Wellness Community: M-Good Health for TB Patient

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ABSTRACT
Tuberculosis (TB) is second only to HIV/AIDS as the greatest killer worldwide due to a single infectious agent, and is one of the top killers among infectious diseases in Malaysia. Study showed that a large proportion of unsuccessful treated cases could be identified and prevented at the earlier stage if the patients are closely observed by the hospital. As a result, a system called “Wellness Community: M-Health for TB patients” is developed as an effective method to closely monitor and communicate with the TB patients by utilizing information communication technology. Implementing push and pull technology, doctors or TB specialists can push messages such as medical advices to their patients using mobile device or pull/retrieve any messages sent by patients to the system. Doctors and specialists can also view the patients’ medical records using the system. The system too can help hospital to educate their TB patients more about the disease.

Keywords: Tuberculosis, information system, communication technology, push and pull technology, mobile application.

I INTRODUCTION
Tuberculosis (TB) is second only to HIV/AIDS as the greatest killer worldwide due to a single infectious agent, and is one of the top killers among infectious diseases in Malaysia (World Health Organization, 2012 Mar). In 2010, 8.8 million people fell ill with TB and 1.4 million died from the disease, equal to more than 3,800 deaths a day (World Health Organization, 2012 Oct 6). Therefore, Malaysia needs to put more effort in improving the treatment success rate and reducing the mortality rate. Table 1 shows the statistic of TB cases in Malaysia (Ministry of Health Malaysia, 2010), (World Health Organization, 2011). Table 2 shows the TB treatment successful rate in Malaysia compared to other neighboring countries from 2005-2009 (World Health Organization, 2011).

Table 1: TB Statistics in Malaysia 2007-2010

<table>
<thead>
<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of cases reported</td>
<td>16918</td>
<td>17506</td>
<td>18102</td>
<td>19337</td>
</tr>
<tr>
<td>*Incidence Rate</td>
<td>62.26</td>
<td>63.10</td>
<td>63.95</td>
<td>68.25</td>
</tr>
<tr>
<td>*Mortality Rate</td>
<td>5.53</td>
<td>5.49</td>
<td>5.59</td>
<td>5.50</td>
</tr>
</tbody>
</table>

*Per 100,000 Population.

Table 2: TB treatment successful rate 2005 -2009

<table>
<thead>
<tr>
<th>Year</th>
<th>2005 (%)</th>
<th>2006 (%)</th>
<th>2007 (%)</th>
<th>2008 (%)</th>
<th>2009 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malaysia</td>
<td>70</td>
<td>48</td>
<td>72</td>
<td>78</td>
<td>78</td>
</tr>
<tr>
<td>Singapore</td>
<td>83</td>
<td>84</td>
<td>81</td>
<td>81</td>
<td>82</td>
</tr>
<tr>
<td>Thailand</td>
<td>75</td>
<td>77</td>
<td>84</td>
<td>82</td>
<td>86</td>
</tr>
<tr>
<td>Indonesia</td>
<td>91</td>
<td>91</td>
<td>91</td>
<td>91</td>
<td>91</td>
</tr>
<tr>
<td>Philippines</td>
<td>89</td>
<td>88</td>
<td>89</td>
<td>88</td>
<td>89</td>
</tr>
</tbody>
</table>

Study showed that patient treated without close observations by the hospital have a substantially higher risk of adverse outcome (Balasubramanian, V. N., Oommen, K., & Samuel, R., 2000). Study also showed that a large proportion of unsuccessful treated cases could be identified and prevented at the earlier stage if the patients are closely observed by the hospital (Ronaidi, N. N., Mohammad, W., Sharina, D., & Rosmawati, N., 2011). Based on an interview with a specialist doctor in Department of Respiratory,
Hospital Sultanah Bahiyah, problems that restrained the hospital from closely observing their patients during the treatment process were identified. The problems are:

1. Most of the patients stayed far away from the hospital (>30km) and their willingness to undergo all the treatment process were compromised due to the travelling cost.
2. Sometimes, TB patients are not well educated on the TB disease, and causing them to underestimate the consequences of not abiding to the treatment process tightly.
3. TB patients lack information communication tools to enable them to communicate with doctors and vice versa.
4. The hospital is also lacking an information system that can help to them to educate the patients about the knowledge of TB.

TB patients are required to go through a 6 months treatment process in order to recover from TB. Therefore, the hospital is looking for an information communication technology that can help them to monitor the patients and motivate them to complete the whole treatment process.

As a result, Wellness Community: M-Good Health for TB Patients is an effort to develop an effective method for hospital to closely monitor and communicate with their TB patients by utilizing the information communication technology.

A. The System
This system is carried out with the collaboration with Hospital Sultanah Bahiyah, Alor Setar, Kedah. The project name is Wellness Community: M-Good Health for TB patients, an information communication system for the hospital to manage TB patients’ treatment progress and to communicate with their TB patients and vice versa. TB patients (especially from remote area, poor background and less educated) will be able to communicate with doctors regarding their treatment and ask for advices using SMS. Doctor can read and reply patients’ SMS, and even send reminder messages to patients using the M-Health web application or iPad apps, via the Internet. In addition, doctors and TB specialists can view and manage detailed information of the patients such as treatment progress and medical history of their patients. A dedicated server (M-Health server) is deployed to handle the SMS or messages sent by doctors or TB specialists, as well as the services for managing patients’ information. This will give a fast and convenient way for doctors and TB specialist in providing accurate medical advices to the patient.

B. Benefits and Importance
With Wellness Community: M-Good Health for TB Patients, the system helps in many ways such as:

- helping to ease the problem faced by hospital in managing their TB patients’ treatment progress.
- providing a convenient method for doctors and TB specialists to manage patient’s information, and also communicating with their patients.
- providing a systematic way to manage TB patients’ information in hospital.

C. Uniqueness and Innovation
Wellness Community: M-Good Health for TB Patients has its very own uniqueness and innovations:

- An effective management and database system for hospital to manage and monitor their TB patients’ treatment progress.
- A cheap, fast and convenient solution for TB patients to communicate with doctors, especially for those who stayed far away from the hospital or those who have difficulties to go to the hospital, especially during emergencies.
- Real life application and implementation of system and technology to help hospital to overcome their problem.

D. Objective
The overall objectives of Wellness Community: M-Good Health for TB Patients is:

- To improve the management of TB patients’ medical information and treatment progress.
- To improve the compliance of TB patients in following their treatment tightly.
- To catch any medical complications of patients early using the communication system.
- To provide easy and convenient access to TB patients’ information and messages for doctors and medical staffs.
- To deploy an information communication system which will help doctors and TB specialists in managing TB patients’ treatment progress and communicate with their patients using both web-based application and mobile application (iPad).

II BACKGROUND & RELATED WORK
Surveys were conducted on both TB patients and the medical team of Hospital Sultanah Bahiyah. The first survey involved 53 patients (ranged from 20 to 60 years old) regarding the impact of TB disease and their TB treatment in their life. Based on the survey, 40% are having problem with the TB treatment, and the top 3 reasons for that are tiring hospital visit, unpleasant medicine and no time.
Although 87% of the patients can cope with the TB treatment method provided by the hospital, there are still about 32% of the patients hoping to get doctor’s advices all the time. In addition, almost all of the surveyed patients (98%) have a mobile phone that has SMS capabilities (with 69% of them owning a smart phone), and over 96% of them opt for SMS in such cases where they will be communicating with doctors or receive any reminder from the hospital. Therefore, the communication system provided by M-Health project can be very useful and helpful to overcome the problem faced by the hospital where patients could not follow their TB treatment tightly.

The second survey was done on the TB medical team of the same hospital that consists of 18 medical personnel (6 doctors, 6 nurses, 2 medical assistant and 4 hospital staff). Based on the outcome of the survey, 100% of the medical team supports the idea of digital medical record, with 64% of them acknowledge the IT advantage in their work, and are prepared for change and believe it will be beneficial to them. Almost 95% of the medical team also embraces the idea of mobile health. Opinions were also taken from them for such a scenario where the M-Health system is deployed for their hospital and their responses are as follows:

- They preferred to be identified by staff ID
- They preferred to use self-created password for info access
- All of them are willing to learn to use the new system

Overall, the survey shows or showed positive responses from the TB medical team.

A. Existing Solutions

With tuberculosis (TB) being one of the major diseases in the world, various kinds of methods have been developed to help combat this disease. There are various kinds of tuberculosis-related software available from the Internet.

Tuberculosis Information System. An information system called staffTRAK-TB is used to facilitate surveillance of TB infection among healthcare workers, developed by the Centers for Disease Control and Prevention (CDC). staffTRAK-TB evaluates each healthcare worker and determine if they were infected by active TB based on analysis of the worker’s information such as occupation, work location, and tracking each workers’ tuberculin skin test (TST) results.

Another web-based tuberculosis information system called Integrated Tuberculosis Information System (i-TIS) is developed by the Philippine Department of Health (DOH) and the Global Funds to fight AIDS, Tuberculosis and Malaria (GFATM) (Integrated Tuberculosis Information System, 2010). The system’s purpose is to enhance the existing National Tuberculosis Program (NTP) Reporting System and to process and analyse various kinds of reports of TB initiatives such as Adult TB, Drug-Resistant TB and TB-HIV.

In addition, a web-based tuberculosis database system called TB Database (TBDB) is provided by Stanford School of Medicine and Broad Institute, which provides publication and knowledge about TB. (Broad Institute and Stanford School of Medicine, 2007-2010). The TBDB project aims to provide a platform for public interventions on tuberculosis research with the discovery and use of new vaccines and drugs.

Tuberculosis information system in Malaysia called MyTB (Kementerian Kesihatan Malaysia, 2012) was also made available. MyTB is developed for the Jabatan Kesihatan Negeri Sabah, Kementerian Kesihatan Malaysia that provides database management of TB cases in Malaysia and is only accessible by registered personnel. Figure 1 shows a screen snapshot of the login-page of the MyTB website.

Figure 1: Login-page of MyTB Website

Tuberculosis Mobile Application. The electronic Mobile Open-source Comprehensive Health Application (eMOCHA) TB Detect is a free open-source application developed by the Johns Hopkins Center for Clinical Global Health Education in collaboration with the Johns Hopkins Center for TB Research. It provides an interactive TB symptom screening algorithm for users to detect TB infection (John Hopkins Center for Clinical Global Health Education). The application also provides education about TB prevention and health care information through multimedia tools.

Another mobile application is an iOS app called TB Mobile, developed by Collaborative Drug Discovery, Inc (CDD). TB Mobile provides more than 700 types of drug molecules that are effective against TB bacteria and other known targets, which is only
available in CDD (Scientific Mobile Applications). The app stores information of these drugs including their structures, name and miscellaneous data and allows user to search for them using the app. These data can also be copied to clipboard, open with other apps, bookmarked or even exported (iTunes Apple, 2012).

Table 3 shows the comparison of the various TB systems with the system, Wellness Community: M-Good Health for TB Patients.

Table 3: Summary of Existing Systems

<table>
<thead>
<tr>
<th>System</th>
<th>Targeted Users</th>
<th>Provide TB information &amp; education</th>
<th>Manage patient information</th>
<th>Communicate (doctors &amp; patients)</th>
<th>System Module Breakdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>staffTRAK-TB</td>
<td>CDC</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CDC WONDER OTIS</td>
<td>Public Internet users</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>i-TIS</td>
<td>Philippines Dept. of Health</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TBDB</td>
<td>Public Internet Users</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>MyTB</td>
<td>Kem. Kesihatan Malaysia</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>eMOCHA TB Detect</td>
<td>Smartphone users</td>
<td>✓</td>
<td>Provides TB screening</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>TB Mobile</td>
<td>Smartphone users</td>
<td>✓</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Wellness Community: M-Good Health for TB Patients</td>
<td>Doctors &amp; patient (SMS)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Via SMS</td>
</tr>
</tbody>
</table>

III SYSTEM DESIGN

A. System Architecture

Figure 2 shows the system architecture of Wellness Community: M-Good Health for TB patients.

The system consists of client application (web application and mobile application) that will be used by the users of the system. The web application serves as the main platform to be used by any user of the system; whereas the mobile application is an additional feature that is designed for the doctors and TB specialists. The M-Health server is used to store the patients’ information and medical records, as well as to handle any data retrieving by doctors and also the communication between doctors and patients. A GSM modem is used to receive and send any SMS from and to the patients. Using the client application, doctor and TB specialists can retrieve their patients’ information and medical records from the server. Doctors and TB patients can communicate with each other using SMS, where patients can send SMS to the system using mobile phone and doctors can view and reply their SMS using the client application through the Internet. Messages sent by patients with highest priority will be pushed to the web application, mobile application and also doctor’s personal mobile phone. In addition, data transfer between the client side’s application and the server will be secured using client/server authentication and data encryption methods, as well as requiring doctors and specialists to login into the system using self-created user password in order to access the patients’ information.

B. System Module Breakdown

Figure 3 shows the system components breakdown of Wellness Community: M-Good Health for TB patients.
The system consists of 3 types of users (doctor, nurse and admin). The web-based application consists of all these modules, while the mobile application consists of only the doctor’s module. The reason is only the doctors or TB specialists will be using the mobile application (iPad) but not the nurse and system administrator.

These modules are further explained below, starting with nurse’s module.

Nurse’s Module. Whenever a new patient comes for a new TB treatment, they will generally required to fill in their personal information and medical records. This module is designed for user to add new and manage patients’ information in the system.

- **Add New Patient**: Register new patient and also fill in the patient’s required information (TBIS10A-1) into the system database. This information is necessary to obtain the background of patients in order for doctor to diagnose the patient.
- **Manage Patient**: View list of registered patients, and also allow editing of patients’ information.
- **Assign Patient to Doctor**: Assign patients to specific doctor or a group of doctors.

**Doctor’s Module.** This is the main module of the system. This module is designed for doctors to view and manage patient’s information and medical records, as well as providing communication mechanism for doctors to communicate with their patients.

- **Doctor’s Workspace**: View and manage patients’ information (TBIS10A-1) and medical records (TBIS10B-1). TBIS10A-1 is the initial information entered by nurse in the nurse’s module. TBIS10B-1 is the form initiated by doctors every time patients come for treatment or visit. Doctors will add new or update this information to track patient’s treatment progress, including their medication records etc. Doctors are able to set patients’ priority in this sub-module.
- **Messaging**: Allows doctor to view and reply patients’ SMS, and also send scheduled message to patients as reminder message. SMS sent by patients with highest priority will be sent not only to the system, but also to doctor’s mobile phone.
- **Add Medicine Information**: Add TB medicine information into the system database for quick references by the doctors.

**Administrator’s Module.** This module is designed for system administrator to manage the system’s user and their information.

C. **M-Health Mobile Application**
The two primary functions for the mobile application are to manage patients’ information and medical records, and also communicate with patients using the messaging system. Figure 4 shows the flow design of UI of M-Health mobile application on iPad.
D. Message Handling Service

Message handling service is a windows service that runs in the background of the Windows operating system. Its main function is to handle any transmission of messages between the M-Health server and the Global System for Mobile (GSM) modem – a modem that contains a Subscriber Identity Module (SIM) card, which will be used to send and receive messages from and to any mobile phone numbers, generally patient’s mobile phone number. Figure 5 shows the overview of how messaging works between iPad, M-Health server and patient’s mobile phone.

Figure 5: Overview of How Messaging Works between iPad, M-Health Server and Patient’s Mobile Phone

IV CHALLENGES, FUTURE WORK AND CONCLUSION

Challenges for the system are the Graphical User Interface (GUI) design for iPad and the mobile application development that has to be compatible and closely resemble the web-based application. Future works that should be implemented are listed below that include creating a wider user interface, adding local clinic module and report module, enhancing data security and privacy and integration of chatting application. In conclusion, Wellness Community: M-Good Health for TB Patients is a project that can help the hospital to improve the treatment rate of TB patients in Malaysia. The current prototype system has already established a solid platform for many further improvement and upgrades of the system. Nevertheless, this project can help our country in combating TB disease for a long run in the near future.

ACKNOWLEDGEMENT

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