The Healthcare Future for the iGeneration: Integrating the Patient and the Healthcare System

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Abstract:
Objective: To propose a vision to integrate patients, their health-related data, and their wellness plans into the healthcare system using smartphone and tablet computer technology.
Setting: Ambulatory care and community practice
Practice Innovation: Utilization of smartphone and tablet computer technology to assess health care conditions, educate and involve patients, and facilitate seamless communication between the patient, electronic health record, pharmacy system, third-party payers, point-of-care testing, and all health-care providers.
Main Outcome Measures: By providing integrated and customized information at the point of use, medication adherence and access to care will be increased and patients will engage in healthy behaviors more often resulting in an improved level of care for patients.
Results: In the future, the authors believe if the vision is achieved, the health care system and patients will see improved health outcomes and more efficient utilization of the healthcare system.
Conclusions: Our proposed use of technology provides an opportunity to empower patients to positively improve their own health which could be a vital advancement in health care, especially in the areas of medication adherence, improving access to care, and health behavior support. As pharmacists, we may also embrace technology opportunities to expand our roles as health care professionals as we continue to partner with patients and the health care team to improve outcomes.

Background

In healthcare, as in other industries, technology is a partner with the researcher and clinician in innovation and progress. The microscope, radiography, laminar air flow hood, magnetic resonance imaging, and laparoscopic surgery have all advanced diagnosis and treatment of disease. Large scale pharmaceutical manufacturing shifted many in the pharmacy profession from compounders to communicators and advisors. With the more sweeping social changes that accompanied the introduction of the telephone and the automobile, patients were able to call before they came to pick-up their prescriptions and utilize a drive-through so they wouldn't even have to come into the pharmacy. The introduction of the fax machine brought concerns about degradation of fax paper and legitimacy of faxed prescriptions, while prescribers became easier to contact with their pagers and cell phones. Starting in the mid-1990s, use of the internet became common and, with it, electronic mail (email). Not only have most consumers shed dial-up connections in favor of broadband, but seemingly overnight, we are in a world filled with smartphones and tablet computers with wireless internet connectivity. With these devices we communicate socially via email and social networking sites as well as take pictures, video, and voice recordings. We also use them to communicate with our work colleagues and professional contacts, maintain our calendars, conduct personal banking, and shop for personal and professional needs. In 20 to 30 years our patients will not have known a time without instant access to information. This group, known as the iGeneration, was born in the early 1990s, and the "i" stands for "individualization".[1] If music, television, advertising, and internet search engines can be customized and available in a click or a tap, then the same expectation will be placed upon healthcare. While some healthcare providers are able to use technological devices to communicate with patients, access the electronic health record (EHR), and document patient care activities, functionality of applications may be limited or use of multiple health information systems may be required.

Barriers to Use of Tablet Technology

The tablet computer has emerged as a useful portable electronic resource in many health care settings, including health education,[2,3] critical care,[4] and surgery;[5,6] however there is little data on its use in pharmacy or ambulatory care settings. As presented in a previous poster, ambulatory care pharmacy faculty members at the authors' institution each

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received an iPad® to increase computer access in order to improve consistency in patient care provision at a variety of clinical practice sites. The ambulatory care setting was chosen due to its strategic position related to the expanding role of pharmacy services in medical home models and due to the physical limitations often present in this setting. A multi-departmental focus group was established to explore any challenges and efficiencies associated with use of the iPad. Emphasis was placed on the ability to standardize clinical pharmacy interventions, electronic health record and resource access, and educational capacity of the iPad. At each site, ambulatory care faculty and students performed various activities including reviewing patient charts, reconciling medications, providing disease state counseling, addressing adherence, making drug therapy recommendations, answering drug information questions, and enrolling patients in assistance programs. The iPad tablet technology was found to be useful and provided improved accessibility, portability, applications, communication, and documentation capabilities. However, a deficit of patient-focused applications and patient involvement, in addition to barriers accessing site-specific EHR, clinical electronic resources, and documentation portals were found.[7] These barriers highlighted the fact that, while technology has come to the healthcare system, the healthcare system is not prepared to take full advantage of the technology that is currently available.

The Healthcare Future
How could information availability change? If the software could interface and security of patient information could be assured, how would care for our patients change? Would we post on our patient's health wall? Could we check medication therapy adherence by "following" our patient on a medication-media site? Would the community pharmacist and the prescriber be able to view the same patient records including history and physical, laboratory results, problem lists, social work consults, and prior authorizations? Could we all, the prescriber, pharmacist, patient, and caregiver utilize a telecommunication application such as Skype™ to discuss a patient's adverse event and change therapy?

The greatest hindrance is our own imagination. Our own preconceived ideas hold us back. To truly take advantage of the technology, we must rethink how we interact with the interdisciplinary team and the patient. We must shift to a truly patient-centered approach in which timely care for the patient is not limited by our schedule or billable office visits.

A group of pharmacists who participated in the iPad project mentioned above met to discuss how the optimization of tablet and smartphone technology could dramatically change

the health care system in future years.[7] Following are three case vignettes representing patients whose health may be positively affected by using smartphone and tablet technology to improve medication adherence, improve access to care, and provide health behavior support.

Technological Strategies to Improve Medication Adherence
Susan Thompson is a 56 year old black female with a past medical history of type 2 diabetes, peripheral neuropathy, chronic obstructive pulmonary disease (COPD), hypertension, hyperlipidemia, gastro esophageal reflux disease, depression, and osteoporosis. She takes the following medications: metoprolol tartrate, lisinopril, amlodipine, insulin glargine, insulin aspart, albuterol sulfate HFA, tiotropium, fluticasone/salmeterol, simvastatin, niacin, fish oil, duloxetine, gabapentin, alendronate, and calcium + vitamin D. She was recently admitted to the hospital for a COPD exacerbation and now has an appointment with the pharmacist at her primary care physician's office for her post-discharge medication reconciliation. Upon interview, she admits to not using her inhalers as prescribed, as well as missing doses of her other medications. Her vital signs indicate that her blood pressure is uncontrolled and a review of her blood glucose log indicates possible non-adherence with lifestyle recommendations and medications. Ms. Thompson's pharmacist recommends utilizing an application on her smartphone to aid in improving her adherence.

The above scenario is reflective of a common, recurring theme in healthcare today: patients with multiple chronic conditions have an accompanying complicated medication regimen. Even the most motivated patients can have trouble staying adherent or appropriately administering their medication regimen. In recent years, much discussion has occurred surrounding strategies to improve adherence. There have been several methods introduced to improve adherence such as combination medications, "talking" prescription bottles, automatic refill systems, pillboxes, and calendar reminders. However, nonadherence to medication and lifestyle regimens continues to greatly contribute to overall poor disease state control and rising health care costs.

An ideal adherence application builds on today's concept of a pillbox by bringing it into the electronic realm. A patient's complete medical history, medication regimen, insurance carrier, provider network, and pharmacy information would all be integrated into the application. This application would communicate with pharmacy systems and claims software in order to electronically communicate adherence data to responsible providers to better utilize adherence strategies such as automatic refills, medication reminder alerts, messages, and phone calls. All reminders could be

individually customized to provide interactive education, complete with images, directions, technique, and patient specific counseling points. In cases such as our patient example above, we feel that this type of technology could substantially improve outcomes by identifying adherence barriers and better empowering patients to overcome them.

Technological Strategies to Improve Access to Care

Yolanda Akers is a 45 year old white female who has had symptoms of frequent and painful urination worsening over the past three days. She had similar symptoms 4 years ago and was diagnosed with a urinary tract infection which she was given an antibiotic and pain reliever. Ms. Akers goes to her local pharmacy and buys a urinary tract infection screening kit compatible with her iPhone®. After Ms. Akers follows the instructions on the kit, her iPhone confirms that she does have a urinary tract infection caused by Escherichia coli*, and forwards this information along to her physician and pharmacist. The pharmacy receives this data and, through a collaborative practice agreement, is able to review susceptibility data for the organism and allergy information for Ms. Akers, then to fill prescriptions for sulfamethoxazole/trimethoprim and phenazopyridine.*

Access to medical care is an issue for many patients, both insured and uninsured. Contributing factors include, but are not limited to lack of provider availability, financial resources, and time required for the patients to access medical care. Many advances have been made with point-of-care testing devices. Optimal integration with smartphone and tablet technology could improve availability and speed of diagnostic and monitoring data resulting in more efficient and accurate therapeutic treatment.

In the case above, the patient was saved having to call her physician's office to make an appointment, time missed from work to go to the appointment, the cost of the physician's visit and any laboratory testing needed, as well as the inconvenience of having to wait at her pharmacy for her physician to contact the pharmacy. This can save stress to the healthcare system in both time and cost, thus allowing providers to target their efforts more effectively. This idea involves not only advancing the technology of point of care testing, but increasing ease of communication between the patient, patient's device, and health care providers.

Improving the ease of access to care with smartphones and tablet technology has many possibilities. If a patient were to fall and injure an ankle, the patient could utilize a smartphone to perform an x-ray scan to determine if the ankle were broken and in need of immediate medical care. In this case, the x-ray could be sent to the emergency

department (ED) of the patient's choice so that the health care team there would be prepared for the patient when arriving, thus decreasing time spent at the ED. A negative x-ray could give instructions for rest, ice, compression, elevation, and to seek attention if symptoms worsened.

Utilizing this technology could impact both acute and chronic care situations. Consider a patient with chronic dyslipidemia who is due for a six month follow up and has no other complaints. If he sends a fasting lipid panel, performed in his home by his tablet computer, to his primary care office, states he has no other concerns or adverse effects, and his lipid panel is at goal, a visit to the primary care office could be saved. This would result in time and cost savings for both the patient and the health care system. Technology could also be used for patients requiring more intensive monitoring for multiple chronic disease states. Disease state monitoring would not require blood for point-of-care testing, so patients will not be required to prick themselves, but instead a nanochip will be placed in the blood stream and remain for one year, wirelessly communicating with both the patient's and provider's tablet technology, reporting real-time lab values. Tablet computers or smartphones could be used to monitor blood glucose, hemoglobin A1C, lipid panel, blood pressure, and body mass index for example. The patient's smartphone could alert when attention is needed, such as if the blood sugar is dropping or blood pressure is elevated. If severe values or symptoms are detected, the smartphone will automatically contact emergency medical services. Utilizing and optimizing already existing technology provides an opportunity to improve medication access and to help the health care system more strategically use its resources. This also presents opportunities to remove barriers to health care for many patients.

Technological Strategies For Health Behavior Support

Kevin Jimenez is a 49 year old Hispanic male who was recently diagnosed with type 2 diabetes at a primary care appointment. His past medical history is significant for hypertension, hyperlipidemia, and obesity. None of his disease states are well-controlled and Mr. Jimenez has failed to make necessary lifestyle modifications despite education and counseling on multiple occasions. When picking up his medications at his local community pharmacy, Mr. Jiminez expresses frustration about his new diagnosis. Mr. Jiminez's pharmacist recommends using a tablet computer application as a personal health coach to provide individualized decision support and reminders based on the patient's current health status. This technology is covered by Mr. Jimenez's insurance plan.

There are many ways the authors envision the applications for tablet computer technology of the future could help patients improve their health and promote wellness. This technology could provide less invasive, virtually painless point of care testing and serve as a personal health coach for patients to assist with making decisions which affect their health throughout the day. These are health issues facing much of the population. The impact of streamlined, fully developed, easy to use applications and devices addressing these health concerns will greatly benefit our patients.

In the scenario above, the patient will be educated by his pharmacist on how to utilize the iPad's health behavior support application to improve his lifestyle and associated disease states. The application could provide patients with tailored diet and exercise recommendations calculating basal metabolic rate and automatically recording the number of calories ingested and burned throughout the day. The application could be set to aim for a caloric goal reflective of the patient's health needs, such as a deficit, if needed, to produce weight loss. The application could provide reminders on the number of calories ingested and the amount left to burn each day as well serve as a scale to weigh his foods and aid in estimating portion size. The patient also will receive tailored meal options which will adapt throughout the day to help him to achieve, but not exceed, recommended daily allowances of vitamins, minerals, and macronutrients based on measured blood levels throughout the day.

The application could use point of care technology in combination with health behavior support tools to improve health quality of life by detecting signs of stress such as increased heart rate, blood pressure, and cortisol release then, in turn, alert the patient to engage in deep breathing and other stress relieving exercises. It will also have the ability to monitor the quality and length of time spent asleep, and, if it detects noises which could awaken patients, will produce white noise to drown it out. The possibilities to take technology and optimize it to improve whole person health, lifestyle, and behaviors seem endless and extremely underutilized. Having one application that can be tailored to provide point of care testing integrated with health behavior support more could provide an easy to use and highly functioning patient health behavior support tool.

Limitations
While technological advances have made our lives more efficient by providing newer methods of accessing, using and sharing information, and reducing physical effort, there are various factors that may limit one from fully engaging in use of technologic innovations in healthcare. Most practically is

the ability to acquire the products necessary to participate. The costs of healthcare innovations remain a limitation, considering the device costs, connectivity, compatibility, and the need or desire to upgrade with each new generation of devices. While technological innovations are less costly for personal devices than in the past, each person will need to budget an ongoing expense for the device and the contract to use it.

Being "connected" will continue to be a challenge and possibly a limitation for everyone that desires to adopt technology. Many homes, work places, and public areas remain signal-deficient, within a building or in rural areas of the world. Recently, the number of devices in the work area has grown so dramatically that bandwidth must be upgraded regularly. Cloud technology has been proposed as a solution to some of these concerns, but is not yet as widely used as a source of energy, storage, and security as it needs to be to maximize its efficiency. The ability to seamlessly cross over from one platform to another, from one database to another, and from one service to another will be required for efficiency.

Steep learning curves remain a limitation, as well. While most persons are familiar with a keyboard, making strokes with all fingers, or only two, advanced methods of data capture such as voice recognition are not widely used. Many patients, as well as providers, may have difficulty adapting to advanced technologies, though the ideal product would be as user friendly as possible.

Vendors and users will continue to struggle to create solutions that will allow common use and ease of use in the upcoming years. Too many times information needed to solve problems is not available to the end user. Technology sources on a web page, via telephone, or in person still do not support the end user in a way that is one-size-fits-all. Vendors know their product line but are not always able to collaborate with other vendors or end users to solve problems.

Will end users continue to be enamored with the ability to over stimulate themselves with information? When will we become saturated with information? Once we talked on the telephone for hours, now we text, and join multiple social media groups. But at some point will all of this will feel like work because it will be the way we do our work? Voice recognition may be the answer. Newer methods of artificial intelligence will be needed to work for us to make these ideas into reality.

Conclusion

Pharmacists have the opportunity to guide technological advancements to our patients' and the profession's benefit. Optimizing and proactively seeking opportunities for technology to empower patients to positively improve their own health could be a vital advancement in health care especially in the areas of medication adherence, improving access to care, and health behavior support. This advancement may also allow for pharmacists to expand their roles as health care professionals and continue to partner with patients and the health care team to improve outcomes. The future is bright for those who embrace the opportunity.

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