

## **e-Prescription: An e-Health System for Preventing Adverse Drug Events in Community Healthcare**

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### **Abstract**

The paper describes development activities of an e-health system for community health center (Puskemas) with integrated adverse drug events e-prescription module, consist of system design and development, human resource development, e-health system realization, laboratory and implementation test of e-health system. Some e-readiness evaluations were conducted, through a number of field visits and questionnaires. The results had been used in the e-health system design and development, installation of the internet access infrastructure, and implementation of the education and hands-on training for the medical and administrative staff of the healthcare units. After completing the e-health system design and development as well as system realization and laboratory tests stages, a series of field implementation and experiments have been successfully conducted at Puskesmas Babakansari in Bandung. A number of users feed back have been obtained and used for further improvements on both of the software and hardware modules. The e-health system with integrated e-prescription module has successfully developed and shown its expected functions in: patient registration, medical record, paperless prescription, producing the required reports and preventing possible adverse drug events.

**Key words:** Adverse drug events, community health center, e-health, e-prescription

### ***e-Prescription: Sistem e-Health untuk Pencegahan Adverese Drug Event di Puskesmas***

### **Abstrak**

Artikel ini mendeskripsikan pengembangan sistem *e-health* untuk puskesmas dengan modul *e-prescription* yang terintegrasi *adverse drug event*. Modul ini terdiri dari desain sistem dan pengembangan, pengembangan sumber daya manusia, realisasi sistem *e-health*, laboratorium dan tes implementasi sistem *e-health*. Beberapa evaluasi kesiapan penggunaan elektronik (*e-readiness*) dilakukan melalui kunjungan lapangan dan kuesioner. Hasil evaluasi digunakan dalam desain dan pengembangan sistem *e-health*, instalasi akses internet, implementasi pendidikan dan pelatihan bagi staf medis dan administrasi. Setelah sistem *e-health* selesai dan dikembangkan sesuai dengan realisasi dan tahapan tes laboratorium, sejumlah implementasi dan eksperimen telah sukses dilakukan di Puskesmas Babakansari di Bandung. Respon yang diperoleh digunakan untuk pengembangan modul lebih lanjut dari segi *software* dan *hardware*. Sistem *e-health* yang terintegrasi dengan modul telah sukses dikembangkan sesuai dengan fungsi yang diharapkan: registrasi pasien, medical record, resep tanpa kertas, pelaporan dan pencegahan kemungkinan *adverse drug events*.

**Kata kunci:** *Adverse drug events*, pusat kesehatan masyarakat, *e-health*, *e-prescription*

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## Introduction

This paper was developed from the thesis entitled "Design and Implementation of An e-Health System for Community Health Center Recording and Reporting with Integrated Adverse Drug Event e-Prescription Module" presented at Master Program Examination on Biomedical Engineering Program Institut Teknologi Bandung in January 2010.<sup>1</sup> e-health is a new term used to describe the combined use of electronic, computer, communication and information technology in the health sector" OR is the use, in the health sector, of digital data-transmitted, stored and retrieved electronically-for clinical, educational and administrative purposes, both at the local site and at a distance.<sup>2</sup>

e-Prescription or electronic prescription is a tool for prescribers to electronically prepare and send an accurate, error-free and understandable prescription directly to a pharmacy from the point-of-care.<sup>3,4</sup> With e-prescription, physicians enter orders into a computer rather than on paper. Orders are integrated with patient information, including prescription data. The order is then automatically checked for potential errors or problems. Specific benefits of e-prescription include:

1. Prompts that warn against the possibility of drug interaction, allergy or overdose;
2. Drug-specific information that eliminates confusion among drug names that sound alike;
3. Improved communication between physicians and pharmacists; and
4. Reduced healthcare costs due to improved efficiencies.<sup>5</sup>

Based on research, computerized physician order entry (CPOE) or e-prescription systems can be remarkably effective in reducing the rate of serious medication errors. A study led by David Bates MD, Chief of General Medicine at Boston's Brigham and Women's Hospital, demonstrated that CPOE reduced error rates

by 55% from 10.7 to 4.9 per 1000 patient days.<sup>6</sup> Rates of serious medication errors fell by 88% in a subsequent study by the same group.<sup>7,8</sup>

Medication errors are the frequent cause of Adverse Drug Events (ADEs). More than one million serious medication errors occur every year in U.S. hospitals. Medication errors defined as any error in the prescribing, dispensing, or administration of a drug, irrespective of whether such errors lead to adverse consequences or not, are the single most preventable cause of patient harm. They occur for many reasons, including illegible handwritten prescriptions and decimal point errors.<sup>9,10</sup> It is believed that medication error cases also exist in Indonesia, although there is no official quantitative data reported on medication error yet.

Our new e-prescription system has been designed to be implemented in Community Health Center, a technical implementation unit of the Public Health District responsible for organizing health development in a region; it has a role to organize some of the technical operational public health district and the main of health development in Indonesia.<sup>5</sup> The system is expected to assist recording and reporting of patients data, to prepare medicine data recording and reporting, to improve patients and medicine data management and to prevent and reduce medication errors at CHC level.

## Methods

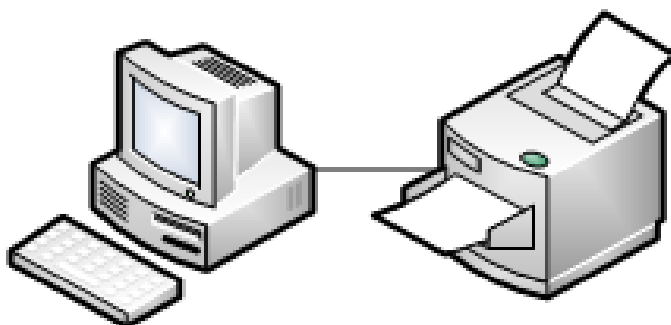
### A. System Design

The e-health system with integrated e-prescription module has been designed to be used in CHC. It consists of a specially developed web-based software package which has the following main functions: to do recording of patient data (patient registration), to prepare medical record (during medical examination phase) and paper-less prescriptions with ADEs alert, to prepare the prescribed medicine (drugs) for each patient, and to prepare different types of patient and

medicine regular reports, and to send the appropriate reports to the District Health Office as needed. Moreover, the e-prescription has been designed so that future modifications/improvements could be easily conducted.

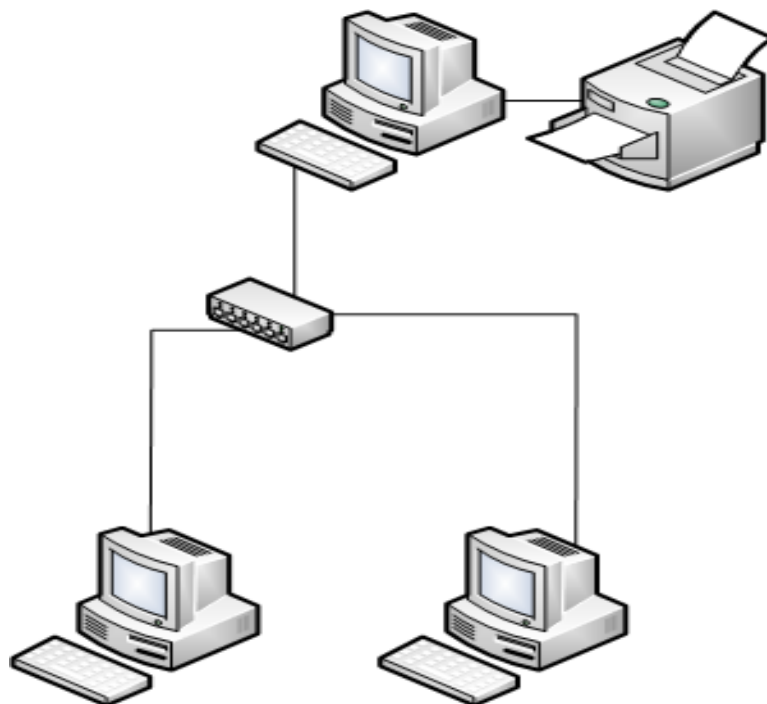
Considering that there are many community health centers in the country having limited

infrastructure, we have anticipated the situation by designing a number of e-health system configurations that could match with local environments. The system has been designed so that it can be implemented in either one of the following hardware configurations: minimum, medium and full size configurations.

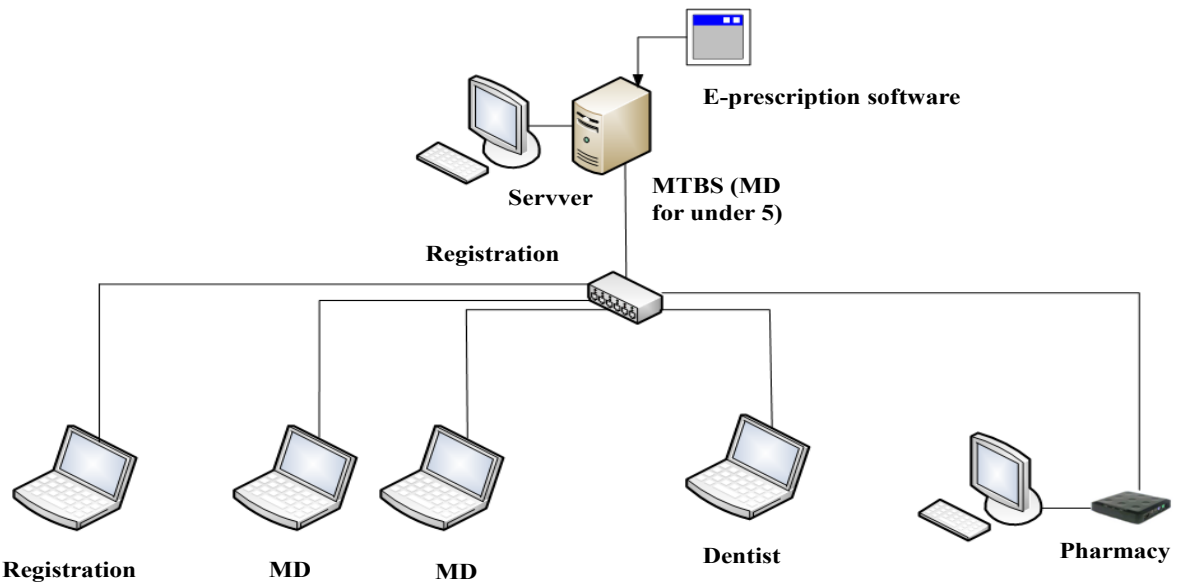


**1 PC 1 Printer**

**Figure 1** Simplified block diagram for minimum system



**Figure 2** Simplified block diagram for medium system



**Figure 3** Simplified block diagram for full system

Figure 1 shows a minimum e-health system configuration consisting of one PC. Figure 2 shows a medium e-health system size/configuration consisting of 3 PCs/laptops connected in a local area network (LAN). A full size system configuration needs at least 6 PCs (laptops or Net stations) in a LAN is shown in Figure 3.

**B. System Development**

System development of e-health system consists of several steps, they are: Evaluation (Questionnaires)

1. Initially, some e-readiness evaluations (of the medical personnel and healthcare unit) had been conducted, through a number of field visits and distributions of questionnaires.
2. Human Resources Development  
Hands-on training to medical staffs and administrative staffs were conducted and designed based on e-readiness evaluation. Other preparation was installation of an ADSL (asynchronous digital subscriber line) internet access infrastructure in CHC for implementation of the system and a training medium of using web base application.

3. Software development of e-Health System with Integrated e-Prescription

The web-based software package was developed using open source software (XAMPP from [www.apachefriends.org](http://www.apachefriends.org) which consists of server, PHP program and MySQL database) and presented in Bahasa Indonesia (Indonesian language) to facilitate healthcare providers in using this program without problem. Drug-drug interaction data of CHC's medicines were collected during software development and were integrated in MySQL database. The technical specifications of the e-Health System with Integrated e-Prescription for Community Health Center is shown in Table 1.

4. System Realization and laboratory test  
The system was realized and tested in Biomedical Engineering Laboratory Institut Teknologi Bandung for all functions and in all types of system configuration.
5. Implementation and evaluation  
The e-Health system with integrated e-prescription system was implemented in Puskesmas Babakansari Bandung Indone-

sia to gain feedback from users for future system improvement.

ber of field visits and distributions of questionnaires result in summary as follows:

**Results**

**A. e-readiness Evaluation**

e-readiness Evaluations through a num-

1. 35% of the healthcare providers have never used PC
2. 70% of them have never accessed the internet, and
3. 75% of them have no email account.

**Table 1** The technical specifications of the e-health system with integrated e- prescription for community health center

Main Functions	Main Functions
1. Patient Data Recording	a. Search patient card b. Create new patient card c. Store patient data in database d. Print patient card
2. Prescribing paperless prescription	a. Search patient data and medical record b. Record medical record c. Store medical record in database d. Print medical record e. Prescribe with or without mixture drugs f. Display drug information g. Calculate dosage h. Drug-drug interaction test i. Adverse drug event report j. Store prescription in database k. Print prescription
3. Prescription Reading	Display prescription based on patient card number, patient name, date, and all prescriptions
4. Recording drug inventory and drug information	a. Record entering drug with their information b. Record drug-drug interaction c. Record drug out based on prescriptions
5. Preparing reports based on the medical doctor's examination	a. Display or print reports based on recently MD (Medical Doctor) examination to Excel format b. Display or print reports based on date MD examination to xls format
6. LB1 Report Preparation (patient diseases data)	Print LB1 report based on period for district health office in Excel format
7. Drug Inventory Reports' Preparation	a. Display or print entering drug report based on date in Excel format b. Display or print drug out report based on date in Excel format c. Print drug in, out and remaining drug report for district health office base on period in Excel format
8. Sending Reports to Health Office [optional]	Send selected reports (as email attachments) to the Health Office

This data was a basic information to design the e-health system and conduct hands-on training.

**B. Human Resource Development**

All the staff members of Babakansari CHC have to complete a series of hands-on training on personal basis, required for operating the ICT-based e-health system. The training was conducted personally (1 tutor and 1 staff) for

all staffs in 2 months.

**C. System Realization**

Realization of the e-health system has been successfully conducted in a software package which has 9 menus (login menu, main page, patient card, send prescription, see prescription, drug inventory, report and help menu). Screenshot of main menu can be seen on Figure 5.



**Figure 4** Hands-on training in CHC



**Figure 5** Screen shot of e-prescription main page

**D. Laboratory and Implementation Experiments**

The system was implemented in CHC for 8 days with full system configuration (6 terminals = 1 terminal for registration room, 3 terminals for medical doctor, 1 for dentist, and 1 for pharmacy). The e-health system implementation results have successfully shown its expected functions in: patient data registration & retrieval, medical record, paperless prescription, and producing the required reports. Number of registered patients in 8 days in

implementation experiment is 804 patients (average a hundred patient each day), number of prescriptions is 607 prescriptions (average 76 prescriptions each day), 3 out of 607 prescriptions (0,5%) have drug-drug interactions that indicate adverse drug event, and data base capacity is approximately 300 KB. Simplified summarized of clinical trials of e-health system with integrated e-prescription in a CHC is shown in table 2 and adverse drug event report is shown in table 3. Figures 6, 7, and 8 show some clinical implementation activities at the CHC.

**Table 2** Summary of implementation experiment at CHC

Day	Number of registered patients	Problems Encountered	Notes
1	106	Unable to send prescriptions simultaneously from 2 PCs or more	Need software improvement
2	87	Prescriptions can be sent simultaneously but can not display drug name at pharmacy	Need software improvement
3	89	Prescription can be sent simultaneously, drug name at pharmacy can only be displayed until patient number = 255	Need software improvement
4	87	-	All functions work properly
5	77	-	All functions work properly
6	148	Overload of electricity power	All functions work properly
7	119	-	All functions work properly
8	91	-	All functions work properly
total	804	[in 8 days]	

**Table 3** Adverse Drug Event (ADE) Report

Prescription number	MD Name	Day	Interaction	Reason
2	A	1	1-2:duplication	Patient needs
430	B	6	1-2:duplication	Patient needs
542	C	7	2 2 1-2:Antacid reduces cimetidine absorption (DOI, 2002, p.315)	Information of separate drug administration has been provided



**Figure 6** Registration process



**Figure 7** Registration process



**Figure 8** Dispensing process





E. Feed back after implementation  
 There is virtually no significant problem occurs during continuous system implementation. Small technical and non-technical problems

have occurred and provided us with positive suggestions. To evaluate and to get feed back from real implementation, a questionnaire has been used. The result is shown in Table 4.

**Table 3** Feed back questionnaire result

Questions	Results	%
Appearance	attractive	90 %
Data input process	easy	70 %
Information for users	a. complete	90 %
	b. easy to get	70 %
	c. clear	90 %
Assist daily activities	Yes	100 %
Need of the system	Yes	90 %
Willing to use the system	Yes	100 %

**Discussion**

e-Prescription shows it’s function on preventing ADE in implementation result. The report shows that only 3 out of 607 prescriptions (0,5%) have drug-drug interactions that indicate adverse drug event, however the reason of those interactions are acceptable based on patient’s benefit and safety. Using the system, medical staffs in CHC learn and get more information about drug-drug interaction, therefore they prescribe more carefully. At the time of writing this paper (February 2012), our e-Prescription system has been improved and clinically used for more than 22 months, and has successfully processed more than 58,000 patients at Puskesmas Babakan Sari (Bandung).

Other finding of using e-prescription is positive responses in utilizing e-health system integrated with e-prescription in CHC from actual users (both medical and administrative staffs). Implementation result shows that e-prescription module provides significant assistance to MD to obtain information of medicine availability at pharmacy, drug information from selected drug (including:

indications, contraindications, side effects, important notes, dosage, possible drug interactions and references), calculator to calculate drug dosage, drug interaction test before sending prescription to the pharmacy, confirmation whether the contents of the written prescription is correct and generate various types of reports easily. This may be our challenge in future to make the system better and can assist in improving healthcare quality service to the public. Role of Pharmacist may be needed for system improvement in the future in collecting drug-drug interaction database and give suggestion to create best algorithm for preventing other adverse drug events and other pharmacy practice.

Furthermore, additional benefit from e-prescription can be obtained from of e-prescription database. The database can also be utilized in specific research such as drug utilization, epidemiology, pharmacoepidemiology, pharmacosurveillance and pharmacovigilance research.

**Conclusions**

The e-health system for CHC recording and

reporting with integrated adverse drug event e-prescription module has been successfully developed and implemented in CHC. The following main functions work properly: recording of patient data (patient registration), preparing medical record (during medical examination phase) and paper-less prescriptions with ADEs alert, prescribing medicine (drugs) for each patient, preparing different types of patient and medicine regular reports, and sending the appropriate reports.

The system can be implemented in a CHC that has only one PC for minimum system configuration, 2 or 3 PCs for medium system configuration and at least 6 PCs are needed for full size system configuration. The system has also successfully showed its function in preventing adverse drug events. When the e-health system could be implemented in more and more CHC in Indonesia.

### Acknowledgement

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