

# e-Health for Improving Community Healthcare:

## Encouraging Clinical Experience of Simple e-Prescription System and m-Health System Development for Mother and Childcare

S. Soegijoko

School of Electrical Engineering  
and Informatics  
Institut Teknologi Bandung  
Bandung, Indonesia  
[soegi@ieee.org](mailto:soegi@ieee.org)

I.M. Puspitasari

Faculty of Pharmacy  
University of Padjadjaran  
Jatinangor (Jawa Barat), Indonesia  
[irmamelyani@gmail.com](mailto:irmamelyani@gmail.com)

A. Aridarma, I.D. Jani

School of Electrical Engineering  
and Informatics  
Institut Teknologi Bandung  
Bandung, Indonesia  
[arga\\_aridarma@yahoo.com](mailto:arga_aridarma@yahoo.com),  
[iradewijani@yahoo.com](mailto:iradewijani@yahoo.com)

**Abstract**—In this paper, we describe the eleven month encouraging clinical implementation experience of our e-prescription system in a community health center and further development activities of a mobile e-health system for mother and childcare. The e-prescription system has been developed for supporting the patient and medicine data recording, retrieving and reporting systems, as well as for minimizing the possible medication errors through improving the prescribing process. Several months of clinical experience have been used to enhance further development activities in our m-health system dedicated for supporting mother and childcare (especially the safe motherhood program). The m-health system consists of an SMS (short messaging system) manager module which is responsible for sending short messages with four different operating modes.

**Keywords** – community healthcare, e-health, e-prescription, m-health

### I. INTRODUCTION

Having more than 17,500 islands and more than 230 million people, Indonesia is the world largest archipelago country and is divided into 33 provinces; about 60% of its population is estimated in the rural area. The country applies a referral healthcare system, with a total of 8600 community health centers (CHCs) acting as the spearheads of the community healthcare services [1]. Each community health center has to face a lot of day-to-day challenges towards achieving the Millennium Development Goals (MDGs) in healthcare. In general, there are a lot of centers, in less remote or underserved areas, that have to serve healthcare services for patients in the range of 100 to 200 patients per day. For these types of community health centers, electronic health is expected for supporting and improving day-to-day healthcare services. Moreover, e-health can provide further advantages to increase healthcare services, quality of healthcare providers and the healthcare units [2].

A lot of time and efforts were needed to introduce the information and communication technology (ICT) for healthcare and e-health, through various human resource development programs [3], [4]. We have conducted a series of promotional activities on the importance of ICT applications

in healthcare, since 1997, through presentations, seminars and workshops. More than 250 healthcare providers have been covered through different types of hands-on training activities in about three years. Similar activities have also been conducted by other groups in the country, and it is estimated to have covered about 1000 healthcare providers. Unfortunately, a lot more efforts still need to be done to cover half of the existing healthcare providers of the community health centers in the country.

### II. E-PRESCRIPTION SYSTEM DESIGN AND IMPLEMENTATION

#### A. e-Prescription System Design

The e-prescription system [4] has been designed as a web-based e-health system with the following main functions: to improve general daily recording and reporting process, as well as to provide paperless prescription to avoid or reduce the adverse drug event cases. The following sub – functions have been designed and implemented for enhancing the general recording and reporting process: automatic patient numbering, new patient data recording, retrieving of registered patients' data, building of electronic medical record data base, and generating up to seven different types of regular reports for clinical/administrative purposes. The paperless prescription functions have been designed and implemented to support the prescribing process, which includes: pharmaceutical information for more than 210 standard drugs; information on possible allergy, overdose and drug interactions; simple dosage calculator; drug – drug interaction tests; adverse drug reactions alert; drug inventory and reporting [5].

During the system development phase, we have taken special care to come up with a user friendly prescription software for the healthcare providers. Fig. 1 shows the main page of the e-prescription system, presented in the Indonesian language.

#### B. Simplified Block Diagram

Since there are many community health centers with different infrastructure environment, the e-prescription system has been intentionally designed, so that it can be implemented

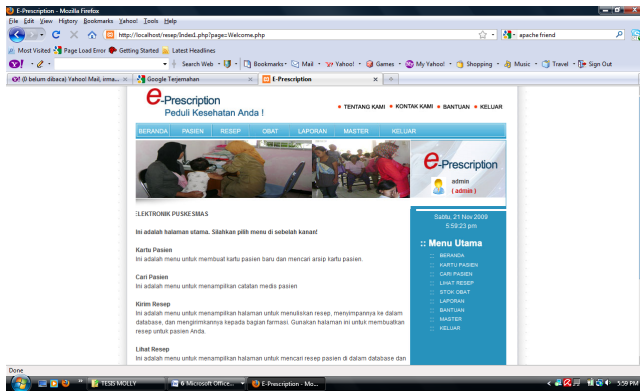


Fig. 1. The main page of the e-Precription system

in various configurations, i.e. from an e-health system consisting of a single personal computer to a system with 9 personal computers (or more) in a local area network. Fig. 2 shows a simplified block diagram of the e-prescription system with multiple PCs. As shown in the diagram, a PC is used as a “server” with the necessary web-based e-prescription software package. Depending on the size of the community health center and the hardware elements availability, such system can have 3 PCs to 9 or more PCs. Each personal computer (desk top PC, laptop, or “net-station”) can be used and placed in a particular health unit (for example: a registration unit, a medical examination unit, an underfive unit, a mother & child unit, a dental unit, a tuberculosis unit, a laboratory unit, or pharmacy unit).

### C. System Implementation

Before implementing the e-prescription system at the targeted community health center, the following activities have to be completed: hardware & software e-health system tests, education & training for the healthcare providers, and site preparation. In our experience, site preparation in a community health center took much longer time than our prediction, as it involved red tapes and financial matters.

Initially, the existing electricity power was not sufficient when the system design was started. A power capacity increase from 900 VA to 13,200 VA and new electricity power installation were needed, which took about three months to complete. The system implementation was ready in a week. The first two weeks of system implementation, was a familiarization period, where a lot of users’ feedbacks and suggestions were obtained for further system improvements.

A technical supervisor was needed to help users in obtaining the necessary guidance and information for using the e-prescription system appropriately. During the familiarization period and some more additional weeks, a number of system improvements have been made, based on the bugs encountered, users’ feedback and suggestions. It was found that a quick technical response was very useful towards future users’ acceptance.

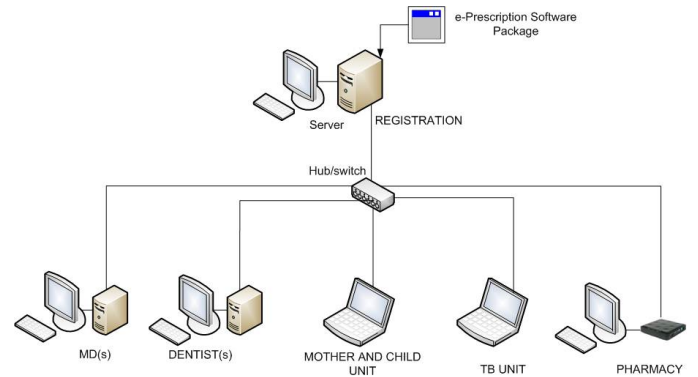


Fig. 2. Simplified e-Precription system Block Diagram

### III. SOME CLINICAL EXPERIENCE

After 11 months of day-to-day clinical implementation of the e-prescription system at Babakan Sari Community Health Center, Bandung (Indonesia), since March 2010, a number of clinical observations and experience can be noted. The moderate size center has an average number of patients between 80 to 200 patients per day, served by 20 – 25 healthcare providers. A total of more than 31,300 patients have been served by the health center in 11 months.

#### A. Healthcare Providers’ Education and Training

For a successful e-health system implementation, capacity building (human resource development) of the healthcare providers is of primary importance. Class type education, on site hands on training and hands on training on personal basis have been conducted. Continuing education of all the healthcare providers is necessary and should be made on regular basis. Inviting healthcare providers from other community health centers, to learn from the implementation experience, is also an advantage. Moreover, continuous promotional activities of e-health for the large community (patients and their relatives) should be prepared.

#### B. Infrastructure Preparations

Special consideration on the existing infrastructure (particularly: electricity and telephone lines) is a must, especially when a community health center is located in a rural or underserved area. The relatively fast penetration of mobile phone networks and (relatively slow) availability of internet access in the country, have been very helpful for further e-health system developments. The internet access currently installed at selected community health centers, have improved the communication among healthcare providers and their skills in appropriately working with personal computer and operating the e-health system. Although mobile phone usage has been very common, its healthcare application still needs further enhancement.

#### C. Summary of the Evaluation Results

Before preparing human resource development and training,

a series of evaluations on the computer competency usage of the healthcare providers have been conducted. In summary, the results are as follows:

- 35% of the healthcare providers have never used PC
- 70% of them have never accessed the internet, and
- 75% of them have no email account.

After the e-prescription system implementation, different evaluation activities have also been conducted to the users. Some important results are as follows:

- The system is easy to use [90% users]
  - The system has interesting appearance [90% users]
  - The system has helped them in solving their tasks [100%].
- However, only 70% of users responded that the input data process and searching of information are easy.

#### D. Advantages of the e-Prescription System

Based on the evaluation conducted after 11 months clinical implementation and a number of users' suggestions, we can list the advantages of the e-prescription system. The e-health system has significantly shown its effectiveness in the following healthcare applications:

-General patient and medicine data recording and reporting: less paper is needed

-Faster retrieving time of already registered patients' data,

-More efficient report generating process: at least seven different reports can be generated in much less time.

During the prescribing process, the e-health system provides supportive drug information and prescribing tools for medical doctors, but it does not affect the time needed for medical examination.

Reports on adverse drug event cases were found during the first two months of the e-prescription system implementation. The reports have been discussed among the medical doctors and healthcare providers; therefore during the prescribing process all the healthcare providers have been more aware on the adverse drug event. Although some adverse drug event "cases" are still found, they have been conducted "on purpose", i.e. when the prescribed drugs should be administered not at the same time (for example: *antacid* and *ranitidine* should be taken separately at least after two hours).

It was also found that the e-prescription system has made healthcare providers be more aware and more careful in selecting drugs during the prescribing process. Their awareness on possible medication errors in prescription has also improved.

Further benefits are expected for future use of the data base in supporting community healthcare research activities such as: drug utilization research, *epidemiology*, *pharmaco-epidemiology*, *pharmaco-surveillance* and *pharmaco-vigilance*.

#### E. Technical Hardware/Software Problems

During the eleven month of continuous clinical application (based on 6 days a week operation), a number of minor and major hardware/software problems have been encountered.

Most minor problems could be fixed in relatively short time, but some major problems needed longer time, thus added the down-time of the system.

Special attention should be given to avoid unnecessary lost of important data due to computer viruses and operational errors. Therefore, a standard operational procedure should be involved.

#### IV. M-HEALTH SYSTEM DEVELOPMENT

Based on the encouraging clinical experience obtained with the e-prescription system, we have conducted further development of mobile e-health system for supporting mother and childcare. Basically, it is a PC-based e-health system with additional SMS (short messaging system) software module and a modem (or a mobile phone) attached to it. The SMS software module is responsible for the management of sending and receiving different types of SMS messages as required by the application [6]. The software module has been developed using a number of open source software elements, namely: the Apache – based Web server, MySQL – based Database server, and Gammu – based SMS engine. For practical reason, a short message is limited to 150 to 155 characters.

We have developed and tested four different modes of operations, for supporting mother and childcare services. As shown in Fig. 3, the four operating modes are as follows:

-a). Sending short messages to a selected single client (or group of clients). The short message can be instantly prepared or prepared in advance; the clients can be patients and/or healthcare providers/officials. [Dotted lines in fig. 3]

-b). Sending short messages at pre-scheduled time, to a selected single client (or group of clients). [Dashed lines in fig. 3]. The default scheduled time has been set as during the working hours, e.g. 09.00 am.

-c). Sending short messages to a selected single client (or group of clients), initiated by "triggering" from a remote (registered) mobile phone. [Close dotted lines in fig. 3]. Initially, the selected client (or clients) and the corresponding message have to be prepared. A short message will be sent to a selected client, through remote triggering from the remote mobile phone. This feature adds the flexibility of the m-health system.

-d). Sending short messages to a particular single client in response to a typical incoming SMS (keywords) request with specific format (on demand auto reply). [Dotted – dashed lines, as shown in fig. 3]. This feature permits a patient (client) to request healthcare information by sending keywords with specific format to the m-health system.

Both laboratory and limited clinical experiments of the mobile e-health (m-health) system have been successfully completed. We use the GSM (global system for mobile communication) mobile phone type, since it is supported by more mobile operators and the system is more popular among mobile users.

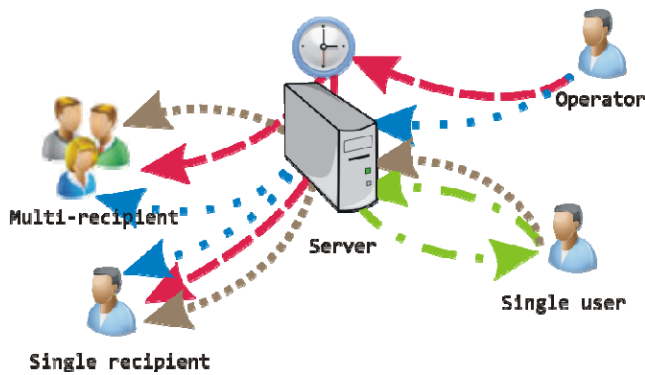


Fig. 3. Simplified Block Diagram of the 4 Operating modes (of the m-Health system)

Before our m-health system development, the healthcare providers have been familiar with the “Mother and Childcare Booklet”, published by the Department of Health in 2010, for their daily healthcare activities. The booklet has been used during the development of our m-health system, especially the short healthcare messages. For mother and childcare applications, we have developed a number of classifications (groups) of different types of short messages:

- a).Messages for the first trimester pregnancy (0 – 3 months)
- b).Messages for the second trimester pregnancy (3 – 6 months)
- c).Messages for the third trimester pregnancy (6 – 9 months)
- d).Messages for the *post partum* (after delivery)
- e).Messages for family planning (40 days after delivery)
- f).Messages for parents during the immunization period of their babies
- g).Messages for parents of the underfives
- h).Messages on children food
- i).Messages on child development
- j).Messages on other topics.

(In each group there are about 5 – 15 different messages).

Moreover, similar m-health systems for other specific healthcare applications have also been developed or under development. Some application specific m-health systems currently under development include: m-health system for tuberculosis management, m-health system for outbreak management, m-health system for integrated management of childhood illness and m-health system for movable community healthcare. The above mentioned application specific m-health systems are expected to be beneficial toward achieving the MDGs (Millennium Development Goals).

## V. CONCLUSION

In the previous sections, we have briefly described the e-prescription system design, testing, preparation and implementation activities. Various types of challenges have

also been presented. The encouraging implementation results have been used as the basis of developing our m-health system for supporting the existing mother and childcare, especially the safe motherhood program. Based on the clinical implementation experience of our e-prescription system for eleven months in a community health center, and our recent development of the mobile e-health system for safe motherhood program, the following conclusions can be noted.

The paperless prescription system has successfully support the recording and reporting process, through significantly reducing the patient and medicine data retrieval time, as well as possible medication errors. Moreover, it has significantly reduced the time for generating 7 types of regular reports. The m-health system prototype has successfully shown its functions in sending/receiving short messages with at least four different operating modes. It is expected that further potential benefits could be obtained from both the paperless prescription and mobile e-health systems. Therefore, we hope to achieve clinical implementation of both the e-prescription and m-health systems in more and more community health centers.

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