Patient Education Self-Management During Surgical Recovery: Combining Mobile (iPad) and a Content Management System

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Abstract

Objective: The objective of this investigation was to assess whether a new electronic health (e-health) platform, combining mobile computing and a content management system, could effectively deliver modular and “just-in-time” education to older patients following cardiac surgery. **Subjects and Methods:** Patients were provided with iPad® (Apple®, Cupertino, CA) tablets that delivered educational modules as part of a daily “to do” list in a plan of care. The tablet communicated wirelessly to a dashboard where data were aggregated and displayed for providers. **Results:** A surgical population of 149 patients with a mean age of 68 years utilized 5,267 of 6,295 (84%) of education modules delivered over a 5.3-day hospitalization. Increased age was not associated with decreased use. **Conclusions:** We demonstrate that age, hospitalization, and major surgery are not significant barriers to effective patient education if content is highly consumable and relevant to patients’ daily care experience. We also show that mobile technology, even if unfamiliar to many older patients, makes this possible. The combination of mobile computing with a content management system allows for dynamic, modular, personalized, and “just-in-time” education in a highly consumable format. This approach presents a means by which patients may become informed participants in new healthcare models.

Key words: patient education, older adults, iPad tablet, mobile computing, content management, surgery, hospital

Introduction

Across settings, patient education is an essential care component as it is a means to increased self-management, adherence, and satisfaction.¹⁻⁴ Perioperatively, patient education helps patients understand their condition and the plan of care, to identify and manage potential complications, and to reduce hospital re-admission.³ This type of information reduces healthcare-associated costs through decreased length of stay and improved self-management after discharge.³

Effective patient education has multiple requirements; some relate to the form, content, and mode of delivery required for adults, whereas other contingencies are patient-sided challenges related to illness and hospitalization. Finally, there are multiple requirements of providers.

The format and delivery of education can impact a patient’s ability to learn and act. Information acquisition is affected by the approach to education (type of setting, presenter), mode of delivery (written, electronic, face-to-face, etc.), and how often information is presented.³ Adult education is most effective when the content is individualized, when multiple delivery means are utilized, and when delivery occurs in multiple sessions.^{3,5} Adult education theory emphasizes that adults (1) approach learning as a problem-solving technique, (2) have a need to learn experientially (e.g., interacting with educational content), (3) learn best when the topic is of immediate value, and (4) understand why a given topic is important.⁶

Although perioperative education is critical, hospitalization creates patient-dependent education barriers. Surgery may result in pain, fatigue, and nausea; sleep deprivation, alteration of sleep-wake cycles, medication effects, and cognitive impairment are also common, particularly in older adults.^{7,8} There are also provider-dependent factors relevant to effective patient education. Postoperative patient education has traditionally been delivered through writing (e.g., pamphlets), verbal instruction by a nurse, or a combination of these.³ With verbal education, nurses are typically responsible for the selection of topics that they perceive as important.^{2,3,9} Limitations of this approach include provider-dependent inconsistencies, disconnection between patient needs and the provider’s appraisal, providing too much information in written format, and information that may not correlate with patients’ knowledge level. Furthermore, verbal-only instructions are frequently forgotten or remembered inaccurately,¹⁰ and timing dyssynchrony between nurse and patient availability/readiness is common. Content and content management are also of pressing importance. Educational topics may not be available, content inconsistencies are common, and keeping content up to date is difficult.^{2-4,11}

New approaches to patient education are required. Historically, adult cardiac surgical patients at our institution received two DVDs and a 283-page book covering a wide range of topics. However, the format and content were inconsistent with adult education, were nonspecific, were poorly tailored to incorporate the learning needs of the patient,¹¹⁻¹³ and were not a model that empowers the patient to share ownership of, and participate in, medical care.^{12,14}

Postoperative education that is individualized to patients’ surgical and medical conditions and to their experience has the potential to

address many of these needs. This is potentially possible by modular education configured through a content management system and delivered to patients with mobile computing technology. Mobile computing can enhance consistency of information and keep it current, as well as provide multiple learning methods to engage varying learning preferences. Technology-supported education can allow for individualization of content, which is associated with improvements in outcomes.^{3,5,12} Furthermore, recent studies have found high patient satisfaction with and a preference for receiving information through technology.^{4,5,15}

To test a new model of patient information delivery, we created a new care information platform to put education in the hands of patients and their families. Mayo Clinic Health Connection (Mayo myCare) delivers individualized “just-in-time” education using mobile computing (iPad®; Apple®, Cupertino, CA). The platform links education, recovery planning, and daily self-assessment to a plan of care. A well-defined “plan of stay” and “plan of day” allows education to be delivered “just-in-time” in that the information modules delivered are integrated with the care events of each day. Furthermore, the content is personalized in that content is based on each individual patient’s surgery, his or her medical conditions, and his or her prehospital functional status.

Because this approach to in-hospital education delivery was unprecedented,⁴ we were uncertain even as to feasibility. As such we began studying the impact of the Mayo Clinic Health Connection application by assessing usage by day of hospitalization, overall, and by domain of content delivered. We were also interested in whether usage varies by demographics such as age and gender.

The aim of this study was to investigate a new approach to health information delivery in the peri-operative setting. We hypothesized that the ease of use of computer tablets and new means of content and data management could create a model in which patient self-education is specifically linked, “just-in-time,” to an individualized plan for hospital recovery.

Subjects and Methods

Following Mayo Clinic Institutional Review Board approval and written informed consent, patients were enrolled in an investigation testing a new health information technology system designed to support surgical recovery (Mayo Clinic Health Connection).¹⁶ The study population consisted of patients > 50 years, having elective cardiac surgery, and predicted to have a hospital length of stay of 5–7 days. All patients were able to read, English-speaking, lived at home, and able to ambulate prior to surgery. No patient had cognitive deficits identified in his or her medical record prior to enrollment. After enrollment, if patients had a change in surgery to a type outside of inclusion criteria or surgical or medical complications, including neurologic changes (stroke, agitation, or confusion), or chose not to continue participation, they were withdrawn from the trial.

Patients were given an iPad loaded with the program. The program provided patients with a hospital plan of stay, a plan for each day and education, and recovery planning modules. Patients engaged in self-directed learning through multimedia educational modules organized in daily “to do” lists by day of hospitalization (Fig. 1).

The educational program for each patient was individualized congruent with an individualized plan of stay. There were two structural components to the education materials: template content and configurable content. Template content consisted of information provided to all adult patients having cardiac surgery. Configurable content was content that was patient-specific (specific to the surgery [mitral valve surgery, coronary artery bypass grafting, etc.]) and procedure-related (anticoagulation, echocardiography, etc.) as well as education modules relevant to the patient’s specific medical conditions (diabetes, hypertension, sleep apnea, etc.). Table 1 provides examples of the organization and types of content delivered on a given recovery day. Template and configurable contents were distributed across the projected length of stay and were delivered linked to specific care events of the day. Content was also divided into two domains each day: “Education” consisted of modules relevant to hospitalization and the patient’s specific medical and surgical conditions, whereas “Planning Your Recovery” consisted of information modules directed to posthospital planning such as follow-up appointments, exercise and diet, and complications.

Finally, some education or recovery planning materials were delivered based on patient survey responses to questions about pre-hospital functional status (delivered by iPad). A discharge risk score

Fig. 1. Screenshot of a “plan of the day,” including the patient’s “to do” list. Each bar opens a series of tasks in each domain: “Gaining Strength,” “Education,” and “Planning Your Recovery.” ICU, intensive care unit. MVR, mitral value repair.

Table 1. Examples of Educational Content Provided on the First Day Out of the Intensive Care Unit

CONTENT TYPE, DOMAIN	TOPIC: DESCRIPTION	MEDIA TYPE
Template content		
Introduction	"Introduction to Current Day of Recovery": describes what to expect for the plan of care and goals for the day	Video
Education	"Pain After Surgery": describes the importance of controlling pain following surgery; includes a patient testimonial	Video
Education	"Sleeping Well in the Hospital": describes why sleep is important, how to change the hospital environment for optimal sleep, how to utilize relaxation techniques to enhance sleep, and tips for sleeping once back home	Voice over presentation slides
Education	"Preventing Falls in the Hospital": provides instructions on how to use the call button to notify nursing staff for assistance from bed to prevent falls	Video
Recovery	"Early Screen for Discharge Planning (ESDP)": describes the purpose of the ESDP tool that was given prior to surgery and what the scores suggest	Written text
Recovery	"Questions for Patients and Families": provides examples of questions on support and care for patients and families to discuss with the healthcare providers before leaving the hospital	Presentation slides
Gaining Strength	"Breathing Exercises and Incentive Spirometry": demonstrates how to perform deep breathing exercises and how to use an incentive spirometer	Video
Procedural and Nursing Cares	"Urinary Catheter": describes what a Foley catheter is, why one would be used, and risk of infection	Written text
Procedural and Nursing Cares	"Chest Tubes": describes what a chest tube is, why it is used, care of the tube site, activity guidelines, and care after the tube is removed	Written text
Procedural and Nursing Cares	"Temporary Pacing Wires": describes the heart's natural pacemaker and function, placement of temporary pacing wires, and uses for a temporary pacemaker	Written text
Procedural and Nursing Cares	"High Blood Sugar After Surgery": describes why high blood sugars need to be controlled for healing after surgery; explains the possibility of need for insulin and blood sugar checks even if the patient is not diabetic	Written text
Content specific to surgery and medical conditions		
Education	"Aortic Valve Stenosis": describes what aortic valve stenosis is, normal aortic valve function, possible causes, effects of, and surgical options for repair and replacement of valves	Written text
Education	"Hypertension": describes what hypertension is; explains the measurement of blood pressure, symptoms, diagnosis, complications, causes, risk factors, treatment, and prevention options	Written text
Education	"Protecting Yourself from Heart Infection": provides current guidelines for protection against developing infective endocarditis (commonly known as bacterial endocarditis) and treatment changes over time	Written text
Education	"Taking Warfarin: Manage Blood Thinners": provides basic information about anticoagulants (warfarin, Coumadin® [Bristol-Myers Squibb, New York, NY]), how anticoagulants work, the purpose, and the risks and benefits of blood-thinning medications. It includes a discussion of the individual's responsibilities in proper use of the medication, including the importance of blood tests, and food, beverages, and supplements that can impact the medication.	Video
Dynamic content: if ESDP > 10		
Recovery	"Options at Discharge": describes the various options for next steps after discharge (home, home with home care, transitional, skilled nursing care). Tips on how to choose what is right for the patient	Presentation slides
Recovery	"Who's Who Discharge Planning": describes the roles of the staff nurse, discharge planner, and social work in coordinating discharge from the hospital	Presentation slides
Recovery	"Transitional Care": describes what transitional care is, possible benefits, services that are provided, and transitional care locations; patient testimonials and frequently asked questions included	Video
Recovery	"Skilled Nursing Care": addresses common questions and answers regarding what skilled nursing care is, how to qualify, average stay, etc.	Written text

The educational plan was populated from three sources. Template content was delivered to all patients. Patient-specific content was populated based on the individual patients' medical and surgical conditions. Dynamic content was populated into the educational plan depending on patients' input (score on a survey tool, the Early Screen for Discharge Planning [ESDP]). An ESDP score of >10 predicts need for advanced discharge support.

was generated based on an early screen for discharge planning,¹⁷ and different content was delivered if the risk score predicted a higher likelihood of need for discharge support services. This score also triggered an algorithm in the program that distributed content over a greater number of hospital days.

Education and recovery planning contents were delivered as 2–5-min videos, as voice over slide presentations, and as text documents. Key words were compiled into a glossary where terms were defined. The glossary and a list of medical illustrations relevant to surgery, cardiology, and general internal medicine constituted a patient “library” accessible by the iPad. The majority of content was estimated to be at the 5th grade reading level, although medical terminology deemed necessary increased reading level estimates for some content. Content was English-only.

Several other features of the educational program were as follows: (1) content on the day of surgery was directed to the family while the patient was in surgery or in the intensive care unit; (2) if content was not completed on any given day, the content was advanced to the next day; (3) content could be completed in advance, or reviewed at any time; (4) an education plan for the hospital stay could be viewed at a glance with completed and pending modules visible; and (5) prior to discharge, a “discharge checklist” was presented. This list was populated from the content specific to that patient when the educational plan was constructed. This checklist queried the patient as to understanding of the education and recovery planning modules delivered over the course of the hospitalization (yes or no). When a patient answered “No,” that module was re-presented to the patient, and the query was repeated. The software kept track of the number of questions answered as well as the final number of “No” answers. After two presentations of content, if the patient still indicated lack of understanding, he or she was referred to a bedside nurse for resolution of questions.

Each patient’s log-on was password protected. The iPad communicated wirelessly with a cloud-based information system where data were aggregated. The information system acquired and documented patient use of the daily education and recovery planning modules, although nurses were responsible for this documentation in the electronic health record (EHR) as the information system was not integrated with the EHR. Data were configured onto dashboards that could be viewed by surgical services and by study personnel. The dashboard showed information consumption for each patient and his or her overall and daily progress. Data transmission and storage security were approved by the Mayo Information Technology security group.

The electronic health record was used to collect information on demographics, type of surgery, comorbid conditions (identified in the pre-admission patient problem list), length of stay, and discharge disposition. Length of stay was defined as the time from operating room entry to hospital discharge in days.

DATA ANALYSIS

The number of modules delivered and the percentage completed were calculated for each patient for the entire study period and also separately for each study day (day of surgery and recovery Days 1–5).

The module completion percentage was calculated both overall and also separately for the two content domains of “Education” and “Planning Your Recovery.” The signed rank test was used to assess whether the percentage of items completed over the study period differed between domains. Spearman rank correlation was used to assess whether the percentage of modules completed was associated with patient age, and the rank sum test was used to assess whether the percentage of modules completed differed according to sex or discharge disposition (home independently versus requiring support at discharge).

Results

Of 185 patients who were consented, 36 were withdrawn after enrollment. Reasons for withdrawal were medical or surgical in 21 patients, whereas 15 patients declined participation following surgery. For the 149 patients who used the program throughout their hospitalization, the mean $\pm$ standard deviation (SD) age was 68 ± 9 years (range, 52–90 years), 68% were male, and the mean $\pm$ SD length of stay was 5.3 ± 1.4 days. Patients underwent elective cardiac surgical procedures including coronary artery bypass grafting, combined valve replacement or repair with coronary artery bypass grafting, and valve surgery alone.

For the 149 patients, in total, 6,295 information modules were delivered, of which 5,267 (84%) were completed. The mean $\pm$ SD number of modules delivered per patient was 42 ± 3 (18 ± 2 “Education,” 18 ± 1 “Planning Your Recovery,” and 5.8 ± 0.4 daily summary). Patients or families were scheduled to complete an average of 10 modules on the day of surgery and 6 or 7 modules on each recovery day. The average completion rate varied from a high of 94% scheduled on the day of surgery to a low of 68% on recovery Day 5. For patients who were discharged on or before recovery Day 5, on average, 6 modules were scheduled with an average completion rate of 59%. Figure 2 presents the average percentages of educational

Fig. 2. Percentage of educational modules content completed by day of recovery for content identified as “Education,” “Planning Your Recovery,” and the “Introduction to the Day” (day summary). Values are means.

Fig. 3. The percentage of modules completed according to age. Each data point corresponds to the percentage of modules completed for a given patient, and the boxes correspond to the 25th, 50th, and 75th percentiles for each age group.

modules completed (100%=all educational modules scheduled for that day were completed) across each day of hospitalization; Day 0 is the day of surgery.

Of the two primary content domains, the percentage completion was higher for “Education” compared with “Planning Your Recovery” (85.4% versus 78.7%; signed rank, $p < 0.001$), and the completion rates were higher for men compared with women (“Education,” 87% versus 81% [$p = 0.045$]; “Planning Your Recovery,” 94% versus 81% [$p = 0.045$]). Completion rates were not significantly associated with discharge disposition. There was also no significant correlation between educational modules completed and age. *Figure 3* shows the percentage of education modules completed across age groups.

The discharge checklist was used by 134 (90%) of the 149 patients. For these patients, the mean $\pm$ SD number of items included was 22 ± 3 (range, 17–32). Those patients answered 90% of the questions delivered, and patients documented understanding of their education (answered “Yes”) on 98% of items. However, 16 patients (12%) still indicated they did not understand one or more of the items (ranging of one to five items not understood) on the discharge checklist after the second presentation of materials. Most patients (92%) omitted one or more of the items on the checklist (64% omitted one item, 18% omitted two to four items, and 14% omitted five or more items).

In approximately 750 hospital days, no iPads were lost.

Discussion

Although there are multiple challenges to effective delivery of health information to patients, new models of healthcare demand patient empowerment and so are fundamentally dependent on success with patient education.^{18–20} Maintenance of health, shared decision making, and acute and chronic recovery all require well-informed patients. Remarkable advances in technology and information systems create previously unknown opportunities to achieve this.²¹ This investigation has demonstrated feasibility of such a model.

In a population having an average age of 68 years undergoing very major surgery, we found that patients would utilize 84% of a very aggressive education program (42 modules over 5½ days). Furthermore, although this was an imperfect assessment, 90% of patients indicated they understood 90% of the content prior to discharge. Additionally, we demonstrated that computing and technology advances allow delivery of both individualized and “just-in-time” education. Finally, we showed that older patients can quickly learn and consume education delivered with new but user-friendly technology (iPad).

Because the platform we introduced was unique, we began with a pilot of 20 patients for 1 month (data not shown). At the end of 30 days we examined utilization by day and interviewed users. We found that we initially delivered too much content on the first 2 postoperative days and that patients were often sleepy, suffered nausea, and struggled with reading. We also identified that a significant portion of patients had hearing impairment. The data also suggested that the foreshortened hospital day on the day of discharge led to lower rates of content completion. These observations lead to several changes: (1) we reduced total content delivered on recovery Days 1 and 2; (2) we changed primary content on these days to video or voice over rather than text; (3) we provided all patients with headphones and an external speaker when needed; (4) we reduced the total content delivered on the discharge day; and (5) we pushed critical content such as “your dismissal summary” and “discharge checklist” to the day before discharge.

Patients completed about 85% of content each day following surgery, but this was reduced on the last day of hospitalization, when patients completed about 65% of their educational modules. In spite of reducing total content on the day of discharge, we presume the shortened and very busy day leads to those lower completion rates.

Because this content management system and mobile delivery system was in a test phase, it has a variety of limitations. In its current iteration the software could not test patient understanding of educational content provided, could not determine how much time was spent on any given module and, with a single log on, could not determine if the educational material was viewed by the patient, the family member, or both. Nevertheless, our system seems robust, and feasibility is demonstrated. Future iterations could provide knowledge testing as well as determine time spent on each educational module. As far as user assessment (patient or family), we made the active choice to treat them as a unit and made no attempt to differentiate between them because a large portion of the education delivered was as relevant to family caregivers as to the patient.

Conclusions

There are multiple barriers to effective information delivery: some of these relate to optimizing the form and content, others relate to patient status during hospitalization, and still others are provider-related barriers. Our investigation shows a content management system can allow for creation of modular, individualized, and “just-in-time” education well suited to adult education. Furthermore, the user-friendly format of mobile computing allows very high rates of content consumption even in older adults following major surgery.

Our model also helps address provider barriers. It helps address the dyssynchrony that is common in the educational schedules of patients and providers, it creates a simple way to keep content current and consistent, and it creates opportunities to track content consumption in ways previously unknown; this has implications for meaningful use. This strategy demonstrated is also dynamic in that the programs “learn” using algorithms to populate different education based on patient input, re-present missed information, and can query patients on understanding and respond to their responses.

Mobile computing allows for highly effective delivery of customizable, and therefore relevant, patient education. Relevance is increased when the education is “just-in-time” and linked to the patients’ daily care experience. Its potential becomes even greater when algorithms enable the program to learn from patient use and responses. This model of delivery has implications for altering the structure and standards of patient education in healthcare. The potential for extending this health education model to postacute and outpatient care is evident, and the implications are profound, as we move toward care models where patients are informed, empowered participants in their healthcare.

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Disclosure Statement

No competing financial interests exist.

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