A Treatment Adherence Mobile Application Designed Specifically for Patients after Open-Heart Surgery

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Abstract—Patients recovering from open heart surgery face many challenges upon returning home, primarily centered around the sudden increase in personal responsibility. Not only is this challenging because they are fatigued from the operation and decreased inpatient recovery time, but also the condition and treatments are all new to the patient and as a result, easily overwhelming. Medication adherence is a major concern and has shown to improve patient outcomes and reduction in costs. Non-adherence to medication regimen has been shown to cause an increase in cost of care, hospitalizations, and complications post-surgery. We are proposing a mobile application to address the challenges of adherence to a new treatment regimen, added responsibility and unfamiliarity of treatments, particularly in the area of medication management, cardiac rehabilitation monitoring and diet management. This application specifically designed for patients after open heart surgery also helps the patient adhere to the treatment regimen prescribed by the clinicians.

Keywords—open heart surgery recovery, myocardial infarction, complication rates, medication adherence

I. INTRODUCTION

Patients who have had Open Heart Surgery following myocardial infarction face many challenges throughout their recovery. In the United States, approximately 735,000 people suffer a myocardial infarction (heart attack) every year; that’s equivalent to one heart attack every 43 seconds [1]. Of these, approximately 397,000 cases result in open heart surgery [19]. Additionally, it is typically recommended that patients maintain low levels of activity for four to six weeks and self-monitor symptoms in the days and weeks that follow surgery [2]. These two recommendations turn out to be much harder than one would anticipate and puts excessive stress on the patients who are recovering from a major surgery. In addition to high patient expectations, six to twelve percent of patients encounter complications during their treatment or recovery [4, 5]. All of these factors play a role in the design of myocardial infarction treatments and interventions. The application developed records medication information, maintains record of all doses administered and a schedule of all upcoming medications, remind and walk through cardiac physical therapy, and provide recommendations and support in diet management. By providing a resource to patients upon their return home, it is also expected to decrease the feeling of abandonment common in recently discharged open heart surgery patients. Finally, this solution empowers patients to learn about their treatments but does not rush this learning. Numerous studies have shown that education is key to achieving medication regimen adherence. Our solution builds off of this research by providing patients access to information about their medications while still managing adherence to ease the transfer of responsibility to the patient. This mobile solution with features of medication management, physical therapy monitor and diet manager is expected to reduce complications after open heart surgery.

II. BACKGROUND

Recovery time after an open heart surgery is about six to twelve weeks, of which only the first four to seven days of that recovery takes place in the hospital [2, 13]. Most patients are home less than a week after their surgery [2]. There are many factors that have been influential in shaping the current situation. The minimal length of hospital stay being seen in open heart surgery has been largely triggered due to high rates of hospital-acquired infections. Approximately 20% of open heart surgery patient contract an infection and for the most common hospital-acquired infection, pneumonia, hospital stay is typically increased by an average of 10.2 days and total costs by 29,692 dollars [8]. Because of this risk of hospital-acquired infections, patients are often discharged at the earliest possible time. In addition, as a hospital stay extends, costs quickly accumulate on an already extremely costly procedure. With an incident rate of approximately 2.75 incidents per 10,000 in the population each year, open heart surgery is both highly expensive as well as highly prevalent [8, 18]. These factors both impact the trend towards shorter inpatient recovery times for open heart surgery patients.

However, this shift towards shorter inpatient recovery time is often challenging for patients. The first concern patients have is the lack of connection and perceived abandonment from the healthcare system upon their return home [10, 11, 12]. While in intensive care, patients’ medications are being administered
and managed by medical professionals. However, upon leaving the hospital, this all changes; patients are responsible for the daunting task of managing all their medications. Adhering to this new regimen of prescribed medications becomes one of the greatest challenges for recovering patients [10, 14, 17]. In an analysis of elderly patients enrolled in government health programs, only 10% of patients filled prescriptions enough to have their medication daily and even among patients enrolled in no cost sharing prescription insurance plans, non-adherence rates was approximately 40 percent [14, 15]. In addition, patients recovering at home were less likely to comply with medication regimens than those in hospital or nursing facilities. It was also seen that changes in medication dosage after leaving the hospital or nursing facility were more commonly administered incorrectly compared to prescriptions that started during inpatient care [14, 15, 16]. After a major procedure, such as open heart surgery, many assume patients meticulously comply with medications. However, irrespective of diagnosis and prognosis, upwards of one third of all patients struggle to adhere to their pharmaceutical regimen [14]. It’s often not for a lack of trying; rather the expectation that patients manage their medications in light of the newness and complexity of the condition, is asking a lot of recovering patients. However, this statistic is unnerving as medication adherence is crucial for maintenance of physical functioning, and avoidance of future events; failure to correctly administer medications leads to preventable and often, costly, complications in patients of open heart surgery. In addition, the patient is prescribed to a set of physical therapy to help improve their physical activity and a strict diet management regimen. This combination of factors surrounding treatment management results in a less than ideal situation for patient recovery.

Medication adherence alone has shown to reduce costs from 10.1% to 17.8%[20]. Coronary artery disease being the most common cause of death accrues healthcare costs around $475 billion. Treatment adherence can be complicated in terms of schedule, timing, dosage amount, and other recommendations. In a study only 50% of the patients adhered to prescribed medication even when their risk of acquiring coronary disease grew many fold [23]. It is critical to device mechanisms that would not only reduce healthcare costs but also help reduce deaths. The application developed records medication information, maintains record of all doses administered and a schedule of all upcoming medications, remind and walk through cardiac physical therapy, and provide recommendations and support in diet management. By providing a resource to patients upon their return home, it is also expected to decrease the feeling of abandonment common in recently discharged open heart surgery patients. Finally, this solution empowers patients to learn about their treatments but does not rush this learning. Numerous studies have shown that education is key to achieving medication regimen adherence. Our solution builds off of this research by providing patients access to information about their medications while still managing adherence to ease the transfer of responsibility to the patient. This mobile solution with features of medication management, physical therapy monitor and diet manager is expected to reduce complications after open heart surgery.

III. EXISTING TECHNOLOGIES

There are several medication management applications available on the market to address the problem of medication management to improve the wellbeing and health of individuals with chronic illnesses. Our mobile app is designed for the iOS and the android platforms. This application not only addresses the medication adherence but also helps follow the treatment regime that include physical therapy, social interaction and diet management. Most applications that address medication management are a general medication support application. Although there are several mobile applications for medication management none are designed specifically for use after open heart surgery [21, 22, 23].

A study that examined some of the popular medication management applications observed that the subjects were mostly content with their existing medication management system and did not feel the need for a mobile application. These subjects were frustrated with their initial interactions with the applications until they got comfortable using it. Noncompliance to medication can be attributed to social and economic factors, health system and health care team factors, therapy related factors, condition related factors and patient related factors [23]. Some of the current existing technologies are electronic pillboxes, mobile medication systems, prescription reminder apps and medicine trackers. None of these offered the complete treatment adherence solution that not only addressed medication adherence but also other recommendations for physical activity, diet management, and vital monitoring. The feature of diet management will also support the adherence of dietary restrictions imposed after open heart surgery by providing diet advice and making recommendations for heart healthy meals.
IV. PROPOSED SOLUTION

To address the challenge of treatment adherence after open heart surgery, we suggest the use of virtual mobile support during the post-hospital recovery phase of open heart surgery to address the pharmacological, emotional and social challenges being faced by patients during recovery. This tool will guide patients’ through medication administration, provide education on medications, such as interactions or side effects, and maintain records of medication history to achieve strong medication compliance in addition to reminding patient about physical activity, diet watch and physiological vital monitoring.

The features of this application are as follows:

1. Reminding patient of medication
2. Displaying a picture of the medication
3. Providing information on dosage
4. Reminding of any dietary restrictions with the specific medication
5. Recording of the medications taken along with the dosage and schedule
6. Educational information on medication adherence
7. Providing any information on side effects of the medication
8. Physical activity tracker and monitor
9. Demonstration of how the physical activity/therapy has to be performed
10. Diet management
11. Recipe preparation based on the diet restrictions provided by the clinicians

These features can be categorized as follows:

1. Medication management
2. Physical therapy monitor
3. Diet manager

Medication Management:

Patients would ideally input their medication into the system before leaving the hospital, as seen in fig. 1. Each medication includes an image of the medication for verification, the dosage schedule and medication instructions which includes instructions on administering the medication, any recommendations made by the doctor or pharmacist, food restrictions related to the drug and any possible side effects caused by the drug. In addition, start and end dates, if applicable, are established for each drug. All imputed drugs form the “medication list”, the first option in the settings menu in fig. 2. Below that is medication history, which serves as a record of all doses administered. Finally, the patient profile serves as a means to save the patient information.

Once the set up has been complete, the application opens to the default home page which shows the list of scheduled drugs for the day and the times each needs to be administered, seen in fig. 3. By selecting a particular dose, the patient can see the medication information, picture of drug, scheduled time as well as being able to mark a dose as complete, thus adding it to the medication history. This software also re-minds the patient of dosages as the scheduled time approaches if the dosage has not been marked complete. This reminder includes not only the medication name but also the image to improve compliance and insure that the correct medication is administered.
Physical therapy monitor/tracker:

This feature is designed to assist the physical therapist in help the patient adhere the physical activity regimen prescribed by the cardiac physical therapist. The patient has certain physical activity restrictions after an open heart surgery while at the same time has to strengthen her/his physical condition to be able to get back to their daily routine life. The physical therapist will be able to prescribe in this mobile app a set of exercises to be performed and the frequency of these exercises. The app will also have a demonstration of these activities.

Diet Manager

This feature offers the patient recommendations to manage their diet by avoiding foods that are restricted by the clinicians and encourages the patient to consume foods that are beneficial to a patient with coronary artery disease. This app feature also makes recommendations and recipes for the patient to follow a healthy diet regimen. Because of the linkage between pharmaceutical effectiveness and food consumption [17], this feature will be valuable in insuring that the effectiveness of pharmaceuticals is maximized. This feature will also support the adherence of dietary restrictions imposed after open heart surgery by providing diet advice and making recommendations for heart healthy meals.

Platform

The app is built on the iOS platform. The app's unique features are designed specifically to follow and adhere to a prescribed treatment regimen for patients after open heart surgery.

V. DISCUSSION

An element of effective cardiac rehabilitation interventions that stands out is the use of education in improving treatment adherence. A meta-analysis of cardiac patient interventions evaluating the role of education found that incorporating education into recovery emphasized the importance of and in turn, increased adherence to treatments [16]. Another benefit of education that was described was empowerment. As previously mentioned briefly, patients recovering from open heart surgery often feel neglected upon returning home. The support and understanding gained through this application is believed to lessen the feelings of distress and abandonment and empower patients to confidently manage their recovery. The proposed intervention shows promise in these areas by balancing the need of patient education while removing the burdensome task of managing medications, physical therapy, and diet with the belief that this combination of accessibility and understanding will increase pharmaceutical adherence. This idea of accessibility is built on the idea that while there is a need for education, the amount of changes in the patients’ life means that imposing too much responsibility could easily become overwhelming and result in non-adherence simply due to the complexity and newness of the scenario. Many solutions have been proposed individually to address issues of medication adherence, diet management and physical therapy monitoring. These solutions are mostly very generic and are not specific to a disease or if they are specific they only offer one of the medication adherence, diet management and physical therapy monitoring. An all-encompassing solution that addresses three main elements such as medication adherence, diet management and physical therapy monitoring is critical to help support patients after open heart surgery. Our proposal addresses all of these features.

VI. CONCLUSION

Recovery from open heart surgery poses many challenges for patients. One of the overarching challenges is the shortness of the inpatient recovery time and lack of assistance upon returning home. Especially in the area of pharmaceutical management, patients’ struggles can lead to preventable complications. This solution manages medications to ensure that they are taken correctly and to avoid putting additional responsibility on patients, helps remind and walk through the cardiac physical rehabilitation activities and diet restrictions. In doing so, patients’ are able to learn how to manage their condition without all the responsibility being instantly put on them when they return home.

Future work, currently in progress, aims to extend the services provided to include additional features that would encourage recovery after open heart surgery. Features that encourage and support emotional wellbeing are important for the complete recovery after open heart surgery.

In conclusion by providing support and education to patients as they adapt to lifestyle changes preventable complications can be avoided. In light of shortened hospital stays alteration to inpatient education need to be explored. Not only do such alternatives limit the amount of education needed to be provided during the patients’ inpatient stay, it also provides a more gradual transition to independent life. Providing such a resource for patients upon their return home is expected to decrease feelings of abandonment and most importantly, gives patients the resources they need. A multi feature mobile application that helps recovery in the areas of medication management, cardiac rehabilitation and diet restriction management will improve recovery time, reduce complication and help reduce healthcare costs.

REFERENCES
