Title: SURGERY AND WOUND MONITORING SYSTEM (MOBILE APPLICATION)

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Abstract:
Currently, there is a lack of standard practice for postoperative follow-up for the patients during in-home recovery. After major operations, the involved patients fail to recognize or identify their wound complications before it gets complicated after getting discharge or do not show up for appointments due to time constraint. This is due to the lack of features like wound image capturing for remote monitoring, real-time monitoring or even appointment reminder in the systems that are being implemented in Malaysia.

In conclusion, remote medicine has the potential to modernize healthcare. Holistic approaches involving healthcare professionals and early adopters are essential for successful implementation since Malaysians are still not very familiar with remote medicine.

Key words: remote-monitoring; telemedicine; remote-health; real time monitoring; mHealth

Content (Project or Innovation)

1. Introduction

One of the most critical parts of doctor-patient engagements is communication. Communication problems between patients and health care professionals (HCPs) as well as within the health care team are a known risk factor for unnecessary patient harm. There is currently no standard procedure for postoperative follow-up, so there is little information available about postoperative in-home recuperation. This problem is more important for day surgery patients because they are postoperatively monitored for a few hours before discharge. It leads to a lack of feedback and information regarding normality and relevant expectations during the recovery period. Thus, many patients or caregivers feeling insecure and worried after discharge. Moreover, unexpected visits or unnecessary readmissions may also happen at this time.

Since smartphones are everywhere now and owned by a large majority of people, regardless of socioeconomic status and age groups, they are known as an ideal device for capturing patient-generated data and patient-reported outcomes. In this regard, some studies confirm the effectiveness of mobile apps for the follow-up of discharged surgical patients. Existing systems, mostly in overseas, like mPOWer and SeamlessMD have revolutionized the remote monitoring by including image uploading and real-time monitoring features to help patients recover in home with peace of mind by remotely monitoring them and giving them feedback as necessary to avoid major complications.

The remote health has proved promising in the managing of chronic illnesses. Little attention is given to the uses of platforms such as mobile applications in the follow-up of patients after their discharge, which is important for early detection of complications and providing proper mediation.

2. Problem statement

There are few problems that patients might encounter after their major surgeries. Common problems being the time constraint in attending follow-up appointments due to other commitments or high travelling cost and postoperative complications like fluid draining or wound infections.

Patients are unable to identify infections and commonly neglect or fail to notice the early indicators of wound complications. As a result, patients frequently present to a routine, scheduled clinic session with an advanced wound complication that necessitates readmission, with or without reoperation. This is due to the lack of wound image capturing feature in the existing systems. Common reasons for these complications are age factor, gender, type of surgeries and hygiene to name a few.

Mobile health monitoring of patients in the post-operative period may not only allow for earlier discharge from the hospital, but also provides insight into the patient's experience while at home and a method for the early diagnosis of developing issues. A mobile application for postoperative and wound management will give the hospitals more control in addressing the risk that surgical patients face after discharge from the hospital and before their follow-up appointment. Keeping track of indications of infection after any surgeries, monitoring patients' incision with images, and communicating with the surgical team right from patients' smartphone will avoid costly unpaid re-admissions.

3. Solutions and the impact of innovation

I have worked to devise a mobile application to monitor patients' well-being and give feedback remotely, especially after major surgeries through features like wound image uploading and doctors' feedback. These features help patients to upload their surgical site wound image daily for doctors to monitor and assess them from far away. Consequently, this fulfills the main objective of this project which is to make remote monitoring easier for patients and Health Care Professionals (HCPs).

It should be noted that, despite the high expectations generated using mobile technology in health care and public health, the potential advantages may be constrained by at least a few variables. Despite their potential benefits, these tools have been underutilized, with most users abandoning them after just a few uses. It is less likely to achieve the positive outcomes of mHealth applications in this situation. According to Mariusz Duplaga and Tubek, a substantial proportion of the users of mobile health applications abandon them after only two weeks.

Not all mobile apps follow regulatory requirements for privacy, protection, and patient confidentiality. In the design, production, and implementation of mobile applications, industry standards and evolving telemedicine regulatory structures should be considered. Patient identifiers should be used sparingly, and any health mobile app that stores and handles patient data should have adequate encryption (Semple and Armstrong, 2016).

The overall benefits of postoperative monitoring using mobile applications can be divided into those affecting patients and those affecting the health care system. According to surgery professionals from Department of Surgery, University of Wisconsin, Telemedicine mobile apps encourage patients to take an active role in their wound care and allow doctors to communicate and monitor them after they leave the hospital. This strategy allows clinicians to intervene early rather than waiting for patients to return after the problem has progressed beyond the point where it can be managed on an outpatient basis.

Patients have realized cost savings, especially in terms of extensive back and forth travelling and significant time saving through mobile health applications. Patients have expressed appreciation for the ease of using mobile apps and telemedicine for postoperative follow-up.

4. Research Methodology (including the flow chart)

The data gathered for preparing this report and project is mainly through searching for the related information from existing expert journals, peer-reviewed research papers and documents. Some of the data are gathered through survey forms distributed to the potential users.

Searching and reading all the journals, peer-reviewed research papers, and documents helped me gain more knowledge about this academic project. As this technique was independent of any stakeholders, there were no constraints while obtaining these pieces of knowledge. But conversely, it was a very time-consuming task. A lot of time has been spent searching through databases and other resources to find the related and appropriate materials and analyzing them. Plus, not every document that I came across were insightful or provided valuable data for my project. Through this technique, I have gained a better understanding of the remote surgery and wound monitoring system, its benefits to the patients, and the hospitals' perspectives on systems. Besides, this helped me develop some requirements on my own to be implemented in my system.

Survey forms were distributed to the public especially among UM students and staff who are potential users of the systems or might have family members who could benefit from this remote health monitoring system. I chose to gather data through survey due to its ability for reaching out to many potential users in a short amount of time. The questionnaire was prepared using the Google Forms and distributed using the public share link. This survey is made up of three parts: Respondent's profile information, respondent's awareness, and knowledge regarding mobile health

systems in general, and respondent's perspective and expectations towards the remote health monitoring system. A total of 71 respondents took part on this survey. The gathered responses form this survey helped me greatly in understanding users' needs to come up with more refined requirements for my project.

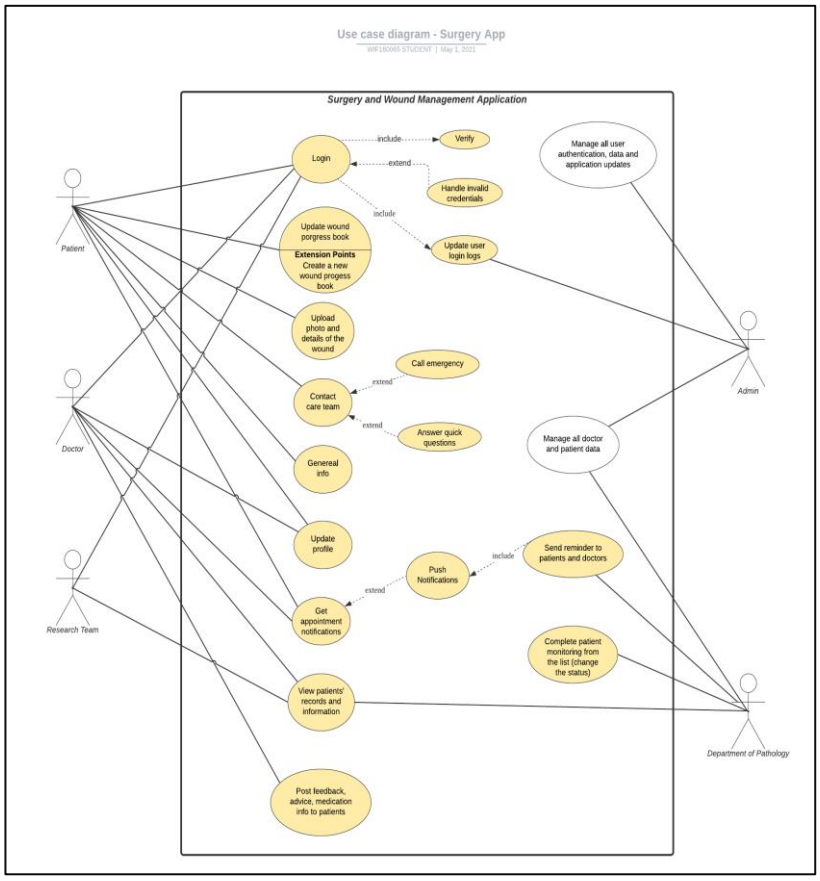

Figure 1: Use Case Diagram of the system

Figure 1 shows the use case diagram of the proposed system. There are five actors here namely Patient, Doctor, Research team, Admin and the Department of the Pathology. All these actors can be generalized as User. This use case diagram has been referenced in developing the Functional Requirements of this system. But due to technical constraints, Admin and Department of Pathology modules has been dropped without affecting the overall key functionalities of the proposed system.

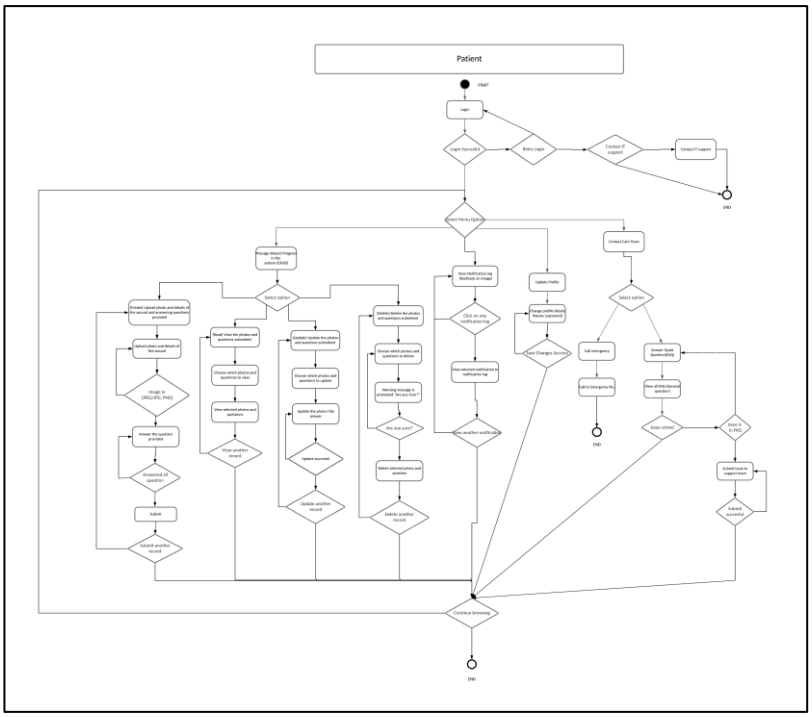

Figure 2 : Patient Flow Chart

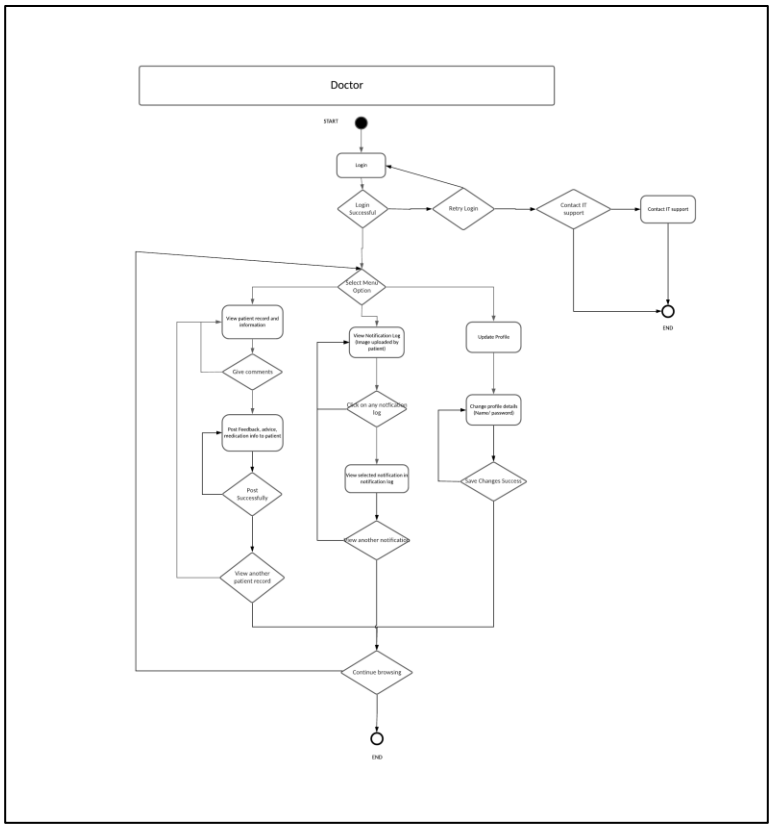

Figure 3 : Doctor Flow Chart

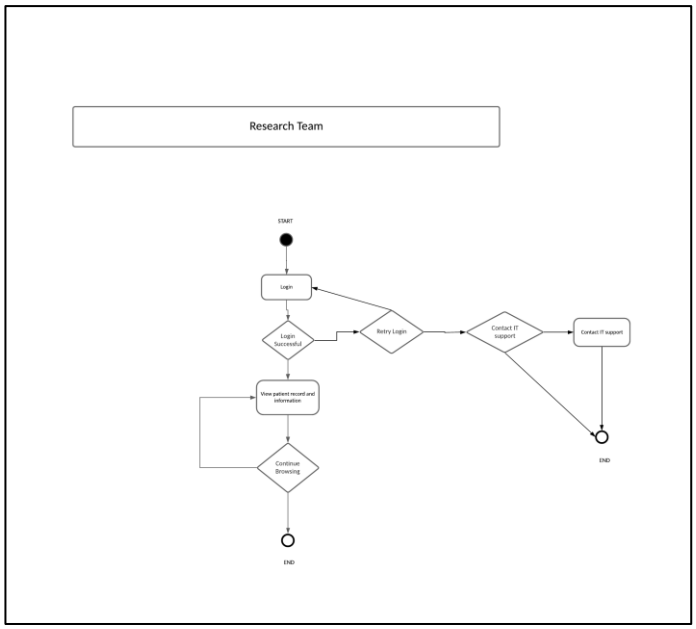

Figure 4 : Research Team Flow Chart

(A much clearer PDF version of these charts can be seen from this Google drive link: https://bit.ly/3w3doqk)

5. Result / Expected Result

At its completion, my developed system has three main user types and other supporting sub-modules integrated into the main modules like authentication module, progress book module, archiving module, quick chat module, note taking module, appointment module, user profile management module, feedback module etc., The developed system has been thoroughly tested through unit testing, hybrid integration testing, and user acceptance testing after being deployed two remote hosting platforms. As per UAT sign-off, the developed system is ready to be applied in real world to aid the health sectors.

To fully utilize application such as I have developed, specialized transitional care program, rather than merely adding a duty to the present staff workload, is required for the efficacy and sustainability of a post-discharge wound-monitoring procedure.

6. Finding and discussion of the project or innovation

Smartphone technology seems to be the next step in remote medicine advancement. Mobile technology is being utilized to link patients and their health care teams as the emphasis on patient-centered care grows. Postoperative and wound management could be somewhat brand-new that is only available in certain regions, and not extensively being implemented in Malaysia yet. Nevertheless, there are few existing systems, mostly in overseas, that can be found in the current market. For instance, SeamlessMD (SMD), MobileSmith, mPOWer (web-based application), TapCloud, myHealth by Stanford, BookDoc, MyHealth. Following table displays the comparisons on the features of the systems.

Functions	SMD	***MobileSmith***	mPOWer	TapCloud	myHealth (St)	BookDoc	MyHealth	NSH App
Real-time monitoring								
Image upload								
Patients' pain rating								
Message to doctor/nurse								
Appointment scheduling								
Emergency Contact								
Patient health record								
Set alerts and reminder								
Medication prescription								
Receive push-notifications								
See progress history								
General info								
Mobile version present								

Figure 5 : Comparison among the existing systems

Based on the table above, almost all, six out of eight, of the systems provide the functionality of real-time monitoring of patients' recovery, included built-in emergency contact, receive push-notifications at the appropriate times. Thus, it can be confidently said that these three functionalities are the most fundamental features of a mHealth application, and they must be implemented.

Surprisingly, only the system named mPOWer provides the feature of uploading images of the wound or surgical site through mobile applications to the patients. There are only five systems from my comparisons provide messaging to doctors or nurses feature for the patients to communicate with HCPs. Even though, pain scale rating is an essential factor in monitoring patients' well-being, only two systems, TapCloud and SeamlessMD, have implemented the feature. Besides, appointment scheduling feature has been only implemented in less than half of the mHealth systems above.

From the comparisons of the mHealth systems above, myHealth application by Stanford University has ticked almost, nine out of thirteen, all the important criteria of a mHealth by implementing especially the real-time monitoring, sending messages to doctors and doctors, scheduling appointments and push notifications features.

From the output obtained, the five (5) most fundamental functions; real-time monitoring, wound image uploading, scheduling appointments, push notifications, and built-in emergency contact, will be included as the primary functional requirements of my system. Furthermore, some of the other features will also be considered but might be assigned with lower priority.

7. **User manual for this application can be found here**: https://drive.google.com/file/d/1OtuHMkGW6kubvP-fm6P3D9M6ZrYfJaiT/view?usp=sharing

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