Integrating Health Information Technology to Develop a Patient-Centered Approach to Medication Management

Erin Sarzynski, MD, MS[1,2]

Assistant Professor, Geriatric Medicine

Ronald Melaragni, RPh[3]

Director of Outpatient Pharmacies

David Weismantel, MD, MS[1,4]

Associate Professor, Family Medicine

University Physician

[1]Department of Family Medicine, College of Human Medicine, Michigan State University, East Lansing, MI

[2]Institute for Health Policy, Michigan State University, East Lansing, MI

[3]Sparrow Pharmacy Plus, Sparrow Health Systems, Lansing, MI

[4]Office of the University Physician, Michigan State University, East Lansing, MI

EXECUTIVE SUMMARY

Among patients with chronic illness, approximately 50% do not take their medications as prescribed. Non-adherence to medications costs the United States more than $100 billion annually in avoidable hospitalizations. Yet patients with multiple chronic conditions who are highly adherent to their medications have lower disease-specific and all-cause medical costs, as well as lower hospitalization rates. Unfortunately, non-adherence to medication regimens is complex with multiple contributing factors, including patient, provider, and systems concerns. Medication adherence applications ("apps") available on smart phones offer potential to engage patients in their own healthcare by providing a tool that addresses patient-related factors that contribute to non-adherence. Specifically, these apps allow patients to develop and maintain a personalized, updated medication list that they can share with their healthcare providers. Patients can use these tools to ask their providers questions about their medication regimens, while simultaneously receiving automated dosing reminders, which offers promise for improving adherence. Unfortunately, none of the commercially available apps are clinically tested, so their impact on improving adherence to medication regimens remains unclear. Furthermore, these apps require manual entry of drug and dosing information, which is both time consuming and prone to errors.

We developed a medication management system – PresRx OCR, an iPhone app – that addresses key barriers to improving medication adherence. Together with a Michigan-based small business, we designed, tested, and validated a mobile app that auto-populates drug name and dosing instructions directly from patients' medication labels. Specifically, patients used their iPhones to take pictures of their medication labels within the app. Next, the app uploads images to a remote database server that uses optical character recognition (OCR) technology to automate data entry for drug name and dosing information. Using a client-server model, the app then receives drug and dosing information back from the server, which schedules dosing alerts in patients' phones according to their dosing time preferences. Ultimately, patients used the app to maintain updated medication lists and respond to dosing alerts. The app also prompted patients to take surveys to assess their satisfaction with the user interface.

Researchers had access to the secure server, which tracked responses to dosing reminders and survey responses. Researchers used the real-time data maintained in the server to assess patients' adherence to drug regimens (pre-test, post-test; i.e. pre-app, during-app), satisfaction with the application, and elicit feedback through review of survey responses.

Optical character recognition automated data entry for key elements of medication labels, including drug name, dosing instructions, and National Drug Code (NDC) numbers. Accuracy of auto-populated information exceeded 95% for drug name and dosing frequency. Overall, eight patients piloted the system for an average of six months. At baseline, patients used an average of 3.4 chronic prescription medications. Their pre-test adherence scores were moderate to high. Patients liked the app's design, rating the system nearly 70% on usability scales, indicating that the app was marginally acceptable for consumer use. Additional feedback included issues with sync speed and system logouts, both of which occurred due to interrupted internet connectivity (iPhones navigating between various internet connection options). We addressed these issues in an app upgrade that was available mid-way during the pilot study. Three patients had the upgrade installed on their iPhones and reported improved sync speed and retained login information.

Post-test adherence – as measured by the app's dose tracking system – was high during the first month of app use (>90%), but waned mid-way during the 6-month pilot study. Adherence improved during the fifth and sixth months, possibly related to re-engagement by installing the app upgrade and because patients with poor adherence dropped out. Among drug classes, patients were more adherent to cardiovascular and psychiatric medications than oral hypoglycemic or respiratory drugs. Compared with pre-test measures of adherence, post-test adherence rates were marginally lower. This trend may reflect limitations of adherence measures, or that patients who used the app became more aware of their non-adherence and responded more honestly in post-test surveys.

Overall, our pilot study demonstrated the feasibility of using a mobile health (mHealth) application to address unintentional non-adherence (due to forgetfulness). Ultimately, we need to conduct larger studies among patients at risk for non-adherence in order to see the impact on adherence. The key strengths of our system include: patient-centered design, incorporating

patient feedback into system updates, real-time adherence tracking, integration with a remote database server, and survey deployment. Many of the limitations we identified are important areas for further research, especially because they will affect interoperability of patient-centered (mHealth apps) and provider-centered (Electronic Health Records) systems. Specifically, our major limitations were due to interruptions in internet connectivity: slow synchronization speed and random system logouts. Once we resolved these issues, we uncovered another limitation: failed partial synchronization, a problem that caused patients' medications to "fall off" their lists at random. While we have since resolved this issue, it is worth exploring on a larger scale, particularly as Electronic Health Records (EHRs) improve their patient portals. As patient portals advance beyond "read only" health data, we anticipate more patient-centered features, including interactive medication dosing reminders. Such features demand a reliable solution to "real-time" data synchronization.

We believe our system uncovered a major [ongoing] barrier to effective health information exchange (HIE): sub-optimal data synchronization. Ultimately, the vision of effective HIE is to allow patients and healthcare providers to electronically access medical information maintained by multiple organizations securely and efficiency. Our pilot study highlighted barriers to data synchronization using a client-server model for smartphone applications. Yet despite our system's limitations, our patients valued its impact on their medication taking behavior. Furthermore, our system was cost-effective – $15 per patient per month, approximately the same cost as a generic monthly medication. Such cost may be reasonable for stakeholders to invest, particularly if it leads to improved adherence, lower 30-day hospital readmission rates, and patient-centered outcomes.

Moving forward, we see opportunities for Sparrow Health Systems and Michigan State University to influence the development and evaluation of evidence-based mHealth tools. Presently, medication management applications are "stand-alone" systems that do not integrate with clinician-centered EHRs. While patient-centered, these systems must eventually integrate with EHRs in order to engage patients and clinicians in making optimal treatment plans. We believe this goal is the intent of many patient portals – for patients to interact with clinicians regarding their care. Yet presently most patient portals are "read only" and do not

optimally engage patients in their own care. Through discussions with Epic, a commercial EHR vendor, we believe they are actively developing enhancements to their mobile patient portal, which would replicate the dosing alert system we assessed in the current study. In the future, we hope to test interactive extensions of EHR patient portals (e.g. MySparrow) in order to clarify the clinical effectiveness of mHealth medication adherence tools. These next steps are critical to advancing the Center for Innovation and Research, and put Sparrow Health Systems and Michigan State University at the forefront of Health IT and interoperability research.

ACKNOWLEDGEMENTS

We want to thank the MSU-Sparrow Center for Innovation and Research for funding this work. We thank Angela Kennedy, PhD for analyzing our exit interviews. We also thank many physicians and professional staff at Michigan State University and Sparrow Health Systems for their time and effort in implementing this work. Finally, we want to thank colleagues at the Institute for Health Policy and the College of Nursing at MSU for reviewing drafts and providing editorial assistance while preparing this report.