The CalproSmart test involves extraction of feces, application to the lateral flow device, and taking a picture with a smartphone after 10 minutes of incubation. Results appear on the screen within seconds. Patients were instructed at inclusion and had a video guide of the procedure as support. When using CalproSmart at home, patients also sent in 2 fecal samples to be analyzed by ELISA.	A total of 894 fecal calprotectin results were obtained by ELISA, and 632 of them from CalproSmart. The correlation coefficient was 0.685, higher for academics than nonacademics (0.768 versus 0.637; P % 0.0037). The intra-assay and interassay coefficients of variation of the CalproSmart test were 4.42% and 12.49%, respectively. The sensitivity, specificity, positive predictive value, and negative predictive value were 82%, 85%, 47%, and 97%, respectively, with an optimal cutoff at 150 mcg/g.
Quinn 2008	Diabetes	Nokia 6682 and 6680	To assess the usability and impact of a remote BG monitoring system on patient A1c outcomes and HCP prescribing behaviors	N = 30	Test the Well Doc Software's ability to teach patients about dietary impacts on BG levels, to direct patients to generate higher-quality blood glucose data, and to determine the effect of provided patient BG data, data analysis, and suggested therapy recommendations on HCP prescribing behavior	Patients in intervention group (using the WellDoc software) had an average decrease in A1c of 2.03%, compared to 0.68% (P =0.02, one-tailed) for control patients. Patients in the intervention group were more likely to have physicians intensify diabetes medications (84.6% vs. 23.25, P 0.002) and have medication errors identified (53.4% vs. 0%, P= 0.002). Diabetes Management improved in the intervention group in three domains (diet, medication, and exercise) compared to patients receiving their usual diabetes care. Patients using the WellDoc were more likely to report being able to better control their diabetes based on their knowledge of food choices (91% vs. 50%), confidence (100% vs. 75%), and provider receiving regular blood sugars (100% vs. 36%).
Seto 2012	Heart Failure	Blackberry pearl 8130	To obtain an understanding of the effects of the mobile phone-based telemonitoring system on self-care and clinical management. In addition, the analysis provides insight into the characteristics of a successful telemonitoring solution	N = 94	The participants were provided with the telemonitoring system, in addition to standard care. They were asked to use the telemonitoring system to take daily morning weight and blood pressure readings, and to answer daily morning symptoms questions on a mobile phone for 6 months. A custom-designed application on the mobile phone was used to display, store, and transmit the information to the data repository at the hospital. Standard care included visits to the clinic from once every 2 weeks to once every 3-6 months and heart failure education during preliminary visits at the Heart Function Clinic.	The clinicians thought the telemonitoring system provided comprehensive information to support clinical decision-making. Patients completed their required weight and blood pressure measurements on average between 5 to 6 days per week throughout the six month trial. The most common clinical action was an instruction or change in medication from a cardiologist. The quality of life as measured with MLHFQ significantly improved only for the telemonitoring group (P = 0.02), including the physical (P = 0.02) and emotional dimensions (P = 0.03). Patients' perception of intervention was that it improved their self-care management, increased empowerment, increased reassurance.

	Sequence Generation	Allocation Concealment	Blinding of Participants, personnel and outcome assessors	Incomplete Outcome Data	Selective Outcome Reporting	Other Source of Bias
Alessi 2013	+	+	+	+	?	?
Carter 2013	+	?	+	+	+	+
Charpentier 2011	+	?	?	?	?	?
Fukuoka 2015	+	+	?	?	+	+
Kristoffer 2015	+	+	?	+	+	+
Quinn 2008	?	?	-	?	?	?
Seto 2012	+	?	?	+	?	+



- The search study yielded a total of 20 articles for review.
- Seven out of the ten studies related to disease and health management showed improvement in clinical outcomes
- Studies in which smartphones were provided to remotely monitor patient data had the most impact in reducing hospitalization and emergency room visits
- No studies examined costs associated with providing smartphones to patients
- All studies pointed toward an improvement in health outcomes

CONCLUSION

- As smartphones are becoming a central part of our daily lives, we are searching for new ways to incorporate them into the patient care process.
- While smartphone use is growing, almost half of smartphone users had to cancel their cell phone service for a period due to financial hardship.
- The purchase of smartphones by health plans may mitigate these issues while improving health outcomes.
- Providing smartphones to patients can improve disease state management and lower overall healthcare costs in clinical pharmacy settings. Several studies point toward decreases in readmissions, but more research is needed to explore the associated benefits and costs.

UNT Health Science Center