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Contents

Abstracts

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Abstract

Telemedicine Tools for Patients and Providers: Systematic Review

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Abstract

Background: From the 1991 Institute of Medicine (IOM) Landmark Report, The Computer Based Patient Record: An Essential Technology for Health Care (Dick, Steen, & Detmer, 1997) which called for computer based patient records, to the 2009 Health Information Technology for Economic and Clinical Health (HITECH) Act, health care has been integrating technology into our delivery systems and transforming the landscape of health care delivery (Wager, Lee, & Glaser, 2017). Telemedicine (also called telemonitoring, telehealth, remote monitoring, eHealth) has brought about new methods of care delivery. These methods will hopefully demonstrate cost effective outcomes as well as new levels of quality. Under the influence of The Centers for Medicare and Medicaid Services, The 2015 Medicare Access and CHIP Reauthorization Act (MACRA) was enacted which pushes the health care industry to improve quality and value. By the end of 2018, it is expected that 50% of alternative payment models will have quality and value tied to them and 90% of fee-for-service will do the same. It is feasible that telehealth could be the link to new health care delivery and payment models. This paper evaluates some of the most recent literature regarding telemedicine to elucidate quality within the domains of cost-effectiveness, hospitalization, mortality, patient adherence, and patient satisfaction.

Objective: To evaluate the effectiveness of telemedicine strategies with respect to cost-effectiveness of care, hospitalizations, mortality, patient adherence, and satisfaction.

Methods: The Google Scholar search engine was used to find articles published between 2015 and 2018 so that preliminary observations could be made regarding the telemedicine literature. Once this was done, a logical search process was used to locate articles using two research databases: Cumulative Index to Nursing and Allied Health Literature (CINAHL) and PubMed (MEDLINE). The titles and abstracts of the records identified were independently screened by four investigators. Five reviewers screened 58 abstracts to determine relevance and significance relative to the research objectives. The final group analysis was 29 articles. Main outcome measures included economic, clinical, and satisfaction outcomes.

Results: Our results showed that examining telemedicine interventions that were either patient or provider driven appeared to improve outcomes related to patient adherence, patient satisfaction, cost-effectiveness, and had a favorable effect in terms of decreasing hospitalizations. Only two articles that were reviewed addressed mortality, so the investigators could not describe results on its effect. Although there are barriers to adherence there is much progress in the field of telemedicine that aids in outcomes, both positive and negative.

Conclusions: The literature is clear that telemedicine is linked to improved outcomes when applied with a sound strategic plan. Patients who adhere to telemedicine interventions appear to show significantly better satisfaction, quality of life, reduced hospitalizations, and related health care costs. When providers take greater responsibility and initiative with telemedicine interventions, this contributes to those patient outcomes. Our review of the literature suggests that the quality of the implementation strategy was linked with better outcomes. Telemedicine appears to hold promise as a cost effective, convenient tool for both patients and providers.

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KEYWORDS

telemedicine; chronic disease; evidenced-based; reimbursement

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Abstract

Measuring Patient Acceptance and Use of a Personal Health Network Application for Chemotherapy Care Coordination

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Abstract

Background: Cancer is a top concern in the United States and globally. Cancer care suffers from lack of coordination, silos of information, and high cost. Interest is emerging in developing formalized coordination mechanisms to address these challenges. Person-centered technology can improve coordination, thereby improving the lives and health of individuals with cancer. However, few examples of patient engagement in technology-enabled care coordination exist and we lack tools to measure engagement or adoption.

Objective: The "personal health network" (PHN) developed by the authors fills this gap: a personalized social network built around a patient for collaboration with clinicians, care team members, carers, and others designated by a patient, to enable patient-centered health and health care activities across a relevant community. The PHN is a mobile, social application that integrates person-generated data related to clinical concerns, symptom assessment, a shared care plan, secure messaging, and educational materials for individuals undergoing chemotherapy. The purpose of this study is to understand patients' acceptance and use of the PHN.

Methods: The PHN was implemented in a two arm (n=60), randomized, pragmatic trial of a 6-month-long care coordination intervention at a cancer center. The intervention arm received nurse care coordination plus the PHN on a tablet and a data plan. Technology acceptance was measured with a new Health Technology Acceptance and Use (HTAU) tool validated in an oncology population by one of the authors (KK). HTAU include 8 constructs (33 items): performance expectancy (8 items), effort expectancy (4), social influence (5), facilitating conditions (4), hedonic motivation (3), price-value (3), habit (3), and behavioral intention (3). Each construct score is the mean of the items within it, all rated from 0=not at all to 6=a great deal. HTAU was collected at 3 months and 6 months. We report on 3-month results.

Results: HTAU at 3 months (n=33 intervention group, 94% response) shows high reliability, and Cronbach alpha is 0.96. The mean total score is 123.72 out of 198 (SD 40.60). The highest scored constructs are facilitating conditions (mean 4.48, SD 0.12), price-value (mean 4.40, SD 0.12), and effort expectancy (mean 3.86, SD 0.11) The lowest scored is habit (mean 2.37, SD 0.08) Other scores are moderate: performance expectancy (mean 3.10, SD 0.40), social influence (mean 3.13, SD 0.10), hedonic motivation (mean 3.30, SD 0.30), and behavioral intention (mean 3.41, SD 0.23).

Conclusions: Person-generated data and access to clinical data for patients has potential for improving cancer care coordination. Technologies to support this purpose must be accepted by patients. An in-depth understanding of technology adoption requires rigorous evaluation of the usability and usefulness constructs that underly it. Using HTAU we found that PHN usability was high, usefulness was moderate, and habit formation was low. Further evaluation of final results and interviews will help elucidate which constructs were meaningful, how they relate to outcomes, and suggest where future effort should be focused to improve adoption. This study contributes to person-centered design of technology-enabled care coordination interventions.

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KEYWORDS

cancer; mobile health; mHealth; Technology Acceptance Model; care coordination

Multimedia Appendix 1

Full poster.

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Abstract

Patient-Generated Health Data Quality for Clinical Use: Human and Technology Factors

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Abstract

Background: The proliferation of advanced wearable medical technologies is increasing the production of Patient-Generated Health Data (PGHD). However, there is lack of evidence on whether the quality of the data generated from wearables can be effectively used for patient care. In order for PGHD to be utilized for decision making by health providers, it needs to be of high quality, that is, it must comply with standards defined by health care organizations and be accurate, consistent, complete and unbiased. Although medical wearables record highly accurate data, there are other technology issues as well as human factors that affect PGHD quality when it is collected and shared under patients' control to ultimately used by health care providers.

Objective: This paper explores human factors and technology factors that impact on the quality of PGHD from medical wearables for effective use in clinical care.

Methods: We conducted semi-structured interviews with 17 PGHD stakeholders in Australia, the US, and the UK. Participants include ten health care providers working with PGHD from medical wearables in diabetes, sleep disorders, and heart arrhythmia, five health IT managers, and two executives. The participants were interviewed about seven data quality dimensions including accuracy, accessibility, coherence, institutional environment, interpretability, relevancy, and timeliness. Open coding of the interview data identified several technology and human issues related to the data quality dimensions regarding the clinical use of PGHD.

Results: The overarching technology issues mentioned by participants include lack of advanced functionalities such as real-time alerts for patients as well as complicated settings which can result in errors. In terms of PGHD coherence, different wearables have different data capture mechanisms for the same health condition that create different formats which result in difficult PGHD interpretation and comparison. Another technology issue that is relevant to the current ICT infrastructure of the health care settings is lack of possibility in real-time PGHD access by health care providers which reduce the value of PGHD use. Besides, health care providers addressed a challenge on where PGHD is stored and who truthfully owns the data that affect the feasibility of PGHD access. The human factors included a lack of digital health literacy among patients which shape both the patients' motivation and their behaviors toward PGHD collection. For example, the gaps in data recording shown in the results indicate the wearable was not used for a time duration. Participants also identified the cost of devices as a barrier to the long-term engagement and use of wearables.

Conclusions: Using PGHD garnered from medical wearables is problematic in clinical contexts due to low-quality data influenced by technology and human factors. At present, no guidelines have been defined to assess PGHD quality. Hence, there is a need for new solutions to overcome the existing technology and human-related barriers to enhance PGHD quality.

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KEYWORDS

clinical practice; data quality; patient-generated health data

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Multimedia Appendix 1

Full poster.

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Abstract

Digital Solutions for Cancer Survivorship Care

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Abstract

Background: Both the National Cancer Institute (NCI) and Institute of Medicine have stressed the importance of survivorship care plans (SCP) for cancer patients/survivors and discussed the significance and importance of required input from survivors and advocates. However, there are many barriers to cancer care coordination and the creation of SCPs, including oncology staff time required to write them. Although survivors valued SCPs and liked them, few survivors or caregivers report receiving survivorship information and in some studies, reported no receipt of an SCP. Digital platforms can support cancer survivorship care by integrating with the existing Electronic Health Record and presenting information in a dynamic and user-friendly format that improves coordination and communication.

Objective: In this paper, we describe our involvement of stakeholders, including medical staff, patients/survivors and informal caregivers in developing a user-centered design for TOGETHERCARE, a smartphone app envisioned to provide critical functionality including planning and sharing of the SCP among survivors, physicians, and informal caregivers.

Methods: Two interviewers conducted a total of nine semi-structured interviews, including a convenience sample of three health care providers who work with cancer patients, three cancer patients/survivors, and three informal caregivers currently caring for cancer patients/survivors. The interviews with Spanish-speaking patients/survivors and caregivers were conducted with a translator. Notes from the interviews were transcribed into a prepared template. The results were compiled and coded by two members of the core team.

Results: We identified areas of consistency in responses between the three different groups in terms of how the application should work, as well as areas of difference. Additional suggestions for features for the application are also presented. Health care providers focused on the efficiency of using the application, features that would improve follow-up visits with patients and reduce the nursing triage, ER visits and readmissions. Survivors and caregivers were more focused on features that would provide assistance with patient appointment schedules, at-home medical tasks and activities of daily living. Although all three groups agreed that there is currently no systematic way for specialists to keep in touch with patients once they have moved to community care, and that SCPs would be useful, the practice of providing SCPs is rarely implemented. Survivors, caregivers, and providers all agreed that they have smartphones and that an app that includes the ability to communicate between the different groups, along with other features such as guidance on assisting with daily medical tasks and activities of daily living would be useful.

Conclusions: The pervasiveness of mobile devices and mobile app use provides an opportunity to make survivorship information and plans more readily available to caregivers and survivors, and to incorporate patient outcome reporting. Health care providers, cancer survivors, and informal caregivers all responded positively to a variety of features that could improve the efficiency of cancer care coordination and dynamic SCP provision.

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KEYWORDS

access to information; ambulatory care information systems; computer, handheld; medical records systems, computerized

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Abstract

Maximizing Potentially Avoidable Hospitalizations and Cost Savings Beyond Targeting the Most Costly Patients

Mariana Simons[1], PhD; Sara Golas[2], PhD; Stephen Agboola[2], MPH, MD; Jorn op den Buijs[1], PhD; Jennifer Felsted[2], PhD; Nils Fischer[2], MPH; Allison Orenstein[3], MPH

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Abstract

Background: Many health care organizations use value-based care strategies that include population health management programs and data analytics to stratify their population and identify high-risk and high-cost patients. Most of these programs target the top 5% most expensive patients. However, little is known about these patients prior to reaching the top 5% of cost, or how their characteristics change over time. To address these gaps, we analyzed the differences in characteristics of patients from 3 different cost segments over 5 years (2011-2015).

Objective: To evaluate potentially avoidable hospitalizations and associated savings in the health care cost of older patients using Personal Emergency Response Service (PERS).

Methods: We conducted a retrospective, longitudinal, multicenter study to evaluate potentially avoidable hospitalizations of 2643 older patients over 5 years (2011-2015). All patients had at least one inpatient and/or outpatient encounter, and at least one episode of home health care during the study period. Additionally, all patients used PERS at home anytime during the study period. We ranked patients by their annual health care cost and then grouped them into the following segments for each respective year: T-segment constitutes the top 5% most expensive patients; M-segment comprises the middle 45% of patients; B-segment includes the bottom 50% least expensive patients. We then evaluated differences in the characteristics of patients in the B-, M- and T-cost segments in each study year. Continuous variables were compared by *t* test (two-tailed) for normally distributed variables and Kruskal-Wallis Rank Sum test for skewed variables. The chi-square test was used for categorical variables.

Results: The three cost segments differed significantly each year ($P<.05$) with respect to: demographics (age, education), PERS utilization (Incidents, ER transport), health care utilization (hospitalizations, length of stay, 30-, 90-, and 180-day readmissions, outpatient encounters) and medical conditions (number of conditions, Charlson Comorbidity Index). Further, we analyzed the number of potentially avoidable hospitalizations (as defined by CMS) and associated cost savings in each segment. All hospitalizations occurred among patients in the T- and M-segments while the B-segment was hospitalization-free each year. The percentage of avoidable hospitalizations in the M-segment compared with the T-segment was 3 times greater (75% vs 25%, $P<.001$). While the potential cost saving from avoidable hospitalizations in the entire population increased from $3.0M to $8.2M (2011-2015), the majority of these cost savings were in the M-segment compared with the T-segment (60% vs 40%, $P<.001$).

Conclusions: Although many health care organizations target intensive and costly interventions to their most expensive patients, this analysis suggests there is untapped potential to control costs and improve care beyond focusing on the highest cost patients. Namely, targeting patients in the middle cost segment may offer great opportunity for population management programs to maximize both potentially avoidable hospitalizations and cost savings.

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KEYWORDS

patient segmentation; avoidable hospitalizations; healthcare cost analysis

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Abstract

Zindagi Mehfooz (Safe Life) Digital Immunization Registry: Leveraging Low-Cost Technology to Improve Immunization Coverage and Timeliness in Pakistan

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Abstract

Background: Despite free access to vaccines through the Expanded Program on Immunization (EPI) in Pakistan, only 54% of children receive all basic vaccinations. The global success of mobile health (mHealth) technologies, particularly, Digital immunization registries (DIRs), offers immense potential for comprehensive improvement in immunization programs. In 2012, we developed and piloted Zindagi Mehfooz (Safe Life; ZM) Digital Immunization Registry, an Android phone-based platform that enables vaccinators to digitally enroll and track the immunization status of their catchment population while allowing real-time access to data and easy generation of monitoring reports. Leveraging cutting edge mHealth technology, ZM includes features such as identification through quick response barcodes, interactive SMS reminders, decision support systems for routine/catch-up immunizations, real-time workforce tracking, predictive analytics for identifying high-risk children and customized report generation for monitoring. In 2017, ZM was scaled up, in collaboration with EPI, across the entire Sindh province and is currently being used by 1589 government vaccinators in 1296 basic health facilities.

Objective: We evaluated the ZM Registry in terms of improvement in immunization coverage and timeliness. The primary outcome of interest was fully immunized child (FIC) coverage in children under 2 years of age, ie, a child who has received one dose of Bacillus-Calmette-Guérin (BCG), three doses each of OPV and Pentavalent immunizations, and one dose of Measles vaccine. The secondary outcomes of interest included the Pentavalent-3 coverage rate and dropout rate between BCG and Measles-1 vaccine.

Methods: The provincial scale-up commenced in October 2017, and as of July 2018, over 700,000 children between 0-2 years have been enrolled in the Registry. At enrollment, the caretaker's information, child's bio-data, and immunization history are recorded and a unique Quick Response (QR)-code sticker is provided for identification. For the follow-up immunization visits, 3 SMS reminders are sent to parents for each vaccination. At the follow-up immunization, the child's history is retrieved on the phone by scanning the QR-code, and the vaccination record is updated accordingly. Data exported from the ZM DIR records was used to calculate the coverage rate for children enrolled in the Registry and the outcomes were compared with the coverage estimates from the most recent demographic survey (MICS 2014) to determine the impact of the Registry.

Results: Full immunization coverage of children (12-23 months) increased significantly from 35% as reported in MICS 2014 to 45% for children enrolled in ZM. Pentavalent-3 coverage of children enrolled in the Registry showed a 7% increase (from 53% reported in MICS 2014 data to 60% for children enrolled in the Registry). The dropout rate from BCG to Measles 1 vaccine was 24% as per the MICS 2014 figures and only 4% for children enrolled in the Registry.

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Conclusions: ZM demonstrates the potential of DIRs to improve immunization outcomes within low-resource settings by enabling better child tracking, efficient data monitoring and most importantly a higher retention rate for completing all the recommended immunizations. The evidence base generated through the evolution of ZM over the years has also facilitated global replication and can be leveraged to achieve universal immunization coverage in underserved regions.

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KEYWORDS

immunization; mobile health; digital immunization registry

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Abstract

Cloud-Based Implementation of New Frontline Clinical Workflows: Standardizing Practice at Scale to Improve Patient Safety

Jennie Yoo[1], MD; Mary Han[1], MD; Gemma Jamena[2], MD; Phyllis Pei[2], RN; Hillary Baldocchi[2], PhD; Emilie Menard[3], NP; Shelley Diane[3], RN; Peter Oishi[4], MD; Tam Nguyen[2], PhD

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Abstract

Background: Implementation of new practices in large health care settings is difficult. Staff are already overwhelmed, and practice deviation is common. With time-constrained visits, providers struggle to address complex problems. Three scenarios were identified where frontline practice standardization would improve patient outcomes: sedation and analgesia for intubated patients (inpatient), colorectal cancer screenings (outpatient), and safety measures for opioid prescriptions (outpatient). We implemented these practices through a cloud-based solution designed for frontline health care staff, fostering peer-accountability and transparency of processes.

Objective: 1) Introduce a standard approach to sedation and analgesia for intubated patients. 2) Increase colorectal cancer screenings for the clinic population. 3) Improve opioid safety for patients with chronic opioid use.

Methods: Practices were implemented through a cloud-based app (Elemeno Health, Oakland, CA) that allows frontline health care teams to access an organization's best practices through interactive decision guides, smart checklists, and how-to videos from any device. In a pediatric ICU, we first delivered a Critical Care Comfort Algorithm (CALM) for titrating sedative and analgesia medications, a bottom-up self-assessment for frontline staff to evaluate their performance, and a top-down audit checklist for charge nurses to complete. For multiple community health centers, we created colorectal cancer screening practice decision guides for medical assistants (MA) and providers, and deployed the practices through a 3-week gamified contest between individual clinics conducted through the app. For the opioid safety initiative, we created a Provider Chronic Pain Management Workflow checklist, Provider Pain Evaluation Guide, and a MA checklist for medication reconciliation; implementation was paired with a 2-month inter-clinic competition.

Results: Within 2 weeks of the formal roll-out of the Pediatric ICU charge nurse audit tool, 107 checklists were completed and 83% of intubated patients were on the sedation protocol. During the gamified 3 weeks for colorectal cancer screening, 2107 checklists were completed with engagement from 74% of MAs and 80% of providers. MAs appeared to habituate to the practice with ongoing practice post-competition; there was a 70% increase in colorectal cancer screenings 1 year post-intervention. During the contest period for increased opioid safety, naloxone prescription increased from <10/month to 27/month for new prescriptions and 21/month for renewals. Opioid contracts with historically negligible adherence increased to 45/month for new contracts and 53/month for renewed contracts. There was also a 70% increase in referrals to the Behavioral Health Pain Management Program.

Conclusions: Our clinical improvement initiative using cloud-based real-time actionable and trackable decision guides facilitated staff engagement with standardized protocols for pediatric analgesia and sedation, led to a significant increase in colorectal cancer screenings with high levels of provider and staff participation, and improved opioid safety and utilization of behavioral support resources for patients with chronic opioid use. The cloud-based application empowers staff with just-in-time access to microlearning

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tools and resources to manage patient care, simplifying management's ability to train staff at scale. Standardizing practice and streamlining workflows liberalizes valuable face-to-face time with patients and improves patient safety.

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Abstract

mHealth App for Patient Self-Management of Chronic Kidney Disease Improves Renal Outcome: Pilot Study

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Abstract

Background: The prevalence of chronic kidney disease (CKD) is approximately 850 million worldwide and 120 million in China. Approximately 2% of the CKD population will progress to end-stage renal disease (ESRD) requiring renal replacement therapy or transplantation. The total health care expenditure on dialysis for the entire ESRD population in China is estimated to be 240 billion RMB per year. Using mobile health information technologies to conduct low-cost, large-scale, and personalized populational health interventions show a great promise.

Objective: In this pilot study, we assessed the feasibility and clinical effectiveness of a mobile application designed to improve patient's self-management of chronic kidney disease over a 3-month intervention with a pre-post design and a quasi-trial design.

Methods: Patients with CKD stage 1-3 and uncontrolled proteinuria (proteinuria>1g per day) were recruited. Eligible patients who were waitlisted served as the control. Patients in the experiment group were invited to install a mobile application known as Shen Shang Xian (Chinese pinyin for kidney online) for CKD self-management. The enrollment included a questionnaire for medical history and self-reported objective physical parameters and laboratory values. Each participant was assigned to one nephrologist who communicated with the patient on an ad-hoc basis. Blood pressure and laboratory test results were entered by the patients on a regular basis. The application has a built-in clinical decision algorithm to generate health recommendations to users based on one's data-entry. The application also sends various alerts to patient's nephrologist for timely interventions. Blood pressure, proteinuria, serum creatinine and eGFR were measured before and after the management period.

Results: Fifty-three patients were enrolled in the experimental group and 11 patients were in the control group. The average daily usage in minutes was 11.2 (25%-75% quartile [7.5, 16]) and the average of total physician-patient conversation was 116 (25%-75% quartile [51, 274]). There is a significant correlation between average daily usage and physician-patient conversation (R2=0.30, P<.001). The starting eGFR was 102 ml/1.73cm^2 (95% CI 92-105]) in the experimental group and 118 ml/1.73cm^2 (95% CI 100-134]) in the control group (P=.04). The body mass index (BMI), blood pressure, and proteinuria had no statistical significance. At the end of the study, the mean change of proteinuria was -1.39 g (95% CI -2.07 to -0.72]) in the experimental group and 0.37 g (95% CI -2.11-2.85]) in the control group (P=.14). After adjusted for ACEi/ARB use, the mean change of proteinuria was -1.46 vs 0.47 in the experimental group vs the control group respectively (P=.16). The eGFR was not changed at the end of the study. There was no correlation between the average daily use and change of proteinuria.

Conclusions: Participants used the mobile app on a daily basis and communicated with the nephrologists for their CKD management. Patients who used the CKD self-management app exhibited a non-statistically significant trend of proteinuria

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reduction after 3 months. This pilot study was underpowered and the follow-up period was short. A larger retrospective controlled trial is needed to confirm the effectiveness of mHealth app in CKD self-management.

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KEYWORDS

self-management; chronic kidney disease

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Abstract

Humanizing the Chart: Becoming More Responsive to Patient Needs Through Implementation of PatientWisdom

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Abstract

Background: Over the past several decades, health care has been shifting to a care model that more fully values patient engagement. Recently, there has been increased attention on the role of health information technology that enables patients to collaborate with clinicians through the sharing of patient-generated contextual data. We implemented the PatientWisdom tool using a sociotechnical model to improve patient experience and visit effectiveness.

Objective: To understand the facilitators and barriers to the routine incorporation of patient contextual data into the record, and the subsequent initial impact on the experience of care within academic and community practices affiliated with an academic health system.

Methods: Our health system co-developed the PatientWisdom tool, which elicits patient values, preferences, and other contextual data ahead of visits through an email invitation to a secure Web application. Results are summarized and viewable within the EHR. To assess the implementation, we performed workflow shadowing and semi-structured interviews of clinical staff from April through July 2018. The Consolidated Framework for Implementation Research (CFIR) guided the collection and analysis of qualitative data. Researchers used the PatientWisdom platform to elicit patient data ahead of visits and summarize insights in the EHR. The researchers conducted sampling and data analysis in tandem; sampling concluded when the researchers determined no new themes were surfacing; therefore reaching data saturation. To assess the impact of the program on health care operations, including patient experience, a random sample of clinicians and patients (both users and non-users) was performed.

Results: In workflow assessment and clinician interviews, we learned that the data needed to be more visible within the chart, and we made improvements within our electronic health record to make link to the data more apparent and visible when data were available. Main themes from our interviews were: Patient contextual information fosters a holistic approach to care; PatientWisdom is an innovative tool used to sync clinician-patient goals; clinicians may have an incorrect perception of PatientWisdom adopters (expecting millennials); and clinicians who proactively integrate PatientWisdom into their workflow identified it as an asset to care. In our initial assessment of impact, 945 patients completed surveys following their visits. Of participating patients, 87% say it improves communication and 90% rate the visit as going “extremely well” (compared to 82% when not used $P<.05$). Clinicians were significantly more likely to ask patients about barriers to care using the tool (65% vs 48%). The tool surfaced information about patient needs for clinicians and leaders. For example, we identified that 47% of participants did not have a health care proxy, and 60% of these patients were ready to talk about it with their clinician.

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Conclusions: Consumer informatics tools that link with electronic health records may help "humanize" the record and improve patient centeredness. This session highlights the initial implementation of an effort to collect patient-contextual data through the PatientWisdom tool and highlights the use of the tool to drive clinical and operational improvement.

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KEYWORDS

communication; consumer health informatics; electronic health record; implementation; sociotechnical

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Abstract

Improving Care in the Pediatric Emergency Department With Virtual Reality

Jessica DeClercq[1]; Marie Bowen[1], MEd; Shelia R Cotten[1], PhD; Aileen Hansen[2], BS, CCLS, CEIM; Kelly Hebert[2], BA, CCLS; Jodi Nohel[2], BRE, CCLS; Kristin Weber[2], RN; Karl Engler[2], RN; Kathy Marble[2], MSN, RN, RNC-NIC

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Abstract

Background: Emergency departments (EDs) are often perceived as scary and have been shown to induce anxiety in children. Some hospitals utilize Certified Child Life Specialists (CCLS), hospital staff trained to meet the psychosocial needs of children, to assist when children show signs of anxiety and/or pain during treatment. The CCLS will distract the child, such as with an iPad; however, the child may still watch the IV start, which could result in a failure of the distraction. Digital distraction, distracting a child with technology during stressful procedures, has shown to reduce pain and anxiety better than medications or no distraction at all. Virtual reality (VR) is one form of digital distraction and is increasingly being used in hospitals, as both vision and hearing are blocked by the headset. Previous research shows that the more senses used in the distraction, the less likely the patient will experience pain and anxiety.

Objective: The main goal of this study was to improve care delivery for children in the ED while receiving IV placements. To achieve this, we utilized VR to determine whether it could decrease pain and anxiety for children by acting as a form of digital distraction.

Methods: The intervention included patients between the ages of 5 and 12 who needed an IV in the ED at a public, Michigan hospital. Each participant was randomly assigned to either VR or the standard of care distraction (SD). For those in the VR group, the child played a game while wearing a VR headset. For those in the SD group, the CCLS used standard distraction methods, such as watching a video on an iPad. The guardian then completed a survey to measure the effectiveness and satisfaction of the distraction.

Results: Thirty children participated in the study. Of those who participated, 12 guardians from the VR group and 16 from the SD completed surveys. Seventy-five percent of the VR group and 94 percent of the SD agreed that the distraction reduced the child's anxiety, while 75 percent of the VR group and 88 percent of the SD agreed that the distraction reduced the child's pain during the IV placement. Sixty-seven percent of the VR group versus 94 percent of the SD were more satisfied with health care delivery because of the distraction, and 83 percent of the VR group while 88 percent of the SD were more likely to choose this hospital again because of the distraction.

Conclusions: Although there is potential for the use of VR in health care settings, the use of technology in addition to the CCLS shows great potential to reduce pain and anxiety while improving health care delivery and patient satisfaction. Because most guardians reported positive outcomes with both VR and the SD, the use of technology compared to no distraction should be examined in larger studies to fully understand the effect of digital distraction along with human interaction. With the option of technology in conjunction with caregiver guidance, pediatric patients may perceive less pain and have a better care experience during IV placements in the Emergency Department.

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KEYWORDS

anxiety; pain; pediatrics; virtual reality

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Multimedia Appendix 1

Full poster.

[PDF File (Adobe PDF File), 152KB - iproc_v4i2e11796_app1.pdf]

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Abstract

Automated Patient Navigation Platform Increases Referral Conversion for Surgical Consultations

Aiden Feng[1], MD, MBA; Josephine Elias[1], MBA, MPH; Kevin Hart[1], MBA; Philip Roberts[1], MBA; Karl Laskowski[1], MD, MBA

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Abstract

Background: Provider organizations often lack closed-loop systems to convert referrals for surgical consultations, relying on patients to proactively follow-up and schedule their initial evaluation with surgeons. Referrals that do not promptly converted into appointments result in delays in care and lost revenue opportunities.

Objective: The aim of this study was to evaluate the impact of an automated referral navigation platform on referral conversion rate and scheduling efficiency.

Methods: Referral information, prompts to schedule appointments, and appointment reminders with digital wayfinding services were delivered to patients using time-released text messages and emails via an automated HIPAA-compliant software platform (Medumo, Inc, Boston, MA). All patients who were referred for evaluation by General Surgery, Oral Medicine, Otolaryngology, and Urology at our institution for 16 weeks starting February 12, 2018 were enrolled in the automated referral navigation program (intervention cohort). Exclusion criteria were incomplete referral information and absence of email address and cell phone number in the medical record. The primary outcome metric was conversion rate of referrals to appointments within 12 business days. Outcome metrics on scheduling efficiency included conversion rate of referrals to appointments within 2 business days and percent of patients contacted within 24 hours of referral. Success of patient navigation was measured with appointment no-show rates, digital wayfinding service utilization, and patient satisfaction. All outcomes of the intervention cohort were compared to referrals made in the 16 weeks ending February 11, 2018 (baseline cohort).

Results: During the intervention period, there were 4991 patients enrolled in the referral navigation program. Compared to the baseline cohort, the conversion rate of referrals to appointments within 12 business days increased from 63.4% to 65.6% (P=.01). Efficiency with which referrals were converted to appointments improved: referral conversion rate within 2 business days increased from 40.0% to 52.0% (P<.01) and patient contact rate within 24 hours increased from 54.5% to 95.9% (P<.01). For appointments scheduled during the study period, no-show rate decreased 22.7% (5.7% to 4.4%, P=.01) and utilization of the digital hospital wayfinding service increased 1777.6%. Average satisfaction score was 4.4/5.0 for the referral navigation program.

Conclusions: Implementation of a software platform that facilitates referral capture with appointment navigation increased referral conversion, boosted efficiency of appointment scheduling, and improved patient preparedness with fewer no-shows in surgical specialties.

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KEYWORDS

mobile text reminders; referral conversion; patient navigation

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Abstract

Using a Web-Based App to Improve Hand Hygiene Compliance Rates

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Abstract

Background: Our institution has prioritized improving hand hygiene rates. Empty or broken alcohol-based hand sanitizer dispensers are a barrier to efficient hand hygiene practices. One barrier is the lack of modalities for employees to alert when a dispenser is empty or broken.

Objective: We hypothesize that adding predefined QR code functionality to an existing web-based service repair application for staff will facilitate increased alerts about empty hand sanitizer dispensers.

Methods: The FixIt app is a Web-based application that enables staff at our academic hospital to report issues to environmental services including when supplies are broken, if rooms are dirty, or if an item in a room needs to be restocked. However, users must type a free text description of the problem to report it. We propose adding functionality to allow users to scan a QR code with their SmartPhone or enter a unique text code that will be labeled on each hand sanitizer dispenser. This unique code will be directly associated to a specific dispenser and alert the environmental services department to the exact dispenser to fix or replace, thereby reducing the number of empty or broken dispensers. To measure the scope of the problem, we evaluated the functionality of all hand sanitizer dispensers in public spaces on patient wards and hallways in our institution at a single point in time and then sequentially over a course of 48 hours. We also evaluated the usage of the existing FixIt application and categorized the types of requests that FixIt has processed to date.

Results: Out of 535 hand sanitizer dispensers, forty-nine dispensers (9.2%) were not functional on our baseline evaluation. After 12 hours, 23 of these non-functional dispensers (46.9%) had not yet been fixed or refilled. After 48 hours, 17 dispensers (34.7%) were still not functioning. The existing FixIt application without QR codes was deployed in September 2017. Since then, the application has generated over 400 FixIt requests via manual text-entry form. Of those requests, 17% were categorized as “repair/restock” requests.

Conclusions: We propose adding a QR-based feature to an existing Web-based application to streamline and facilitate repetitive tasks such as reporting empty or broken hand sanitizer dispensers. Our preliminary results suggest that users are already willing to utilize a manual form via a Web application to request restocking or repair of items within the hospital. We think that lowering the barrier for reporting by utilizing QR codes may improve usage rates of this feature. Our next steps are to implement a small pilot of the FixIt QR code evaluate uptake and utilization.

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KEYWORDS

electronic symptom reporting; hand-washing; quality indicators

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Abstract

Reinventing Inflammatory Bowel Disease (IBD) Clinical Trial Recruitment Using Novel Digital Medicine Tools

Emamuzo Otobo[1], MD; Christopher Park[1], BA; Jason Rogers[1], BA; Farah Fasihuddin[1], MPH; Shashank Garg[1], MS; Chloe Yang[1], BA; Zahin Roja[1], BA; Vishu Chandrasekhar[1]; Kritika Singh[1]; Vinod Kumar[1]; Divya Madisetty[1], MD; Harkirat Dhillon[1]; Ashish Atreja[1], MD, MPH

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Abstract

Background: Issues with patient recruitment and enrollment are the primary barriers for missed clinical trial timelines; 8 out of 10 clinical trials are delayed or unable to be completed because of lack of timely patient recruitment. Current patient recruitment efforts are inefficient and time-consuming, since they are typically dependent on manually screening patients during face-to-face visits to the clinic or hospital. With the rapid development of digital communication platforms within health care and the broad consumer adoption of smartphones, there are increasing opportunities to overcome some of these barriers. These platforms have particularly great potential for research and clinical care of chronic conditions, such as inflammatory bowel disease (IBD), an often debilitating disease which currently affects over three million adults in the United States.

Objective: To integrate and utilize a digital medicine platform to improve patient recruitment and enrollment processes in clinical trials.

Methods: Patients enrolled in the Mount Sinai Crohn's and Colitis Registry (MSCCR) were remotely approached about enrolling in a mindfulness study for IBD patients. A text-based clinical rules engine was used to inform registry patients about the trial and to allow patients to indicate interest in participating via text message. Eligible IBD patients were bulk "prescribed" a notification through RxHealth's digital medicine platform, RxUniverse. Characteristics of the enrolled population, characteristics of patients who responded, and timeliness of responses were analyzed.

Results: Of the 1364 patients in the MSCCR with available phone numbers, 270 patients affirmatively replied they wanted to participate in to the study. Patients who opted into receiving more information about the study were more likely to have inadequate control of their IBD (25.64% vs 18.97%; $P<.05$) and more likely to have a recent history of depression based on a validated patient health questionnaire (15.38% vs 8.4%; $P<.05$) than those who opted out. Furthermore, patients who opted in tended to be younger, were more likely to be female, and less likely to have ulcerative colitis, though these trends did not reach statistical significance. Patient race did not significantly differ between those who opted in and opted out. In terms of timeliness of response among those enrolled, the majority of patients responded within 2 hours of notification.

Conclusions: Digital medicine software platforms can facilitate large-scale, lower-effort recruitment of eligible patients for clinical trials. Future research should be done to explore their expanded use for recruitment, patient education, and study data collection. Additional technologies such as patient-powered networks, social media, e-recruiting bots, and other remote engagement platforms can aid clinical trials by saving time and reducing costs of patient recruitment.

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KEYWORDS

clinical trials; internet recruitment; mobile health; mHealth; recruitment; IBD; Crohn's disease; ulcerative colitis

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Abstract

A Novel Digital Platform Approach to Enhance Enterprise-Wide Patient Portal Adoption

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Abstract

Background: Patient portals provide a simplified route for health providers to share medical information with individual patients, and are incentivized under Meaningful Use. Currently there are numerous friction factors in the onboarding process of patient portals that limits patients signing up for them. As a result, health systems are spending significant resources to drive the adoption of patient portals, with limited success.

Objective: To evaluate the effectiveness of a innovative rules-driven digital patient engagement strategy for patients to sign up for online patient portal at an academic medical center.

Methods: Rx.Universe is a digital platform integrated into provider EMR systems that enables physicians to directly "prescribe" mobile health applications and/or digital care bundles to patients. Rx.Universe Bulk Prescription feature was used to prescribe—via SMS—a direct link to the MyChart login page with the patient's unique code and personal information embedded within the link. This removed several key barriers to adoption: patients needing to copy and paste access codes, fill in their personal data and complete this process within 30 days—after which their unique access code expires. The Rx.Universe engagement dashboard displayed the total number of patients who received prescribed messages, the number of unsuccessful prescriptions, prescriptions opened in the first 24 hours, and total prescriptions opened.

Results: We digitally prescribed MyChart Activation to 23,485 patients under the care of Yale-New Haven Hospital over a period of 2 days. Of these prescriptions, 21,997 (93.66%) were successfully delivered and 1488 (6.33%) failed to be delivered because of incorrect cell phone numbers in EHR. Of the prescriptions successfully prescribed, 2170 (9.86%) were clicked within 24 hours of being prescribed with a total of 2378 (10.81%) clicked within a week.

Conclusions: Digital Medicine Platforms offer new channel for onboarding and following up patients through customized digital care plans. The power of this approach in removing barriers for patients is highlighted by the fact that Yale-New Haven Hospital met their yearly MyChart adoption target through this campaign within a week. Furthermore, the data could be assessed and acted upon in real-time as opposed to the usual weeks. This technology can be extended to close the care gaps for hospitals and Accountable Care Organizations (ACO) in a scalable manner for a subpopulation, with manual processes reserved for patients unable to be reached in an automated fashion.

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KEYWORDS

patient engagement; platform

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Abstract

A Two-Arm Randomized Pilot Study to Evaluate the Impact of a Mobile Health App on Quality of Life in Patients on Oral Anti-Cancer Medications

Nils Fischer[1,2]; Stephen Agboola[1,2]; Ramya Palacholla[1,2]; Mursal Atif[1]; Joseph Kvedar[1,2]; Kamal Jethwani[1,2]

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Abstract

Background: CORA is a personalized smartphone-based self-management app designed to help cancer patients on oral anti-cancer medications manage medication, medication side-effects, and symptoms with the overall goal of improving their quality of life.

Objective: To evaluate the effect of CORA on quality of life in patients on oral anti-cancer medications.

Methods: Eighty-four patients were randomized to either an intervention group that received CORA plus usual care or a control group that received usual care. Quality of life was measured using the Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F) scale administered at enrollment, 6 and 12 weeks. Engagement with the app was assessed by determining the unique days using the app. We evaluated the effect of engagement on FACIT-F both as a continuous variable (days using the app) and as a categorical outcome (low, medium, and high). Group differences for all outcomes over the study period were assessed using repeated measures mixed model analysis.

Results: Relative to the control group, the intervention group improved FACIT-F by 0.36 (95% CI 0.10-0.61) *P*=.006 per week over the study period. As a continuous variable, each additional day using the app was significantly associated with an improved FACIT-F score per week in the study [0.0060 (95% CI -0.000034-0.012), *P*=.05]. Within the intervention group that used the app, those who were most engaged with the app were significantly more likely to improve their quality of life over the study relative to the least engaged group [0.37 per week (95% CI 0.19-1.94), *P*=.05].

Conclusions: CORA may have significantly improved quality of life (FACIT-F) in cancer patients over 12 weeks. Smartphone applications may positively impact health and behavioral outcomes in cancer patients on oral anti-cancer medications.

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Abstract

A Protocol-Driven, Digital Conversational Agent at the Hospital Bedside to Support Nurse Teams and to Mitigate Delirium and Falls Risk

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Abstract

Background: Up to 1 million falls per year occur during hospital stays in the US, costing hospitals up to $7 billion per year to treat. Delirium, a major cause of falls, is highly prevalent (29%-64%) among hospitalized elders. Our team is developing a care technology that provides 24x7 proactive patient support to mitigate falls and delirium in a scalable, cost-effective, yet person-centered manner. We were awarded an NIH SBIR Fast-Track grant to further our work.

Objective: Prior research showed that digital avatars can build psychosocially supportive relationships with older adults living in the community. We conducted a pilot study of these digital avatars in a community hospital setting, and found that bedside avatars helped reduce the rate of falls among elderly inpatients while mitigating delirium and loneliness. Thus, in our present NIH-funded work, we seek to enhance the clinical robustness of our avatar intervention by implementing a more complete set of protocols derived from the evidence-based Hospital Elder Life Program (HELP), and to validate the benefits of this next-generation intervention in a larger scale, multi-site clinical study.

Methods: Avatars are displayed on tablets as virtual dogs or cats, responding to touch. They are able to talk intelligently due to live support from a 24x7 team of trained humans combined with protocol guidance and process automation software. At the bedside, avatars talk with patients and implement protocols including reorientation and bed exercises, based on HELP. English-speaking patients aged 65+ on three medical surgical units were selected in our pilot study based on subjective nursing risk assessment and patient consent. Participants on two intervention units received an avatar for their entire hospital stay. Participants on a control unit received a daily visit from a nursing student. Measures were administered upon study enrollment and discharge. Quarterly fall rates by unit were reported by the hospital. In our present work, we will conduct a larger, multi-site clinical study starting with two hospitals in late 2018 and incorporating electronic medical record integration to increase the objectivity of patient enrollment, ease the patient enrollment process, and apply interventions intelligently tailored to each patient. Additional hospitals may join the two-year study through 2020.

Results: In our pilot study, intervention (n=41) and control (n=54) patients were equivalent except for an intervention group bias toward females (*P*=.02). Mean age was 76.5 years, with 55% female, 46% African-American, and 44% speaking English as a second language. Typical length of stay was 3-6 days. On average, avatars performed 71.3 observational check-ins, 61 minutes of engagement using 11.5 images or audio files, and 6.5 protocol-driven tasks per patient per day. Compared to control patients, intervention patients showed a significantly greater reduction in delirium score (CAM, *P*=.003) and loneliness (UCLA-LS, *P*=.008). The primary intervention unit had 0.9 falls per 1000-patient days during the 3-month study period, compared to 6.5 on the control unit (86% reduction).

Conclusions: Previous findings support the use and development of avatar technology for hospitalized patients at risk for delirium or falls. Hospitals interested in joining our two-year clinical study may contact the principal investigator.

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KEYWORDS

avatars; clinical trials; elderly; health care technology; hospital information systems; loneliness; mobile health; mHealth; patient care; psychosocial support systems; falls; delirium; nursing; Hospital Elder Life Program; Confusion Assessment Method; HELP; hospitals; SBIR

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Abstract

First 28: Design of a Mobile App for Neonatal Health Risk Assessment and Support for New Mothers

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Abstract

Background: Factors like dehydration and respiratory infection pose risks to infant survival in the critical first 28 days of life. UNICEF reported the 2016 global rate of neonatal death was 19 per 1000 live births. Typically, women manage multiple household and family responsibilities in addition to care of a new baby and often feel overwhelmed by the demands of new motherhood. The American College of Obstetricians and Gynecologists recommends that support to new mothers be an ongoing process, rather than a single postnatal visit. However, in low-resource environments such as developing countries and remote communities, access to ongoing support for breastfeeding, health education, and infant check-ups from a professional health care provider or health worker may not be possible. Numerous examples exist of successful mobile health interventions in low-resource environments. However, existing mobile apps for newborn health often focus on single issues that are disconnected from health care providers. There is a need to comprehensively address multiple newborn health issues, with evidence-based and personalized interventions that support new mothers.

Objective: This study aims to design and build a prototype of a mobile app to comprehensively identify early signs and symptoms of common newborn illnesses, access relevant evidence-based health information, and support decision-making with the overall goal of enhancing new mothers' ability to improve newborn health outcomes. The prototype will be used in a future pragmatic trial.

Methods: An interdisciplinary and international team including nursing, medicine, dietary, health informatics, and public health collaborated on this study. First, a literature review was conducted to supplement the team's existing knowledge on common neonatal problems, generate the evidence base for appropriate in-home interventions, and identify best practices in breast feeding. Second, a review of current mobile apps available in neonatal risks was conducted to assess gaps with attention to comprehensiveness of health issues, interface/integration with clinical decision support systems, and application of user-centered design and state of the art design principles and standards.

Results: Our app, First 28, works offline for easy accessibility and displays evidence-based best practices and guidelines, personalized for mothers based on risks. Using a tailored symptoms list and computerized data entry to gather information, the mobile app performs analysis using a decision table algorithm to identify the risks the baby might encounter and suggests best solutions based on the outcomes. Mothers can submit images or crucial information about their baby and track growth through the app's data visualization tools. Data is stored on a FHIR server for integration with health care services and electronic health records. Future plans include automated data and image analytics of the uploaded information to alert health care providers of any abnormalities that may provide critical early evidence for potential neonatal risks and complications.

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Conclusions: First 28 empowers mothers with the knowledge and resources to maintain proper breastfeeding techniques, assess newborn health risks, and improve health outcomes within the crucial first 28 days of life. In the next phase, the prototype will be evaluated by users with a plan to utilize it in a pragmatic trial.

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KEYWORDS

mHealth; neonate; neonatal; clinical decision support (CDS); breastfeeding; neonatal health risk; neonatal complication; dehydration; respiratory infection; mother; postnatal; decision table; FHIR

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Abstract

A Smartphone App to Leverage Positive Psychology to Support Smoking Cessation in Nondaily Smokers: Results of SiS Study 1

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Abstract

Background: The population of nondaily smokers is large (ie, 24.3% of adult smokers) and increasing (ie, 27% increase over the past decade). The cancer risk of nondaily smoking is substantial (40%-50% of that seen in daily smokers). Existing treatments are ill-suited for nondaily smoking, because the treatments are based on nicotine dependence, and traditional treatments and treatment modalities (eg, in-person counseling, medication) do not appeal to non-dependent nondaily smokers.

Objective: We sought to develop a smartphone app that acts as a behavioral, in-the-pocket coach and uses positive psychology exercises to enhance quitting success.

Methods: Nondaily smokers (n=30) used Version 1 of the "Smiling Instead of Smoking" (SiS) app while undergoing a quit attempt (1 week pre-, 2 weeks post-quit). The app assigned daily positive psychology exercises, provided smoking cessation tools (ie, scheduling quit day, logging personal reasons for quitting, planning for challenging times, enlisting social support), and made information about smoking cessation available (ie, benefits of quitting, strategies for cravings). Participants answered surveys at baseline and 2, 6, and 12 weeks post-quit and participated in structured user feedback sessions 2 weeks after their chosen quit day.

Results: During the 3 weeks of 'prescribed' use, 50% of participants completed every daily positive psychology exercise, and the remaining 50% completed on average 85% of the daily exercises. Use of the user-initiated tools was limited: 20% did not use the "Challenging Times" tool at all; those who did only used it twice (median); 27% used the "Social Support" tool on multiple days. Self-reported smoking abstinence rates were 43.3% (7-day abstinence) 2 weeks post-quit, and 40.0% and 43.3% (30-day abstinence) at 6 and 12 weeks post-quit, respectively. Most participants (90%) felt the app helped them during their quit attempt, especially in terms of staying on track, giving them confidence, and reinforcing the idea that quitting was worthwhile. Usefulness ratings were particularly high for functionality that allowed participants to (re-)schedule their quit day and log their personal reasons for quitting smoking. In line with putative mechanisms underlying smoking cessation, compared to baseline, participants reported a lower urge to smoke ($F(1,29)=20.55$, $P<.001$), increased self-efficacy to abstain from smoking, both in response to internal ($F[,29]=12.69$, $P<.01$) and external stimuli ($F[1,29]=18.95$, $P<.001$), decreased endorsement of the psychoactive benefits ($F[1,29]=16.24$, $P<.001$) and pleasure ($F[1,29]=5.44$, $P=.03$) of smoking, and lower perceived importance of the pros of smoking ($F[1,29]=18.26$, $P<.001$). Qualitative feedback indicated a desire for more variety in the positive psychology exercises, more recommended strategies for dealing with cravings, less wordy but more frequent behavioral counseling check-ins, a reward systems, and the removal of the "social support" tool.

Conclusions: A positive psychology approach to support smoking cessation resonated well with nondaily smokers. App usage of these exercises was high over a 3-week period, suggesting that this treatment approach is sustainable during the critical phase of smoking cessation. Abstinence rates were substantially higher than natural quit rates in this population, and thus offer some promise, which will need to be evaluated in a randomized trial.

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KEYWORDS

cigarette smoking; mHealth; mixed methods

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Abstract

Predicting Obstetric Disease With Machine Learning Applied to Patient-Reported Data

Danielle Bradley[1], MPH, MS; Erin Landau[1]; Adam Wolfberg[1], MD, MPH; Alex Baron[1], PhD

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Abstract

Background: The rise of highly engaging digital health mobile apps over the past few years has created repositories containing billions of patient-reported data points that have the potential to inform clinical research and advance medicine.

Objective: To determine if self-reported data could be leveraged to create machine learning algorithms to predict the presence of, or risk for, obstetric outcomes and related conditions.

Methods: More than 10 million women have downloaded Ovia Health's three mobile apps (Ovia Fertility, Ovia Pregnancy, and Ovia Parenting). Data points logged by app users can include information about menstrual cycle, health history, current health status, nutrition habits, exercise activity, symptoms, or moods. Machine learning algorithms were developed using supervised machine learning methodologies, specifically, Gradient Boosting Decision Tree algorithms. Each algorithm was developed and trained using anywhere from 385 to 5770 features and data from 77,621 to 121,740 app users.

Results: Algorithms were created to detect the risk of developing preeclampsia, gestational diabetes, and preterm delivery, as well as to identify the presence of existing preeclampsia. The positive predictive value (PPV) was set to 0.75 for all of the models, as this was the threshold where the researchers felt a clinical response—additional screening or testing—would be reasonable, due to the likelihood of a positive outcome. Sensitivity ranged from 24% to 75% across all models. When PPV was adjusted from 0.75 to 0.52, the sensitivity of the preeclampsia prediction algorithm rose from 24% to 85%. When PPV was adjusted from 0.75 to 0.65, the sensitivity of the preeclampsia detection or diagnostic algorithm increased from 37% to 79%.

Conclusions: Algorithms based on patient-reported data can predict serious obstetric conditions with accuracy levels sufficient to guide clinical screening by health care providers and health plans. Further research is needed to determine whether such an approach can improve outcomes for at-risk patients and reduce the cost of screening those not at risk. Presenting the results of these models to patients themselves could also provide important insight into otherwise unknown health risks.

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KEYWORDS

machine learning; mobile health; positive predictive value; obstetrics

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Abstract

Implementing mHealth Apps for Child Developmental Screenings: Opportunities and Challenges

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Abstract

Background: Clinical care guidelines for universal developmental screening are meant to identify at-risk children as early as possible so that early intervention can be initiated. However, despite years of initiatives, developmental screening rates remain less than ideal. Recent innovations in mHealth apps that integrate developmental screening may offer an alternate way to optimize screening rates if it can encourage co-use and seamless integration into clinical workflow.

Objective: Prior to the planned deployment of a clinic-based mHealth developmental screening app, the research team sought to identify and characterize opportunities and challenges to implementation, focusing on clinic workflow and multi-stakeholder engagement with providers and parents.

Methods: Three clinic settings were recruited to participate from one children's hospital in Indianapolis, Indiana. Preimplementation clinical observations of workflow and team dynamics were performed. Potential adoption barriers and facilitators were explored through interviews with health care teams guided by the Consolidated Framework for Implementation Research (CFIR). Parents with children aged 0-5 were recruited from study clinics and social media to complete a 26-item survey to gauge their attitudes towards using apps in place of paper screening forms and for tracking their child's development.

Results: Proposed implementation workflows were co-created with each clinical team so to not increase overall visit length, which was the main concern for health care providers. Providers had enthusiasm for use of mHealth tools; however, concerns were expressed about potential technology failures, data security and HIPAA and the workflow impacts. Two hundred fifty parents responded to the social media survey. The top reason for downloading child health apps were for a convenient way to track development (62.6%). Two-thirds of respondents expressed interest in an app that included developmental screening forms. Most parents prefer to complete screening tools on the day of the clinic visit (47.7%) or electronically prior to the visit (44.8%). Seventy-four percent of parents expressed a higher likelihood of using an app if recommended by the pediatrician.

Conclusions: Parents and providers are interested and open to mHealth apps for child developmental screening. Provider buy-in and involvement in implementation planning is critical, both to integrating apps into clinic workflows and to encouraging parents to use the app.

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KEYWORDS

mobile health; mHealth; pediatrics; screening

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Abstract

Feasibility and Acceptability of Using Smartphone Apps in Diabetes Self-Management in an Underserved Population: Qualitative Study

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Abstract

Background: The successful management of diabetes is a chronic endeavor. It involves a whole host of factors ranging from a consistent patient-provider relationship to regular physical activity. Not all patients with diabetes, however, have access to the resources needed for effective disease management. Health disparities contribute to a higher frequency of diabetes development in poor and minority populations. Moreover, health care disparities limit the care these patient populations receive. Because underserved populations have little to no access to traditional means of health care, providers must explore other avenues to reach this patient group. Mobile health (mHealth) has grown significantly in the last decade. With the fast-paced adoption of cell phones across all socioeconomic groups, mobile health presents the opportunity to offer patients a low-cost way to receive health information, to communicate with providers, and to self-manage chronic conditions. It has been well established that low-income, minority populations experience several barriers to receiving basic health care including uninsurance, limited transportation, and high out-of-pocket costs. The provision of health care via mobile devices may have the potential to address such health disparities. Little is known about the effectiveness of using mobile health and smartphone applications (apps) in underserved populations to help with diabetes management. Knowledge of these patients' interest in using mobile apps to augment their home self-management may have use in future implementations.

Objective: The objective of this study is to examine the perception of and willingness to use diabetes mobile health apps on smartphones in patients with limited access to primary care providers.

Methods: This study used purposive sampling to select patients for personal interviews. The study was conducted at a general hospital located in a part of town with predominate minority and low-income residency, as well as the highest diabetes prevalence rates. Semi-structured interviews were conducted according to McNamara's interview staging. A total of 15 interviews were collected and coded by the researcher according to the interpretative phenomenological analysis framework. An independent committee reviewed all interview transcripts and coding to verify trustworthiness of collection and analysis.

Results: The data produced 7 clusters related to smartphone app use and mHealth, each highlighting a component of the patient experience, which supported 3 overarching themes. The themes are as follows: despite limited knowledge about health apps and varying phone use patterns, patients were all willing to try at least one diabetes-related app; apps functions should be individualized to meet each patient's needs for maximum benefit; and barriers to app use were varied but commonly included knowledge and technological challenges and security issues.

Conclusions: Personal interviews of this underserved patient population demonstrated an interest in and willingness to try mobile health apps, despite limited knowledge about the technology. Responses indicate that tailoring app choices to individual needs, instead of choosing a multi-functional one-size-fits-all app, would provide the most benefit for at-home diabetes self-management. Smartphone apps may serve as a viable low-cost resource for patients with diabetes who have limited access to traditional health care providers.

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Abstract

Individualized Diet and Lifestyle Modifications Reverse Symptoms of Systemic Lupus Erythematosus

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Abstract

Background: There is increasing evidence that digital therapeutic tools can bring personalized medicine to the masses improving outcomes and decreasing cost. Many factors influence the expression of autoimmune disease, and understanding and removing these underlying triggers provides an opportunity to minimize use of medications and some patients can achieve sustained remission if the right triggers for a patient are identified. This randomized controlled trial is the first to test the efficacy of a digital therapeutic intervention which combines adaptive patient generated health data tracking with health coaching to identify factors triggering lupus and to evaluate reductions in symptoms, and improvements in quality of life.

Objective: Evaluate impact of personalized dietary and environmental interventions on quality of life and health care costs.

Methods: This a randomized controlled trial using a convenience sample. The Mann-Whitney U test determined that a sample size of 40 patients (20 intervention and 20 control) provides a power of 80% for continuous and ordinal variables. The Bonferroni Correction was used to ensure that the probability of a type 1 error is less than 5% even with the large number of hypotheses being tested. Subjects in both groups received standard of care from their physicians. All subjects repeated the online questionnaires (Fatigue Scale - FACIT, Lupus QOL, and BPI-SF) at weeks 4, 8, 12, and 16. The experimental group going through the mymee protocol received health coaching (weekly calls to educate and implement changes based on data analysis). Digital data collection and tracking was used to correlate dietary/lifestyle/environmental patterns with symptoms. The control group completed the same assessments during the 16 week intervention period but did not receive any additional coaching. The intervention uses correlations between symptoms and triggers that are reported daily to create an iterative cycle of hypotheses tailored to each individual. With 5 min of tracking a day using the app, patients easily report what they have eaten, other triggers, and their symptoms. Using our machine learning platform, coaches identify each patient's personal disease triggers and help patients implement changes to remove them.

Results: The interim results of the study showed that 78% improved in the experimental group and 36% in the control group with a $P<.01$. Furthermore, 67% of the patients have gone off some or all of their drugs after consulting with their doctors.

Conclusions: Results show a significant improvement for lupus patients who completed the protocol, demonstrating the potential for digital therapeutics to dramatically improve the quality of life for patients diagnosed not only with lupus, but other chronic diseases (80% of the trial patients also had rheumatoid arthritis). Broad adoption of the mymee intervention could assist in building a database of lupus triggers and symptoms that could lead to further understanding the causes of lupus. Based on interim results, a 78/36 effect size is competitive if not more effective than current drugs in the pipeline like Stelara which shows a 60/31 effect size and includes potential side effects of drug-induced MS and cancer.

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KEYWORDS

population health; digital health; digital therapeutics; lupus; precision medicine; personalized medicine; chronic disease

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Abstract

The Impact of Providing a Tool Kit for Innovators in an Academic Medical Center to Scale Digital Health Innovation

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Abstract

Background: An internal iHub survey shows that 72% of innovators within Academic Medical Centers abandon their ideas due to a lack of direction for their visions. While internal innovators are frustrated without direction and support to launch their ideas, hospitals need to balance innovation while ensuring information security-HIPPA compliance. Brigham and Women's Hospital houses a digital innovation hub (iHub) that fosters innovation for Brigham clinicians, scientists, researchers, administrators, and staff. In 2014, BWH founded a program called Digital Health Innovation Guide (DHIG) to provide structure for innovators to pilot new and novel technology in a safe, efficient, and successful manner. As a continuous cycle of innovation, the iHub identified successes and ways to improve the DHIG process and quality of service.

Objective: We gathered and analyzed data from participants of the DHIG and creators of the program to project the outcomes of the Digital Health Innovation Guide. With that information, we were able to quantify the impact of providing these resources and determine ways to improve the process of helping scale and structure digital health innovation.

Methods: We conducted a case review of existing data on DHIG projects. This included gathering data on projects from 2014-current. We reached out to 40 participants that went through the DHIG program to fill out a survey of questions regarding logistics of their project, successes and failures they faced, their thoughts on DHIG process, and its impact on the piloting process. We interviewed 10 participants to discuss the impact of the DHIG process, and to quantify where more support is needed from the iHub to better aid innovators to utilize and innovate new technologies in health care.

Results: From the responses collected, 50% of the innovators collaborated with external startups, while the other 50% were custom developments. 86% of teams had over 4 members, and of the remaining 14%, only 20% were still actively working to pilot completion. Conversely, 100% of stalled projects had less than 4 members. Participants listed that upholding deadlines and maintaining communication with internal stakeholders as well as external, such as developers and other hospitals, brought on successes for their project. Internal bottlenecks like indeterminate delays of IRB approval timelines and info sec reviews slowed down progress and, in some cases, led to withdrawal from sponsors.

Conclusions: Based off team sizes and member engagement, we found that it is crucial to have a team of at least 4 members with an engaged clinical champion, administrative champion, and project manage to ensure pilot completion. The iHub and DHIG process can improve pilot completion by expanding external support resources such as developers and other hospitals. The DHIG, while successful in providing a clear and rigid structure for innovators in an AMC to further develop their innovations, must continue to breakdown internal barriers by acting as an expediter.

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KEYWORDS

implementation; innovation; innovation adoption process; digital health; startups; scaling innovation; pilot

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Abstract

Integration and Adoption Analysis of Digital Health Monitoring Devices: Reflections of a Pilot Project

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Abstract

Background: Congestive heart failure (CHF) is a disease that affects about 6.5 million people in the United States with a mortality rate of around 30%. With the incidence rate projected to rise by 46% to exceed 8 million cases by 2030, projections estimate that total CHF costs will increase about to nearly $70 billion. Recently, the advent of remote monitoring technology has significantly broadened the scope of the physician's reach in chronic disease management. Using remotely monitored health data, providers may be able to better manage and predict their patients' outcomes, leading to reduced incidence and hospital admission costs.

Objective: This project aimed to demonstrate the feasibility of a digital medicine engagement platform for CHF patients, including identifying factors associated with increased risk of readmission and assessing usage patterns of remote monitoring devices.

Methods: The project included 60 patients admitted to Mount Sinai Hospital for CHF. A digital medicine platform by Rx.Health, called RxUniverse, was used to prescribe HealthPROMISE and iHealth mobile apps. Patients updated and recorded their CHF-related symptoms and quality of life measures daily on HealthPROMISE. Vital sign data, including blood pressure and weight, were collected through an ambulatory remote monitoring system that integrated the iHealth app and complementary consumer grade Bluetooth-connected smart devices (blood pressure cuff and digital scale). Physicians were notified of abnormal patient blood pressure and weight change readings and further action was left to the physician's discretion. We used statistical analyses to determine risk factors associated with 30-day all-cause readmission.

Results: Overall, there were six 30-day hospital readmissions (10%), compared to the national readmission rates of around 25%. Single marital status (P<.1) and history of percutaneous coronary intervention (P<.1) were associated with readmission. Readmitted patients were also less likely to have been previously prescribed angiotensin converting enzyme inhibitors or angiotensin II receptor blockers (P<.05). Notably, readmitted patients utilized the blood pressure and weight monitors less than non-readmitted patients, and patients aged less than 70 used the monitors more frequently on average than those over 70, though these trends did not reach statistical significance. The percentage of patients using the monitors at least once dropped steadily from 83% in the first week after discharge to 46% in the fourth week. Additionally, 88% of patients used the monitor at least 4 times and 62% at least 10 times, with some patients using the monitors multiple times per day.

Conclusions: Given the increasing burden of CHF, there is a need for an effective and sustainable remote monitoring system for CHF patients following hospital discharge. We identified clinical and social factors as well as remote monitor usage trends that identify targetable patient populations that could benefit most from integration of daily remote monitoring. In addition, we demonstrated that interventions driven by real-time vitals data may greatly aid in reducing hospital readmissions and costs while improving patient outcomes. Future studies should seek to implement remote monitoring and confirm usage trends as well as risk factors in a large-scale population.

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KEYWORDS

congestive heart failure; innovation adoption process; mobile health intervention; remote monitoring

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Abstract

Cloud Connected Non-Invasive Medical Device for Instant Left Ventricular Dysfunction Assessment via Any Smartphone

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Abstract

Background: Left Ventricular (LV) dysfunction is the inability of the heart to effectively pump blood through the circulatory system, leading to compensation and eventually heart failure (HF). Ninety-one million American adults with predisposing conditions are at risk for HF and need better screening and diagnosis to prevent disease progression, and 24 million Americans with diagnosed HF need better monitoring to reduce the high hospital readmission rates (25% within 30 days; 50% within 6 months). This epidemic of HF is causing a significant burden on our health care system, with $20 billion in direct medical cost related to HF and $1 billion in in-patient hospital costs annually. Clinical interventions based on standard measurements (blood pressure, weight, electrocardiograms) have not demonstrated a significant reduction in readmissions or all-cause mortality within 180 days after enrollment. Successful treatment may be determined from 2D transthoracic echocardiography (echo) or right heart catherization, but these gold standard methods have limitations of cost, accessibility, and availability of sonographers and cardiologists. An alternative is the HEMOTAG CardioPulmonary Assessment System (CPAS), a new cloud-connected medical device that delivers cardiac time intervals comparable to the gold standard measurements of an echo from an easy-to-use, noninvasive device accessible via any smartphone.

Objective: Given the clinical and economic impact of LV dysfunction and in view of the cost and accessibility of existing devices, there is a need for accurate, absolute, and actionable measurements, available instantly through a noninvasive and easy-to-use system. With the ability of provide rapid assessment of LV dysfunction in adults, keeping patients healthy and safe. The objective of the current study was to compare HEMOTAG to an echo for accuracy in assessment of LV dysfunction, using heart sounds and an ECG signal transduced via 3 thoracic electrodes.

Methods: One hundred twenty-three consecutive patients undergoing 2D transthoracic echocardiograms were recruited at an outpatient cardiology clinic from March 2016 through February 2017. Conventional echo variables and cardiac time intervals were assessed, and all patients were analyzed using HEMOTAG which recorded multi-channel acoustic and ECG data. LV dysfunction was assessed using the 2016 American Society of Echocardiography (ASE) standard and compared to cardiac time intervals from HEMOTAG. Patients were separated by age for comparisons. HEMOTAG indices were then assessed to identify normal/abnormal LV function.

Results: ASE diagnoses: 46 normal, 21 heart failure with preserved ejection fraction (HFpEF), 15 heart failure with reduced ejection fraction (HFrEF), and 41 indeterminate patients. HFrEF was defined as EF <53%, and systolic time ratio (STR=pre-ejection period/ejection time). 0.3 was a sensitive measure for detecting reduced EF as in HFrEF. Detecting EF <53% in patients older than 60: HEMOTAG STR sensitivity=65%, specificity=80%, AUC=.765; Echo STR sensitivity=85%, specificity=80%, AUC=0.895.

Conclusions: HEMOTAG represents a potentially widely applicable technology for the assessment of LV dysfunction via a noninvasive approach, providing absolute assessment (without requiring certified technicians to operate or interpretation of an echo) and enabling rapid, real-time, anywhere, anytime assessment of LV dysfunction.

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KEYWORDS

diabetes mellitus, type 2; left ventricular dysfunction; heart failure; Framingham index; ejection fraction

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Abstract

Pilot Study Evaluating the Usability and Acceptability of a Mobile App for Overactive Bladder Disease Management

Connor Devoe[1]; Sunetra Bane[1], MPH; Jaclyn Hirschey[1]; Ramya Palacholla[1,2,3], MD, MPH; Amanda Centi[1], PhD; Sharon Odametey[1,2,3], MPH; Stephen Agboola[1,2,3], MD, MPH; Kamal Jethwani[1,2,3], MD, MPH; Joseph Kvedar[1,2,3], MD

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Abstract

Background: Overactive bladder (OAB), defined by urinary urgency with or without urge urinary incontinence (UI), usually with frequency and nocturia, can significantly impact patient's quality of life. Tracking symptoms is an important part of OAB management and has been shown to assist in enhancing patient interaction with health care providers (HCP) when discussing solutions for symptom management.

Objective: The primary goal of this study was to assess the usability and acceptability of an Android smartphone mobile app designed to help participants learn about OAB symptom management through tracking and self-management. Secondarily, we also assessed engagement with the app over the three-month study period.

Methods: Eligible participants were experiencing OAB symptoms without an existing enlarged prostate or urinary tract infection (BPH/UTI), and enrolled through referrals from within the Partners Healthcare network. The mobile app was installed at the enrollment visit, and participants were instructed to complete monthly, 3-day symptom journals, as well as surveys and optional free-text notes for 12 weeks. Additionally, medication reminders, Kegel and bladder training exercises were available for use in the app. A visit with their HCP was scheduled between weeks 6 and 12 of the study for the HCP and participant to review collected symptom data via an app-linked portal. Qualitative input from the HCP, closeout participant interviews and app usage data (percent viewed and number of hits) were used to assess participant engagement. Closeout interviews (n=10) also assessed usability of the various app features. Demographic and usability satisfaction data were collected via questionnaires developed by investigators. Descriptive analyses were conducted to present the demographic and usability data. NVivo for Mac (version 11) was used to conduct a thematic analysis on qualitative data.

Results: Of the total enrolled (n=33), 26 participants completed the study. Participant engagement with the app was 100% for months one and two of the study then dropped to 72% by month three. Most participants (80%) reported using the app as needed vs regularly. As a group, female participants >50 years demonstrated the highest engagement (75%) at closeout. The most used app feature was the free-text diary feature (100%; 5516 hits), followed by the "event log" (100%; 2105 hits). The majority of other app features were also rated as useful by participants (52-100%). Participant interviews found the app was a valuable OAB information source, simplifying symptom tracking and follow-through on clinician recommendations. Perceived usefulness of the portal varied between primary care providers and specialists. Participants indicated the app was "Easy to Learn" (96%), "Simple to Use" (92%), useful for understanding changes in symptoms (91%), enabled better symptom tracking (96%), and facilitated communication with their HCP (75%).

Conclusions: A mobile app to increase awareness of OAB symptoms improved confidence in self-management for participants and increased access to data for decision making and participant communication for specialists. Participant-reported outcomes indicate that the tracking void frequency and urgency features were very useful, while other features such as medication reminders, pad usage, bladder and Kegel trainings were used less frequently among participants.

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KEYWORDS

self-management; overactive bladder; user-centered design; mobile application; usability

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Abstract

Use of Featforward Mobile Phone App Associated with Decreased Cardiometabolic Risk Factors in Patients with Chronic Conditions

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Abstract

Background: Physical inactivity is one of the leading risk factors contributing to rising rates of chronic diseases and has been associated with deleterious health outcomes in patients with chronic disease conditions. FeatForward is a mobile phone app designed to encourage patients with cardiometabolic risk (CMR) factors to increase their levels of physical activity.

Objective: To evaluate the effect of the FeatForward mobile phone app on physical activity levels (primary outcome) and global CMR factors (secondary outcomes) in patients with chronic conditions.

Methods: In this 6-month, 2-arm randomized controlled trial, adult participants endorsing at least 1 study-eligible condition (obesity, [pre-]diabetes, [pre-]hypertension) were enrolled and assigned to either the intervention group (FeatForward app and standard care) or control group (standard care only). The primary and secondary outcomes were, respectively, change from baseline in physical activity (step count) and CMR factors (weight, body mass index [BMI], waist circumference, glycated hemoglobin [HbA_{1c}], fasting blood glucose, systolic/diastolic blood pressures, serum lipids, C-reactive protein [CRP]). CMR data were collected at 3 time-points: baseline, 3 months, and 6 months. Step count data were recorded continuously by patients' study-issued activity trackers and collected in batches at 3 and 6 months. At study end, patients' weekly average step counts (WAS) were calculated as total steps taken divided by days of step data (0-7) for each of 26 study weeks. Mixed-effects linear regression models evaluated change over time between groups for the primary outcome and secondary outcomes. All models controlled for baseline values. The step count model additionally controlled for proportion of days without data, defined as (7 – days of data) / 7. Analyses were conducted for both groups overall, and by disease cohort (obesity, diabetes, hypertension).

Results: Step count and CMR data were analyzed for 128 intervention and 133 control patients. There were no demographic differences between groups. While there was an overall downward trend in WAS for both groups, the intervention group decreased significantly less than the control group, with a slope of -29.3 steps per week compared to controls' -57.9 (P=.02). Intervention patients with obesity slightly increased their step count overtime, differing significantly from controls (slope of 0.9 vs -90.2; P<.001). Intervention patients significantly lowered their BMI per study month compared to controls (slopes -0.23 vs -0.02; P=.04). Additionally, intervention patients with hypertension significantly decreased weight (P=.003), BMI (P=.002), and CRP (P=.03) per month compared to the control group. Waist circumference, HbA_{1c}, fasting blood glucose, blood pressure, and lipids did not differ significantly by group or disease cohort over time.

Conclusions: While it is common for patient engagement with physical activity trackers to decrease over the course of a study, patients using the FeatFoward app had a slower decline in physical activity compared to controls. Intervention patients experienced a reduction in their BMI from a mean of 34.3 to 33.4, compared to controls' 34.8 to 35.0. Patients with hypertension experienced significant decreases in BMI, weight, and CRP compared to controls. Future analyses will evaluate the impact of app engagement levels on step counts and CMR factors for the intervention group.

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KEYWORDS

physical activity; chronic disease; mixed-effects linear regression

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Abstract

Value and Acceptability of a Novel Machine Learning Technology for Heart Failure Readmission Reduction: Qualitative Analysis of Clinical Roles and Workflows

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Abstract

Background: Despite widespread adoption and demonstrated value in a range of industries, machine learning predictive algorithms are yet to be routinely used in frontline medical care. Significant health system and industry-based resources are allocated towards validating and refining predictive algorithms for a range of applications to ensure accuracy and reliability. For these algorithms to be useful and useable, further work is required to understand how and why they might fit into, and augment existing clinical workflows.

Objective: This qualitative study assessed the value and usability of a novel machine learning technology to predict and explain the risk of 30-day hospital readmission in patients with heart failure (HF). It involved exploring opportunities for integration of the technology within existing clinical workflows, and investigating key roles that use current readmission risk scores and may use future scores.

Methods: Semi-structured interviews (n=27) and targeted observations (n=3) were carried out with key stakeholders, including physicians, nurses, hospital administration, and non-clinical support staff. Participants were recruited from cardiology and general medicine units at an academic medical center within the Partners HealthCare system. Data was analyzed via inductive thematic and workflow analysis. Findings were validated via member checking across limited key roles (n=3).

Results: Results highlighted a number of factors that were deemed necessary by staff for successful integration of a risk prediction tool into existing clinical workflow. These included, but were not limited to the following. Staff clearly stated that any new tool must be easily accessible from within the electronic health record, which dictates the majority of existing clinical workflow. Staff emphasized that information should be consistently accurate and that any display must be digestible efficiently, intuitively and quickly (ie, within <5 seconds). Additionally, staff discussed that outputs of the risk prediction tool must match their clinical intuition, experience and interactions with the patient. To be truly valuable, the tool must also provide added value over and above these factors: some staff indicated that provision of role-specific and actionable next steps based on the system output would provide novel value to their daily work. Using these considerations, a number of role groups were identified as potentially able to derive value from the proposed risk prediction tool, including case managers, attending RNs, responding clinicians, hospital administration staff, nursing directors and attending physicians. Acceptability and value varied by role, specialization and clinical context. For example, cardiology-trained clinicians reported feeling well-versed in providing good clinical care and minimizing preventable readmissions, and thus saw less value in the tool. General medicine staff, however, indicated that a HF-specific tool may be impractical for their day-to-day work given the range of clinical presentations seen by them.

Conclusions: Findings resonate with existing literature around successful implementation and adoption of technologies in health care. Frontline clinicians are incredibly discerning around proposed changes to their existing workflow. Many HF readmission risk tools and initiatives have been trialled with mixed success; frontline staff demonstrated fatigue around piloting new initiatives.

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However, given the right conditions, staff reported some perceived value in machine learning-based tools to improve their daily work.

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KEYWORDS

machine learning; artificial intelligence; big data; heart failure; hospital readmissions; readmission risk; human centered design; health care

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Abstract

Prospective Real-World Performance Evaluation of a Machine Learning Algorithm to Predict 30-Day Readmissions in Patients with Heart Failure Using Electronic Medical Record Data

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Abstract

Background: Heart failure (HF) patients have a high readmission rate with approximately 20% of patients being readmitted within 30-days after discharge. Hospital interventions to reduce HF readmissions are resource- and effort-intensive. Widespread availability of electronic medical record data has spurred interest in using machine learning-based techniques for risk stratification of heart failure patients. The predictive performance of machine learning-based predictive models is often evaluated solely using the Area Under the Receiver Operating Characteristic (AUROC) curve. However, the AUROC is independent of prevalence therefore predictive models with the same AUROC can have differential clinical utility. Furthermore, the AUROC does not provide any insight about the presence of overfitting or decay in predictive performance of a model over time, both of which can affect its real-world performance.

Objective: Our primary objective is to assess real-world performance of a 30-day readmission risk prediction model for HF patients, which had an AUROC of 0.71 in the training dataset.

Methods: Predictions for risk of 30-day readmissions in HF patients in the Partners Healthcare System were prospectively obtained from the model. We assessed the positive (PPV) and negative predictive value (NPV), in addition to sensitivity, specificity, accuracy, model calibration and Brier score.

Results: Four hundred twenty index admissions that were not part of the training dataset were included in this prospective evaluation. Readmission rate was 24% (101 30-day readmissions). The AUROC of the predictive model was 0.57. At a discrimination threshold of 0.2 for flagging high-risk index admissions, the sensitivity and specificity of the model were 53.46% and 63.32%, respectively. The PPV and NPV were 31.57% and 81.12%, respectively. The Brier score was 0.19.

Conclusions: Our analysis offers important insights about the real-world performance of this predictive model. The NPV suggests that the model's prediction about patients at low risk for readmission are reliable. This insight can be useful in optimizing resource allocation for patients with heart failure.

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KEYWORDS

accuracy; machine learning; positive predictive value; validation

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Abstract

Provider and Patient-Related Barriers to and Facilitators of Digital Health Adoption for Hypertension Management: Review

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Abstract

Background: Management of hypertension employing digital health technologies (DHT) has been proven to improve long-term patient outcomes. However, the uptake of DHT has been surprisingly low in clinical practice. Despite showing great promise to improve patient outcomes and disease management, there is limited information on the factors that contribute to the limited adoption of DHT particularly for hypertension management.

Objective: This review provides a comprehensive summary of barriers to and facilitators of DHT adoption for hypertension management reported in the published literature with a focus on provider and patient-related perspectives.

Methods: This review was conducted using the methodological framework developed by Arskey and O'Malley. Systematic literature searches were conducted on PubMed/ Medline, CINAHL, and EMBASE. Articles that reported on barriers to and/or facilitators of digital health adoption for hypertension management, published in English between 2008 and 2017 were eligible. Studies not reporting on barriers or facilitators to DHT adoption for management of hypertension were excluded. A total of 2299 articles were identified based on criteria above after removing duplicates and were assessed for eligibility. Of these, 2165 references did not meet the inclusion criteria. After assessing 134 studies in full-text, 98 studies were excluded (full texts were unavailable or studies did not fulfill the inclusion criteria) resulting in a final set of 32 articles. Four hand-picked articles were also included in the review.

Results: A total of 36 studies were selected for data extraction after abstract and full-text screening by two independent reviewers. All conflicts were resolved by a third reviewer. Thematic analysis was conducted to identify major themes pertaining to barriers and facilitators of DHT from both provider and patient perspectives. Key facilitators of DHT adoption by physicians identified include integration with clinical workflow, ease of use, improvement in patient outcomes and organizational support. Improved patient-provider relationship, positive impact on well-being and self-management were most frequently reported facilitators for patients. Barriers to use of DHTs reported by physicians include mistrust in technology, data security, lack of usability, and organizational support and commitment to DHT adoption. Finally, a lack of perceived benefit from technology, lack of ease of use and concern over data security were some of the barriers commonly reported by patients.

Conclusions: Although technology has evolved at a rapid pace, many facilitators and barriers reported by patients and providers are consistent over time. Our findings suggest the settings and context in which DHT are implemented, and individuals involved in implementation such as providers, patients and leadership influence adoption in healthcare settings. Real-world testing and incorporating feedback from key stakeholders including patients, providers and hospital management while designing DHT will improve their usability and thereby the adoption. Finally, to fully realize the potential of digitally enabled hypertension management, there is a greater need to validate these technologies to provide patients and providers with reliable and accurate information on both clinical outcomes and cost effectiveness.

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KEYWORDS

barriers; health; digital; patient; provider

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Abstract

Patient Experience Connecting Mobile-Based Self-Monitoring of Diet and Physical Activity to Diabetes Educators through a Connected Interface in an Electronic System for Diabetes Education

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Abstract

Background: Smartphone applications and wearable activity trackers have become popular tools in recent years in managing chronic diseases such as diabetes. More recently, studies have focused on connecting patient-generated health data from mobile devices directly to health care providers and educators. However, not much is known regarding the patient experience in using these mobile devices for diabetes management, particularly the implications of allowing educators direct access to patients' diet and exercise data.

Objective: The objective of this study was to identify patients' perceived benefits and concerns about using a smartphone application and wristband activity tracker to monitor diet and physical activity, as well as the perceived benefits and concerns of allowing educators access to such data.

Methods: We conducted a qualitative, descriptive study as an axillary study to a clinical trial testing a connected interface to link patient self-monitoring diet and physical activity to a nationally used electronic diabetes education system. Our axillary study examined 13 type 2 diabetes patients' views on perceived benefits and concerns about using a smartphone application and wristband activity tracker to monitor diet and physical activity for three months. A focus group interview was administered to obtain general and specific understanding of the use of smartphone applications and activity trackers during the study period. The central interview questions guiding the discussion included "What did you think about the UP24 wristband and app?", "What are your thoughts about the connection of UP24 data with Chronicle, the Web-based diabetes education system, so that your diabetes educators can see your behavior?", and "Has knowing that someone else has access to your diet and exercise data affected your behavior and self-monitoring?" The interviewer also asked specific questions to gain deeper understanding of the following topics: (1) the app and wristband features used to record and monitor diet and physical activity, (2) materials used for intervention orientation, (3) additional data (eg, weight and blood glucose) that participants would like to share with educators, and (4) suggestions for improvement in diabetes self-management and communication with educators and physicians. The focus group sessions were audio-recorded and transcribed. Transcribed data were analyzed to identify key themes based on interpretive coding procedures.

Results: We identified 11 key themes under three major categories and described these themes with illustrative quotations. The three major categories of themes covered (1) self-monitoring themes: varied experience and self-monitoring patterns and adherence exist among patients using the wearable tracker and its companion smartphone application; (2) themes related to sharing self-monitoring of diet and physical activity data with diabetes educators: sharing self-monitoring diet influences patient self-monitoring adherence and dietary and activity changes, and communication with educators; and (3) research study-related themes: technical barriers, utilization of manuals and tutorial videos in beginning use of the connected health tools, and desired features on combining lifestyle data with glucose data and caregiver access.

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Conclusions: Connected technology aiming to incorporate patient-generated health lifestyle data into clinical workflow should consider patient perspectives in terms of their experience and motivation for generating and sharing such data and technical barriers in using such tools.

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activity monitoring; chronic disease; chronic disease management; dietary assessment; mobile health; mobile technology; diabetes

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Abstract

Zooming Towards Better Health: Participant Experience in a Web-Based Group Cognitive Behavioral Intervention

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Abstract

Background: Internet-based Cognitive Behavioral Therapy (CBT) is effective in the management of several medical conditions such as anxiety and depression. The CBT method addresses the interaction between people's thoughts, feelings, and behavior, and has also been shown to be an effective strategy for patients with dementia and comorbid anxiety. However, no study has evaluated an internet-based group CBT for prevention of dementia in high risk patient groups such as African American people. African American people have twice the risk of developing dementia compared to white people. Therefore, more targeted and easy-to-access interventions are urgently needed in this group.

Objective: The purpose of this study was to survey participant evaluation of the Web-based CBT program for African American people with mild cognitive impairment.

Methods: The LIGHT (Lifestyle Intervention Guidance for a Healthier Tomorrow) study program is a six-month pilot study that aims to test the feasibility and acceptability of CBT in African American people with a diagnosis of MCI through group video conferencing compared with in-person group CBT sessions. Ten participants were randomized to each study arm. An anonymous online survey using Likert scales was administered to study participants to measure the acceptability and feasibility of CBT using Web-based video conferencing via the Zoom application after each session. The survey also included open-ended questions to gauge additional feedback from the participants.

Results: Eighty-three percent of participants (5 out of 6 respondents) in the Web-based arm rated the ease of use of the Zoom technology positively (ie, either very easy or easy to use on a Likert scale). Sixty-seven percent of participants (4 out of 6 respondents) rated that the computerized CBT can be an effective medium to improve health and healthy behaviors. All respondents rated the helpfulness of the online sessions as "most helpful" (50%), "helpful" (33%), or "neutral" (17%). In response to open-ended questions, participants stated that the online sessions were "on spot, in the moment counseling," provided "the ability to interact with others of varied backgrounds, experiencing similar issues," "convenience of being at home versus traveling to a particular location is a tremendous plus," and that "(the sessions) afford the group a certain level of anonymity with the choice of when and/or whether or not to share in the discussions." Other key phrases that were stated included saving travel expenses, time, being cost efficient but at the same time allowing a diverse population to participate. Participants mentioned having the occasional technical difficulty, and one respondent mentioned the lack of physical interaction as a disadvantage. Four participants did not complete the survey.

Conclusions: African American participants with MCI rated Web-based group CBT interventions as helpful to improve healthy behaviors. Participants noted that that Web sessions are easy to use, as they can interact with each other in a group setting from their own homes. Our survey provides preliminary evidence regarding the potential for a Web-based group CBT protocol as a useful modality for interventions designed to improve lifestyle and reduce the risk of dementia in African American people. Ongoing research will further test the effectiveness of the Web-method of treatment delivery.

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KEYWORDS

African American; CBT; cognitive impairment not dementia; computerized cognitive behavior therapy; online survey; online CBT; MCI

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Abstract

Using Qualitative Analysis to Assess a Model of Support for Online Health Communities for People Living with Chronic Health Conditions

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Abstract

Background: Online health communities (OHC) can be a powerful tool to facilitate communication among patients, professionals and family members who live with or care for someone with a chronic health condition(s). Health Union LLC's OHC model engages, empowers and encourages people to take an active role in their health by providing content that aligns with their needs and interests and by cultivating a safe environment where communication, understanding and meaningful relationships can thrive. OHCs included in this study target people living with multiple sclerosis, migraine, IBS, rheumatoid arthritis, lung cancer, and prostate cancer.

Objective: Using qualitative methods we sought to determine if constructs in the Health Union OHC model are supported by themes identified in OHC participant comments. Key components of the model to be tested include: content tailored to needs of community, facilitation, and encouragement of social support, active moderation, opportunities for active and passive engagement, and transparency of community norms and rules.

Methods: A sample of over 5800 comments exported from over 40 Facebook posts from 6 OHCs was analyzed using the Dedoose qualitative data analysis software. Comments from these Facebook posts were extracted, imported into Dedoose software and coded. Interrater reliability of initial coding was calculated using Pearson Correlation Coefficient. An exploratory approach was taken in the analysis and initial codes were grouped into thematic categories and then confirmed through thematic network/framework analysis using the Dedosse software tool. Thematic categories were compared for similarity and differences for each of the 6 OHCs, original post type, and by the extent of active moderation evident in each comment thread.

Results: Qualitative thematic network analysis of posts and comments from 6 OHCs correspond to the primary components of the Health Union OHC model. This analysis suggests that the structural elements of the OHC model, including active site moderation, support high levels of community engagement and information sharing and mutual support of OHC participants.

Conclusions: Qualitative data from the 6 OHCs demonstrates the positive impact the community has on participants, often helping them reframe their health care experience and coping strategies. The principle of adaptive engagement is demonstrated by the thematic network analysis and illustrates the Health Union OHC model constructs. Different community segments have different patterns of engagement. Our primary focus on the content of participant comments in this analysis is a current limitation. While we also examine more passive methods of liking and sharing posts utilized by OHC participants, these may warrant further analysis. This study has practical significance as it helps to demonstrate the value of online health communities for people living with chronic health conditions by providing meaningful engagement, support, and information in an accessible environment.

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KEYWORDS

online patient communities; qualitative research; social media; social sharing; social support

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Abstract

Integrating Technology into Clinical Care to Improve Outcomes in Panic Disorder: Use of Safety Behaviors and Resulting Anxiety as Assessed by Smartphone-Based Experience Sampling Methods

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Abstract

Background: Research in mental health conditions such as panic disorder suffers from issues related to the means of assessing the condition and its contributing factors by self-report in the office setting. The integration of real time technologies into research is critically needed. Panic disorder is the fifth leading cause of missed work days across all chronic medical conditions, and anxiety disorders are estimated to cost more than $40 billion annually in the United States (Greenberg et al, 1999). Panic attacks occur in approximately 23% of the general population (Kessler et al, 2006) and cause substantial functional and social impairment, as well as significant financial burden on the health care system. While effective treatments for panic disorder exist, more than half of patients do not improve, remain symptomatic post-treatment, or return to treatment within two years (Brown & Barlow, 1995; Gloster et al, 2013). Very little is known about what treatment will work for each patient and why. New technologies allow us to identify individual factors that may be important to treatment outcomes. This pilot study aimed to bridge the gap between the human element and technology using smartphones to more efficiently investigate a factor that may contribute to lack of remission in panic disorder, the use of safety behaviors. Safety behaviors represent ineffective attempts to reduce or eliminate anxiety (eg, carrying a water bottle to reduce physiological sensations that arise during anxiety; Helbig-Lang & Petermann, 2010). They are hypothesized with mixed evidence to play a central role in the etiology and maintenance of anxiety disorders, including panic disorder. Existing studies are limited in their temporal conclusions and ecological validity. New technologies such as smartphones permit time-intensive investigation of these phenomena in the natural environment in which they occur, thus improving external validity.

Objective: To examine the effect of safety behavior use on anxiety response in panic disorder using smartphone-based ecological momentary assessment.

Methods: Participants (N=13) were adults with panic disorder. For 14 days, participants answered a brief smartphone-based questionnaire of panic symptom severity and safety behavior use 5 times a day.

Results: Analyses were conducted using N=910 data points from participants (N=13). Safety behavior use was highly correlated with anxiety and predictive of later anxiety level. Increased safety behavior use at time 1 predicted increased anxiety at times 2, 3, 4, and 5 (t[1,100] values > 4.26; P values <.001). Safety behavior use at time 1 was a significant predictor of anxiety at time 2, even when controlling for anxiety at time 1 (t[2,103]=2.83; *P*=.006).

Conclusions: This study was novel in its approach to combine smartphone-based ecological momentary assessment with traditional clinical report, overcoming challenges in later retrospective reporting such as temporality and recall biases. In line with theoretical conceptualizations of panic disorder, our findings support that individuals engage in safety behaviors when anxious and that safety behavior use then robustly maintains and even heightens anxiety. Future directions for novel technological, statistical, and personalized approaches to expand our understanding of safety behaviors in anxiety disorders and implications for treatment will be discussed.

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anxiety; anxiety disorders; ecological momentary assessment; panic disorder; smartphone; treatment

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Abstract

Mobile Game–Based Digital Vaccine for Reducing Risk of Lifestyle Diseases

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Abstract

Background: There is a rising epidemic of pediatric obesity in the United States and worldwide. While many factors contribute to pediatric overweight and obesity, dietary decisions are a leading cause. Children spend many hours a day playing video games, mostly on mobile devices. Hence, personalized gamification and learnification on mobile devices have great potential to influence children's dietary-lifestyle behaviors during the habit formation stage of early childhood. In fact, video games on mobile devices have become a platform through which children learn in a fun and enjoyable way. While there is some early evidence of the positive impact of neuropsychology-based, cartoon-styled, immersive video games on healthy eating behaviors in children, the mechanisms underlying these improved outcomes are yet to be understood.

Objective: To design appropriate interventions in the game environment for children's behavior formation and change, we need to learn more about the underlying patterns of player behaviors evidenced during gameplay through techniques of machine learning and stochastic optimization. Building on prior descriptive work, this study examines the impact of a diet and lifestyle focused mobile game on children's game play patterns and associate these patterns with their actual food choices using machine learning and statistical models.

Methods: Our dataset was generated from an IRB-approved, informed consent–based randomized controlled trial (RCT) with pre- and post-treatment measurements of almost 100 school children using fooya!, a novel mobile gaming, iOS/Android based App that is being developed as a low-risk and non-invasive "digital vaccine" for lifestyle diseases, for 2 exposures of 20 minutes each. Based on artificial intelligence, neuropsychology and cognitive behavior therapy, fooya! has been shown to deliver positive outcomes with respect to food choices, self-reported dietary choices, and healthy eating intentions. We first model the process of game playing at any level across all students as a discrete, time-homogeneous, first-order Markov chain with multiple states, each representing a status of the game. Process mining identifies distinct patterns in the game sequences and statistical models establish the relationship between game patterns combined with demographic and behavioral data with actual food choices at the end of the game.

Results: We find strong evidence of the positive effect of the mobile game on actual food choices, just after 40 minutes of intervention exposure (T: 2.46; C: 1.10; P<.001). Analysis of children's play patterns shows significant variations in game play mechanics among players. Regression analyses further reveal that more engaged, dynamic, and strategic game play patterns are associated with better actual food choices.

Conclusions: This study adds to the growing body of evidence that learning about healthy eating in a fun and exciting way via mobile games, acting as Digital Vaccines, can positively impact children's actual food choices. While promising, additional RCTs

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in varied settings and deeper analysis of the resulting data are needed to confirm Digital Vaccines' potential to reduce the long-term risk of nutrition related non-communicable diseases such as diabetes and cardiovascular disease, as well as health risks from the double burden of overweight vs malnutrition and under-nutrition by educating children regarding healthy lifestyle choices using mobile games.

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Abstract

The Addition of Asynchronous Chat-Based Coaching to a Digital Behavioral Health Tool Promotes Support and Personalization

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Abstract

Background: Digital behavioral health (BH) tools can help improve or maintain BH conditions such as depression, anxiety, substance abuse, stress, chronic pain or insomnia; the efficacy of digital self-care tools can be enhanced via addition of human touch-points.

Objective: The objective of this study was to evaluate the feasibility and acceptability of adding asynchronous chat-based coaching to the myStrength digital BH platform.

Methods: Participants who were at least 18 years old, fluent in English and readily able to access the internet were recruited via Craigslist advertisements to participate in a pilot intervention. Participants were asked to use the digital tool at least 2 times per week and to communicate via online chat with a coach at least 2 times per week. Participants completed online surveys at 2 weeks, 4 weeks and 6 weeks, and completed a 30 minute telephone interview between 5 weeks and 6 weeks.

Results: Of 226 who responded to the advertisement, 200 people were invited to participate, 134 engaged in coaching initially and 96 completed the final interview. Seventy-eight percent of participants were female, 62% were white, 23% were black, 8% were Hispanic and 6% were Asian. One-fifth were in treatment with a BH provider, one-fifth received BH care from a medical provider, and 22% were taking BH medications. In response to the question, “On a scale of 0-10, how helpful has your coach been over the past 2-weeks,” the mean score and standard deviation were 7.5±2.4 at 2 weeks, 8.2±1.9 at 4 weeks and 8.6±1.9 at 6 weeks. Satisfaction with coaching was 7.6±2.5 (out of 10) at 2 weeks and 8.3±1.9 at 4 weeks. Participants felt that coaching increased the value of the digital tool, with a mean rating of 8.4±1.9 (out of 10). Three-quarters of participants felt that the encouragement coaches provided was the most helpful aspect, followed by guidance to specific resources (53%), support (51%), connection to another person (42%), and assurance (40%). These findings were corroborated in the qualitative data; participants emphasized the value of having personalized suggestions amidst a large breadth of content, an outside perspective, and greatly appreciated the “human contact in a digital world.” The coach-patient relationship strengthened over time (2-weeks vs 6-weeks): 78% vs 93% felt that the coach discussed things that were important to the participant; 78% vs 90% felt that the coach liked and understood them; 85% vs 93% felt the interaction with their coach was helpful; 77% vs 88% had confidence in the working relationship with their coach (all $P<0.05$). Eighty-one percent of participants reported that they would prefer to work with the same coach over time whereas 19% would have preferred to talk with a coach in real time.

Conclusions: The addition of asynchronous coaching to a digital BH platform was well received, perceived as helpful, and promoted a more personalized experience with the digital BH tool that improved over time; future studies will evaluate impact on clinical outcomes and engagement. The added human element helped participants feel supported in their struggles with BH issues and has the potential to help increase engagement to myStrength’s effective, evidence-based, well-being resources.

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KEYWORDS

behavioral health; chat; coaching

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Abstract

Improving Adherence to PrEP Though Real-Time Monitoring Paired with Personalized, Automated Text Interventions

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Abstract

Background: Pre-exposure prophylaxis, or PrEP (brand name Truvada), is a once daily medication that reduces the chance of contracting HIV by more than 90% for those facing an elevated risk of HIV exposure. When starting PrEP, it takes at least seven days to reach high levels of protection and seven consecutive days to maintain protection. Unfortunately, many do not follow the guidelines for PrEP, leaving them vulnerable. Metro Wellness and Community Centers (Metro Wellness) provides comprehensive HIV services throughout Tampa Bay. Metro Wellness, with Mail-Meds Clinical Pharmacy (Mail-Meds), deployed a new technology, Nomi, to support patients in their journey of HIV prevention. Nomi accurately captures data through a connected prescription bottle to reveal how patients take their medications in real-time. Nomi translates data into actionable information for automatic patient interventions and engagement.

Objective: To understand patients' ability to adopt innovative technology to maintain adherence to the PrEP regimen. In addition, the study will determine if technology converts non adherent days to adherent through automated, personalized interventions.

Methods: Patients enrolled in Nomi must be HIV negative, at high-risk for HIV infection, receiving PrEP for the first time through Metro Wellness, and have a cell phone with SMS capabilities. Patients receive their Truvada prescription in a connected bottle that measures the amount of medication taken by weight. The prescriptions are filled by Mail-Meds in clinic pharmacy. As patients take Truvada, the bottle sends data to Nomi. Nomi reviews the data and sends automatic text interventions and escalations based on the patient's behavior. The texts sent are designed to be discrete to ensure patient privacy. Nomi also communicates with Metro Wellness staff. Staff receive escalations from Nomi to reach out the patents needing additional assistance.

Results: The program is ongoing. All reported results are as of July 31, 2018. Forty-nine patients have been enrolled. Days on therapy range from 29 to 378. The average length of therapy is 107 days. Reasons for ending therapy include, patients changing prescribers, declining therapy, and side effects. A total of 1914 SMS text interventions have been sent. Patients need an intervention 24% of the time and convert 48% (n=917) of the time. Additionally, 45% of conversions (n=412) occurred within 1 hour of the intervention. Ninety percent (n=44) of the patients responded directly to Nomi at least once. A total of 564 total responses have been received. Each patient has sent an average of 13 responses.

Conclusions: Patients had no perceived barriers to adopting Nomi. In fact, patients enjoy participating and interact frequently through responses. Personalized interventions, based on real-time data, quickly change patient behavior from what would have been a missed day, to a correct day. Metro Wellness integrated Nomi and medication adherence into the daily lives of their patients, through a direct communication channel. By using Nomi, Metro Wellness staff is able to connect with their patients more frequently, building stronger relationships, which has improved adherence in order to prevent HIV infection.

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KEYWORDS

behavior change; HIV/AIDS; interventions; medication adherence; real-time surveillance; tailored messaging; text messaging

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Abstract

Designing Connected Health Interventions for Emerging Mobile Users

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Abstract

Background: While mobile technologies have unlocked opportunities to address health care access and affordability gaps, billions of emerging mobile users are yet to reap the benefits of connected health.

Objective: We studied data enabled mobile phone ownership and behaviors amongst low income young Indian families. Our goal was to study the barriers to usage in this rapidly growing segment and how these barriers can be overcome to design meaningful health interventions.

Methods: Starting with secondary research, our team conducted primary research interviews in a group of 250 young families (pregnancy or an infant in the family) within six diverse low income communities in Mumbai and Delhi. The surveyed population represents the global segment of the next billion emerging mobile users. The hypotheses generated from our research were used for rapid prototype development, testing and iteration over two rounds with similar users in Mumbai. Prototype development was informed by learnings from commercial apps used by emerging mobile users that address patchy connectivity, low data speeds and cost conscious consumers. The prototype testing included qualitative and quantitative methods.

Results: Our primary research showed rapidly increasing and recent ownership of internet enabled phones (83%) in our surveyed population. 56% of users had acquired their smartphone in the last year and only 10% had owned a smartphone for more than 2 years. Phone ownership had a strong gender bias with only 39% women owned phones compared with 85% in men. Smartphone ownership was linked to monthly house income, rising from 35% ownership in households earning less than 20,000 INR to 90% in households earning 20,000-40,000 INR. Phone ownership across the same income segments increased dramatically in digitally ready neighborhoods that had a superior infrastructure and connectivity. The main reasons for not using the internet were lack of knowledge (80%), cost (57%), lack of local language content (39%) and lack of motivation (35%). Emerging mobile users were drawn to the internet primarily for entertainment (95%), social networking (82%), and online gaming (74%). Only 18% of the population was using internet to seek health care related information, and when they did, digital health information was reported as least reliable, with close to 90% of respondents ranking them lowest on the reliability scale. Our users were more likely to respond to the test mobile app when it was data light, transparent, and allowed for offline viewing and sharing. Behaviorally, reducing cognitive load significantly allowed users to make confident decisions. This meant creating linear user journeys, minimizing screen choices and nudging users towards specific messages using a combination of rewards and loss aversion techniques. Even though literate, our users responded overwhelmingly to visual and video content than to written text. Finally, activating the user journey on the app was much more powerful when done through a trusted community resource.

Conclusions: Slimming down existing health apps won't address the unique needs of emerging mobile users. Designing connected health interventions for the next billion mobile users requires multi-disciplinary teams to design content experiences and user journeys rooted in local ecosystems and tailored to the users' unique sensibilities.

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KEYWORDS

emerging mobile users; design; user experience; connected health

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Abstract

Digital Literacy: A Barrier to Adoption of Connected Health Technologies in Older Adults

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Abstract

Background: Adoption and effective use of digital health technologies is especially important for older adults, who bear the greatest burden of chronic disease. However, some older adults lack the digital literacy skills needed to reap the benefits of these tools. Despite the greater infiltration of smartphones in all age groups, including older adults, smartphone ownership does not equate to adept smartphone use. Impediments to smartphone use can impede adoption and use of digital health technologies that rely on apps.

Objective: Our objectives were to 1) determine the barriers to adoption and use of digital health technologies, specifically wearable activity trackers, by older adults; and 2) identify and test facilitators to adoption and use.

Methods: We recruited more than 100 older adults aged 50-75 who owned a smartphone for our tracker studies. We provided each participant with a tracker and hands-on support for its setup and use. Support was tailored to each participant's level of comfort and adeptness with his or her smartphone and new tracker, with the goal of having participants leave with a working tracker and an app they could engage with.

Results: While all participants owned a smartphone, we identified several barriers to successful engagement with their own smartphones as well as with their new trackers. Some older model or pay-as-you-go phones could not download apps. Many participants required assistance to download and setup an app, as well as sync their tracker to the app. In several cases, the use of jargon such as "sync with Bluetooth" required an explanation. Some app features required guidance, such as changing the default of 10,000 steps to one that was more achievable and realistic for older adults. Furthermore, the design of some tracker faces and bands were preferred or more comfortable for participants. We found that once participants were able to overcome barriers to setup through hands-on training, other facilitators, such as a visual reminder of their commitment to physical activity and the immediate gratification of seeing their activity reflected in the tracker and the app, kept them engaged with the tracker.

Conclusions: The digital health market is growing rapidly and has great potential to improve health outcomes, yet it is failing to reach and meet the needs of older adults. Poor digital literacy skills impede adoption of digital health technologies, and their effective use once adopted. While a high-touch approach to helping older adults overcome barriers to adoption and use of digital health technologies has proven to be a successful facilitator in our studies, the challenge is in bringing this approach to scale and applying it to both consumer- and medical-grade technologies. In future studies, we hope to build on this knowledge and further identify design and training solutions that can be scaled to increase successful engagement of digital health technologies by older adults.

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KEYWORDS

barriers; digital literacy; older adults; smartphone; trackers

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Abstract

Mobile Behavioral Therapy for Headache: Pilot Study

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Abstract

Background: Frequently recurring tension headaches, migraines, and orofacial pain affect over 2.4 billion people worldwide, representing the second most prevalent medical condition in the world. In-office behavioral therapy (ie, relaxation and mindfulness exercises) has been shown to be one of the most effective treatment options for these patients. However, it has been underutilized due to stigma, cost, and accessibility. Mobile health apps may be one way to provide accessible, lower cost care in a nonstigmatized environment. As a result, apps are becoming an increasingly popular method for delivering behavioral therapy interventions and may provide an effective means to reach this population.

Objective: The aim of this study was to assess the feasibility and acceptability of delivering a clinically validated behavioral therapy for migraine/headaches through a mobile app.

Methods: Twenty-one migraine or headache sufferers met the criteria for severe migraine disability determined by the MIDAS test. Participants completed a two-week baseline period in which they kept a daily headache diary through the Halo app. They then began a four-week intervention period. During this period they were instructed to complete ten minutes of relaxation training exercises provided by the app each day, as well as monitor headaches via the daily headache diary. Relaxation training exercises consisted of various breathing techniques, progressive muscle relaxation, and mindfulness. Headache frequency was tracked throughout the intervention period, and further assessments, such as an in-person interview and posttreatment MIDAS test, were completed at the end of the four-week intervention period.

Results: Analysis of data showed that there were significant differences between baseline scores (Headache Frequency Average=11.47/mo, MIDAS average=25.4) and postintervention follow-up (Headache Frequency Average=6.63/mo, MIDAS average=11.7, Frequency $P<.01$, MIDAS $P<.01$). Postintervention interviews revealed that more than 90% of the participants felt that the Halo beta app was easy to use and provided a benefit to the user. More than 85% of participants enjoyed using a daily headache diary and felt it gave them greater insights into their condition. More than 90% of the patients felt that the relaxation training had helped reduce the frequency of their headaches or headache related disability.

Conclusions: We found that mindfulness and relaxation-based interventions administered through the Halo beta app was a feasible and acceptable treatment for people suffering from frequently recurring headaches and migraines or disability associated with headaches and migraines. The pilot demonstrated the potential feasibility and usability of a mobile health app in delivering behavioral therapy for headache and migraine as an adjunct or alternative to in-office behavioral therapy for headache and migraine.

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KEYWORDS

app; applications; behavioral health; behavioral interventions; chronic conditions; pain; headache; migraine; chronic pain

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Abstract

Participant Engagement with a Hyper-Personalized Activity Tracking Smartphone App

Amanda Centi[1], PhD; Ramya Palacholla[1,2,3], MD, MPH; Sara Golas[1], MA; Odeta Dyrmishi[1], MPA; Stephen Agboola[1,2,3], MD, MPH; Kamal Jethwani[1,2,3], MD, MPH; Joseph Kvedar[1,2,3], MD

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Abstract

Background: Many mobile apps have been designed to monitor physical activity. While they may have many downloads, most users eventually stop using the app and become disengaged. We created a hyper-personalized physical activity tracking app to promote engagement with physical activity (PA) among users. It is unknown if this increased engagement and how engagement level may affect measured outcomes.

Objective: The purpose of this study was to determine how users engaged with a hyper personalized activity tracking app for 6 months and whether this engagement affected physical activity

Methods: Participants with cardiometabolic risk (CMR) factors were given an activity watch to track their PA (step counts) and asked to use the study mobile app for 6 months. App features included step tracking, personalized educational and motivational messages, biometric tracking and connection to a portal where their clinician could monitor their activity. App usage data were collected at 3- and 6-month study visits to determine app usage metrics for the 6 months. App engagement was determined by app usage metrics such as overall page clicks (number of clicks per page), frequency of use of individual features (number of clicks) and session length (time spent on a page). Participants were grouped by level of engagement with app (high, medium, low, none) post hoc to determine engagement effects on steps.

Results: Information was collected on 128 participants. Over the 6-month study, 60 participants (47%) engaged with the app. Among users, app usage decreased by over 50% with the highest app usage during month 1 followed by month 4. There was no difference in the average app session lengths at 0 and 6 months (12 vs 11 seconds, respectively). The most commonly viewed feature was the personalized daily messages (92% of participants used feature, 20,902 clicks, 58% of total views). At least 85% of app users engaged with all the features. Each additional day of app use was associated with a nonsignificant increase of 13 steps in overall average daily step count. Median days of app use were used to define groups with high, medium, and low engagement (median 89, 35 and 3 days of use respectively). The low engagement group had an average 1220 less steps per day than the high engagement group (P<.001). High engagement group's session length remained steady through the study period, compared to medium engagement group's session length that fluctuated widely. While steps decreased over the 6 months, those in the medium engagement group decreased in weekly step counts at a steeper slope then other engagement groups.

Conclusions: While participants engaged with most app features, we observed a 50% decrease in engagement over the 6-month study. Despite this result, those with high engagement were able to achieve more physical activity than those with low engagement. This increase in physical activity may lead to improvements in CMR factors and better quality of life.

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KEYWORDS

engagement; physical activity; smartphone

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Abstract

Exploring Efficacy of a Serious Game (TOBBSTOP) for Smoking Cessation in Pregnant Women: Pilot Case-Control Study

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Abstract

Background: Tobacco use entails, during pregnancy, a serious risk to the mother and harmful effects on the development of the child. Europa has the highest tobacco smoking prevalence (19.3%) as compared to a worldwide mean of 6.8%. Twenty to thirty percent of pregnant women used tobacco during pregnancy worldwide. These data emphasize the urgent need for community education and implementation of prevention strategies focused on risks associated to tobacco use during pregnancy.

Objective: This study aims to investigate the possibility to address this problem through a serious game (TOBBSTOP), something that has proven efficient as a tool for learning in many situations. By using a game for smoke cessation during pregnancy, we aim to maintain cessation and interest pregnant smokers in learning about health care and effects of tobacco by playing a game that helps them to achieve their challenge.

Methods: A pilot case-control study enrolls 44 women who were visited in two primary care centers in Spain between March 2015 and November 2016. All participants were pregnant smokers over the age of 17 years attending consultation to a midwife during the first trimester of pregnancy who expressed their desire to stop smoking. We recruited the intervention group (n=22) among the attended on the centers and instructed them to install the game on their smartphone or tablet and use it for 3 months. Until the delivery, all participants had to respond to a questionnaire, assessing their stage on smoke cessation during their follow-up midwife consultations. The selected control group participants (n=22), matched for age, level of tobacco-dependence and number of smoking attempts. We tested the amount of CO at each visit with a carboxymeter during the entire intervention period to assess the abstinence.

Results: Pregnant women from the intervention group, with 80.0% (12/15), had significant higher rates of cessation until delivery than control group (χ^2=8.4; *P*=.004). Logistic regression analyses revealed that game's use was associated with an increased likelihood to maintain smoking cessation during the intervention period compared with those not using the game (odds ratio 4.0; 95% CI 1.3-12.2). Additionally, a Mantel-Cox means' analysis revealed that the use of the game was associated with an increased number of days without smoking, with an average of 139.7 days (95% CI 97.1-182.4) in the intervention group (χ^2=13.912; *P*<.001).

Conclusions: Pregnancy is an ideal opportunity to intervene and control tobacco use among future mothers. On the other hand, serious games is an emerging technology, growing in importance, which is shown as a good tool to assist in maintaining women

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without smoking and help behavior change during pregnancy. However, due to study design limitations, these outcomes should be interpreted with caution. More research, using larger samples and longer follow-up periods, is needed to replicate the findings of this study.

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KEYWORDS

pregnancy; serious games; smoking cessation

Multimedia Appendix 1

Full poster.

[PDF File (Adobe PDF File), 1MB - iproc_v4i2e11878_app1.pdf]

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Abstract

Developing and Testing Culturally Optimized Digital and mHealth Solutions for Hispanic, Multicultural, and International Audiences

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Abstract

Background: The vast majority of digital and mHealth applications are developed in English. In the United States, there are 52 million Hispanic people, over half of whom speak Spanish at home. In Latin America, there are nearly 400 million people online. To date, the majority of digital health solutions are either only in English or simply translated into Spanish or other languages, ignoring the cultural relevance and nuances of the target audiences. Culturally adapting digital health solutions may lead to increased engagement, utilization and effectiveness, but there have been few empirical studies comparing culturally adapted digital health solutions to simply translated ones.

Objective: 1) Compare the engagement and usage of culturally-adapted digital health content and programs that have been translated into Spanish with those that have been further culturally-adapted. 2) Generate guidelines for "best practices" for digital and mHealth developers seeking to engage US minority, multicultural and/or International audiences.

Methods: HolaDoctor built and operates the largest Spanish language health website on the internet, with 3 million unique visitors per month. In partnership with Consumer Reports Health, we tested translated versions of CR articles into Spanish with culturally-optimized versions that incorporated Hispanic imagery, examples, beliefs and Spanish-only phrases. In a separate study, we conducted a large randomized trial of over 1000 Hispanic health plan members in collaboration with three Blue Cross Blue Shield Plans, and compared a culturally-adapted health and wellness program with a bilingual, non-culturally adapted healthy weight program. The culturally adapted version was further tested and evaluated at scale in a state-wide Hispanic Obesity Prevention and Education (HOPE) program with the Florida Department of Chronic Disease.

Results: In comparison of a series of digital Consumer Reports articles, we found that the culturally adapted versions of the articles led to a 2x to 10x increased engagement and use than the translated only version. For example, with one article the translated only (TO) compared to the culturally adapted (CA) version received: 1499 (TO) vs 29,157 (CA) page views; an exit rate of 81% (TO) vs 20% (CA) and 3 (TO) vs 52 (CA) social shares. In the randomized trial, the culturally adapted version of the healthy weight program led to twice the engagement, twice the number of changes in positive healthy behaviors and a statistically significant in an intent to treat analysis greater weight loss 0.23 (TO) vs 0.52 lbs/week; $P<.03$) over the 3-month study period. In the Florida HOPE program, we found that cultural adaptation led to significantly increased consumption of fruits and vegetables and daily physical activity.

Conclusions: With now nearly 100% penetration of smart phones, digital health and mHealth solutions offer great promise for narrow the health disparities gap between the underserved multicultural populations and the general population. These solutions are also increasingly "going global." Simply translating digital and mHealth applications is better than English-only, but falls far short of the highly personalized, culturally-tailored solutions are capable of. Best practices for culturally-adapting digital health solutions at an affordable cost will be shared.

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KEYWORDS

cultural appropriateness; Hispanic/Latino; international resources

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Abstract

Development of a Mobile App for Individuals with Co-Occurring Substance Use and Mood Disorders: Integrated Support Now

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Abstract

Background: Mood disorders and substance use disorders (SUDs) co-occur at a high rate. Individuals with co-occurring mood and substance use disorders are less likely to complete treatment. Of those who receive treatment, many do not receive adequate care that addresses both disorders. Integrated Group Therapy (IGT) is an evidence-based psychosocial treatment that treats both mood disorders and SUDs, stressing the similarities and relationship between the two disorders. Although IGT is an effective treatment for individuals with mood and substance use disorders, it is not widely available, and for those who do receive IGT, there is no in-the-moment support.

Objective: A mobile version of IGT would increase access and provide in-the-moment support for individuals when they need it. The aim of this study is to use exploratory, qualitative user-centered design methodology to interview and observe end users and clinicians who treat individuals with mood disorders and SUDs to inform the design of the mobile app.

Methods: Qualitative interviews were conducted with 5 patient participants who were currently receiving treatment for a co-occurring mood and substance use disorder, and 5 clinicians with experience treating patients with mood disorders and/or substance use disorders. All participants completed a short survey to assess demographic information and technology use. Additionally, observations were conducted at 3 IGT inpatient and outpatient groups to triangulate findings across methods. Interviews were audio-recorded and transcribed. Transcripts and field notes were analyzed using thematic analysis using NVivo for Mac (version 11).

Results: Patient participants were predominately male (3/5, 60%), age 45-64 (4/5, 80%), unemployed or disabled (3/5, 60%), and white (5/5, 100%). The majority of clinicians were female (4/5, 80%), age 26-44 (5/5, 100%), and white (4/5, 80%). Most patients (4/5, 80%) and clinicians (5/5, 100%) reported feeling comfortable using technology as a treatment tool, and 40% (2/5) of patients indicated that they had experience doing so. Key treatment themes that emerged from the qualitative data included the importance of IGT in helping patients to develop a common language to describe their co-occurring conditions and experiences, visualizing the recovery journey, the importance of independence and freedom to patients throughout treatment, along with varied acceptance and self-perception of one's recovery journey. With respect to developing a mobile tool, reported patient needs included: in-the-moment support, peer-to-peer support, after-care planning, maintaining structure post-discharge from treatment and opportunities to practice skills. Clinicians corroborated the need for patient peer-to-peer support, help with after-care planning and the opportunity to practice skills.

Conclusions: Patients and clinicians were open to the idea of using technology as part of treatment. Several themes emerged to inform the direction of a minimal viable product (MVP) of the app. Next steps include narrowing down to key themes to focus

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on for the MVP, defining features as relevant to those themes, designing a clickable prototype of the app and conducting iterative feedback sessions with end users.

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KEYWORDS

addiction; mobile health intervention; mood disorders

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Abstract

Participant Engagement in a Commercially Available App-Based Mindfulness Training Intervention Delivered to Women Diagnosed with Breast Cancer

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Abstract

Background: Mindfulness training may improve quality of life (QoL) among women diagnosed with breast cancer, yet barriers associated with instructor-facilitated training (eg, cost, location, time) may limit uptake. Self-directed mindfulness training using smartphone apps may overcome these barriers. However, little is known about who may be most likely to engage in app-based mindfulness training (AMT) interventions.

Objective: We examined baseline predictors of app engagement among women diagnosed with breast cancer (≤5 years) enrolled in a randomized controlled trial (RCT) of a commercially available AMT intervention (Headspace).

Methods: Participants (n=57) received AMT as part of a 12-week RCT. Headspace was available for download from iTunes or Google Play. Participants were asked to complete app registration using a unique activation code and complete ≥ 1 mindfulness session; this was defined as "minimum dose." Overall, AMT engagement was self-guided. Participants completed baseline measures of QoL (FACT-B), dispositional mindfulness (MAAS), pain severity and interference (BPI-sf), and demographics. Log data was obtained from the app developers at the end of the study. AMT engagement was characterized by: attaining minimum dose, number of mindfulness sessions completed, and duration (minutes) of overall mindfulness practice.

Results: Overall, 34 participants completed app registration and ≥1 mindfulness session (minimum dose). Over the 12-week trial, the median number of mindfulness sessions completed was 11.50 with a range of 1-87 sessions completed. Median duration of overall mindfulness practice was 115 minutes, with a range of 10-1411 minutes. Participants who attained minimum dose had greater baseline physical well-being (mean 20.74 [SD 5.67]) compared to those who did not have any recorded engagement with AMT (mean 16.43 [SD 8.15]; t[36.2]=-2.20, *P*=.04). Pain severity was lower for participants who attained minimum dose (mean 3.12 (SD 1.69]) compared to those who did not (mean 4.61 [SD 2.05]; t[29]=2.20, *P*=.04). Other domains of QoL, dispositional mindfulness, pain-related interference, and demographics did not differ between groups. Among those who attained minimum dose, only pain-related interference was associated with fewer mindfulness sessions completed (*P*=.05).

Conclusions: App engagement was not recorded for slightly fewer than half of participants (ie, did not complete registration and ≥1 mindfulness session). Although reasons for non-adherence are unclear, findings suggest physical well-being and pain-related factors may be associated with participant AMT engagement. Given mindfulness practice time is associated with mindfulness skills uptake, future studies should explore approaches to optimize AMT engagement among participants with greater physical well-being and pain-related concerns.

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KEYWORDS

app; breast cancer; engagement; mindfulness

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Abstract

Integrating Tracker Data Into Clinical Care

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Abstract

Background: Adding physical activity to a weekly routine has been shown to contribute to both delaying onset and improving management of existing chronic conditions. With physicians a highly trusted source of advice and care, the physical activity recommendations received from doctors may be adhered to more than other sources, especially when advice is tailored to patients' specific physical conditions and limitations in increasing activity levels. Yet a survey by Smith et al found that fewer than 50% of clinicians were able to provide specific guidance on physical activity. This issue may stem from physicians rarely having objective physical activity data to inform their counseling.

Objective: We aimed to understand physician perceptions of the potential benefits and challenges of integrating trackers in a clinical setting to provide tailored counseling to patients on increasing physical activity.

Methods: Our study consisted of two phases: an online survey and in-depth, key-informant interviews. We recruited 60 clinicians to complete a 50-question survey and recruited fourteen primary and specialty care physicians for 15-20 minute in-person or phone interviews. Results from the survey were tabulated through Google Forms, while the interviews were recorded and then analyzed for emerging themes.

Results: Fifty-seven percent of the fourteen interviewed physicians reported that objective data would be useful in counseling their patients on physical activity. Three-quarters (77%) believed that advice based on an objective data display would be actionable for the patients. Of the 60 clinicians who completed the online survey, only 14% believe their patients are adhering to their physical activity recommendations. More than half (57%) of respondents believe that objective data collected from a tracker would be useful in counseling patients. However, when asked how likely they would be to recommend a tracker to a patient, 43% replied they would recommend a tracker to help motivate patients to make a lifestyle change. From the interviews and the survey, the majority of physicians believed that their biggest barrier is limited time for reviewing data, yet they also expressed strong interest in well-designed displays with a small number of data points highlighting physical activity since the patients' last visit.

Conclusions: The majority of physicians in our study believed that integrating tracker data into clinical settings would improve their ability to make personalized recommendations to patients, but also noted that significant barriers exist, most notably time. Future research is needed to 1) create and test condensed tracker data displays to determine physician willingness to view and use them, 2) evaluate the impact of the displays on physicians' ability to provide tailored advice to patients, and 3) evaluate the impact of tailored advice on increases in patients' physical activity levels.

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KEYWORDS

counseling; data display; patient-physician communication; physical activity; trackers

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