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Medication Refilling Information System based on HL7 Standard in Medical Thailand

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Abstract. Chronic diseases are common health problem in Thailand. In general, chronic disease patients have followed up with physicians. The physicians have usually prescribed the repeated medications, when their clinical treatment results are stable. With an online database accessibility of collaborative health information between hospitals and pharmacy stores, the process of repeat medication without physician appointment, namely medication refilling, is not taken in to account a Thailand's standard policy, and its health information is also limited for access. To develop a policy for implementation of medication refilling system, the Health Level-7 (HL7), the most widely accepted standard for electronic health information exchange, is proposed. With an improved policy under development of HL7 on medication refilling system, most of stakeholders agree and satisfy with this policy and expect the policy should be implemented.

Keywords: Health Level-7, HL7, medication refill, prescription refill

1. Introduction

Chronic diseases are common health problem and major cause of death in Thailand [1]. The number of newly diagnostic chronic disease patients has dramatically increased up to one million since 2012 [2]. Most patients, suffering from chronic diseases, need numerous medications for treatment. With frequent physician's follow-up, the patients are dispensed multiple medications while most of their prescriptions are repeated. This process is called "medication refilling" [3]. Definition of medication refilling system is system that allows to refill prescription a few times without returning to see their physicians [4].

Due to frequent hospital visits, the patients take the high effort for transportation cost and waiting time for medication. These are reasons why some patients prefer to buy their medication at pharmacy store nearing their home, and loss the physician's follow-up. For this concern, with unknown patient's medication profile for pharmacy store, the patients usually go to pharmacy store without any prescription, leading to harmful for patients from inconsistent treatments. Hence, medical information including medication name, dose, frequency, and route of administration becomes important information for medication refilling [4], [5].

At present, in Thailand, an accessibility of medical information is difficult with permission access and is no standard for health informatics system. Some facilities still use legacy system. To overcome the problem, the proposed solution is to build an interoperable system, connecting among healthcare facilities (hospital, clinic and pharmacy store), for medication refilling by implementation of healthcare standard [6]. Then, patients would receive their medications at the preferred location facilities. This would make medication service more convenient/compliance and cost/time saving, leading to successfully treatment [3].

Nowadays, there are many standards for healthcare communication standards. The most widely accepted international electronic communication standard issuing protocols is Health Level Seven International (HL7), developed by the non-profit organization of American National Standards Institute (ANSI), is proposed for

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exchanging, integration, sharing, and retrieval for electronic health information. In addition, HL7 supports the clinical practice and management including delivery and evaluation for health services [7].

The purposes of this study are to demonstrate the implementation of HL7 standard for sharing medication information among healthcare facilities and to design policy of medication refilling system based on HL7. Scope of work is medication refilling system in Thailand.

2. Methods

2.1 Health Level 7 (HL7)

Standards for exchanging health-related information among different systems. Hospital and other healthcare facilities have various electronic medical record (EMR) formats. HL7 provides message format, structure and data types for integration form system to another. HL7 version 3 messages syntax is served by XML (Extensible Markup Language) encoding methods. HL7 messages are allowed to transmit via network between client and server [7]. We use HL7 version 3 standard based on XML. HTTP protocol is used for communication of HL7 message [7-9]. Data flow and communication are shown as Fig.1

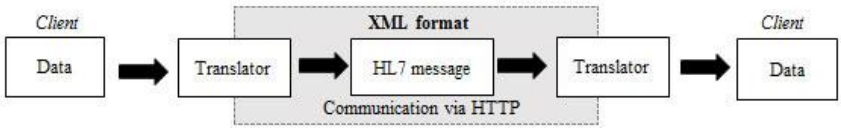


Fig. 1: Data flow and communication.

FHIR (Fast Healthcare Interoperability Resources) is standards framework for implementation purposes and development under HL7. FHIR provides simplicity, flexibility, and manageable resources. Formats of FHIR are given as XML and JSON. HL7 Version 3 methodology and code system, supporting the HTTP, are also included in FHIR [10]. Therefore, the application of FHIR is proposed for our case study.

2.2 Analysis of existing medication refilling service in Thailand

Medication refilling service has been performed in some hospital and limited within one facility. Thai National Health security Office (NHSO) supports accredited pharmacy to handle refill services [11]. The strength is collaboration of NSHO and pharmacy council of Thailand. The weaknesses are limitation of information accessibility and data fragmental. There is no health informatics technology using in refill prescription system. Paper-based documentation has been used for communication between hospital and pharmacy. Implementation of HL7 is opportunity to create seamless communication. Using HL7 standard enhance service's value. The threats are unclear patient education and unawareness.

2.3 Policy of medication refilling information system

We design policy and medication refilling system based on clinical practice in Thailand and success refills clinic from literatures review [3-5], [12]. We adapt HL7 standard in data communication and application design. The schematic of system are shown as Fig.2

2.3.1 Patient enrollment

Refill request by patient is desired. We set inclusion criteria with only stable condition of chronic outpatient allowance by physician. Health condition that effects to communication skill such as psychiatric disease must be excluded. Patients have to sign informed consent. Informed consent is used for patient agreement to protect unawareness. Patients must understand and accept. The detail must cover 3 major topics as follows: First, Medication refill is not physician follow-up. However, after completion of medication refill with given duration, the patient must have a physician appointment. Second, Medical history including diagnostic diseases will be disclosed to pharmacists. Third, Medication brand name may be substituted base on pharmaceutical equivalent, and pharmacist must explain to patient.

2.3.2 Medications for refilling

We do not allow any prohibited medication to refill because these medications can lead to harmful and addiction. Prohibited medications depend on Thai FDA's law and regulation which including narcotics, opioid derivative, and other controlled substances such as sleeping pill. Other serious medications such as

warfarin and its derivatives (medication uses for preventing blood clot) are depended on physician's judgments. Short course medication treatment as follows; antibiotics should be complete at physician visit. Hospital pharmacist must verify all prescription before data is inputted to system.

Time allowance for prescription refill must not more than 6 months per prescription. After prescription refilling is completed, patients must see their physicians to evaluate their condition in order to get the new prescription. Patients can request reasonable duration for refilling such as every month, or every few months.

2.3.3 The pharmacy store

The pharmacy store requires "Good Pharmacy Practice", accredited by The Pharmacy Council of Thailand [13]. Accredited pharmacy ensures the quality pharmaceutical care service standard. On the duty, the registered pharmacists, satisfying a medication refilling system training course, are available for chronic patients with medication refill service.

2.3.4 Electronic data communication

With HL7 standard, data exchange between hospital and pharmacy in XML format [10]. Information for a medication refilling system is divided into 2 parts. First is demographic data including: national ID number, hospital number, name - surname, date of birth, age, sex, diagnostic disease and drug allergy (if known). Another part is refilling part including: prescription ID, medication list, visiting date, next appointment date, attending physician, amount of pills and time of refilling. Underlying disease is useful information for patient education and evaluation the appropriate of drug use.

National ID is the best perform for linking data. This is because Thai people have their own unique ID, having one pattern for person identifier. On the other hand, the hospital number (HN), having various standards, is unsuitable for multiple facilities.

2.3.5 Application process design

1. Refill medication data are inputted into system, whereas the refill medication ID is generated.

2. Other information is transferred to system. National ID is used for linking information to system.

3. System generate "Refill medication sheet" (including ID, refill date, next physician appointment date, pharmacy contact details and medication list) which is given to patient.

4. Notification from system to pharmacy store, the pharmacy manages and prepares the available stock in advance. If stock is not available, pharmacy has to contact the pharmaceutical companies for purchasing.

Three days before due date, the system will send the reminder message to pharmacy store. Then, pharmacist will make a reminder call to patient.

5. Refill data and log, being usable for hospital information system (HIS), are transferred back to system.

2.3.6 Others

Medical dealers sign contracts to provide medication at deal prize, which is as equal as selling to hospital. Lab parameters data are transferred to system by request. This information is useful for patient monitoring.

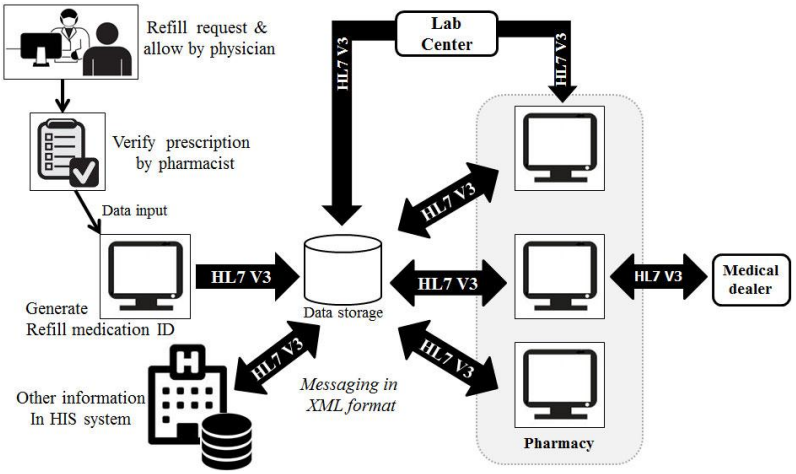


Fig. 2: Illustration of schematic of system

2.4 Key stakeholders' roles and responsibilities

2.4.1 Providers:

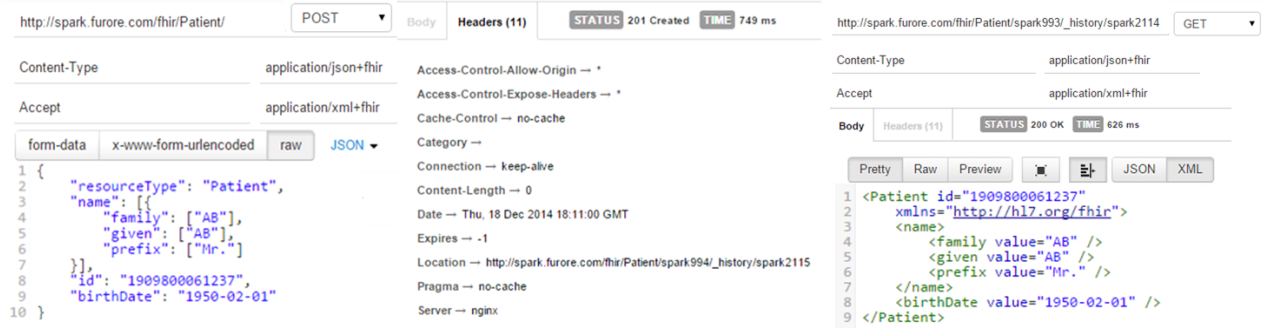
- Physicians treat, order laboratory parameters, prescribe medication for patient and allow, if patients request for refilling system.
- Hospital pharmacists verify the prescription, and input the medication data to the system.
- Community pharmacists (pharmacy store) provide the medication refill service, and give some pharmacy education/counseling.
- Lab center officers input/support the information request into the system.
- Medical dealers provide the medication to pharmacy with the price control.

2.4.2 Customers: Patients request for refilling system and choose pharmacy store where they prefer.

2.5 A case study

Patient Mr.AB, Male 64 years old, Date of birth: 1 Jan 1950, HN 5736260, National ID. 1909800061237. He had underlying diseases which are hypertension and dyslipidemia. He got whole prescription for 3 months, and need to refill prescription every month. Prescription contained 4 medications, given as enalapril 5 mg 1 tab once daily, aspirin 81 mg 1 tab once daily, simvastatin 10 mg 1 tab after dinner, and alprazolam 0.5 mg 1 tab at bedtime for insomnia. Hospital Pharmacist verifies prescription and excludes alprazolam, which is found to be the controlled substance. Solutions are prescribing whole amount of alprazolam at this hospital visit or changing to other that is not controlled substance.

Trigger event was refill request. Medication data and patient information were converted into *FHIR message* and exchange data between hospital (sender) and pharmacy store (receiver). FHIR offers RESTful API to exchange resources via standard HTTP. We use *http://spark.furore.com/fhir* for testing server [10]. Creation procedures of patient information via RESTful API are shown as Fig.3.

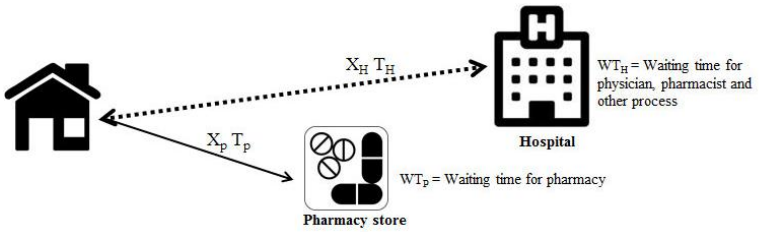


A) Sender requests the server for patient information; B) Server responses the request by giving location link; C) Sender gets information by location link.

Fig. 3: Procedures for creation of patient information via RESTful API:

2.6 Cost savings formulation scheme

According to this policy, we allow patients to choose the convenient pharmacy store. For this assumption, patients will choose pharmacy, located near their accommodations. It is clearly that the new policy outperforms the former policy in terms of lower transportation cost and time saving. Fig.4 shows the scenario of pharmacy store around hospital. Moreover, workload of physicians and hospital pharmacists shall be eliminated. This is because we share workload to pharmacy store for refilling prescription.



X = Cost of transportation;

T = Time for transportation;

WT = Waiting time;

Fig. 4: Scenario of pharmacy store around hospital.

Assumption: $X_P < X_H$, $T_P < T_H$ and $WT_P < WT_H$

$$\text{Cost saving} = n(X_H - X_P) . \quad (1)$$

n = number of transportation

$$\text{Time saving} = (T_H - T_P) + (WT_H - WT_P) . \quad (2)$$

2.7 A survey

After we demonstrated medication refilling system and presented policy, we developed the survey questionnaires to measure perspectives of policy. The questionnaires focused on acceptability, accuracy, efficacy, applicability and satisfaction [4],[12]. Five-point scales (strongly disagree to strongly agree) was used for answering [14]. Target groups were key stakeholders which were physicians, pharmacists and chronic disease patients in Thailand. We used Taro Yamane method to estimate the sample size. The sample sizes were about 100 was required for generating 90% confidence level with ±10% of margin of error [15].

3. Results and discussions

3.1 A survey result

Table 1. Result and descriptive statistics

Responders	N[a]	Acceptability		Efficacy		Accuracy		Applicability		Satisfaction	
		mean	SD	mean	SD	mean	SD	mean	SD	mean	SD
Physician	39 (30%)	3.82	1.1	3.78	1.09	3.87	1.24	3.05	0.92	3.62	1.04
Pharmacist	54 (41.5%)	4.07	0.82	3.90	0.90	3.87	0.91	3.11	0.95	3.78	0.74
Patient	37 (28.5%)	4.20	0.78	4.07	0.69	4.03	0.80	3.57	0.80	3.92	0.72
total	130 (100%)	4.03	0.91	3.92	0.91	3.91	0.98	3.22	0.92	3.77	0.84

[a]N = number of responders, mean = average scales of the questionnaire's answers that maximum scale are five, SD = standard deviation

In data survey, with the responding questionnaire by 130 persons, the responders consist of physicians (30%), pharmacists (41.5%) and patients (28.5%).

It is shown that policy acceptability is 80% of total's answer scale, and policy satisfaction is 75.4%. The 78.2% of responders expect the accuracy of system in data exchange. The 78.4% believe that policy can provides effectiveness of electronic refill medication system result in time and cost saving. The 64.4% agree with policy and should be implemented.

3.2 A cost/time saving scenario

The scenario: Pharmacy store is 4.9 km far from hospital. Patient's house is 2.1 kg far from pharmacy store. (Hospital is 5.3 kg from house)

At pharmacy store, pharmacist spent time per prescription was about 27 min including preparing and dispensing time. A transportation cost by taxi was 47 THB and took about 5 min without traffic jam.

At hospital, time was spent for physician included waiting time and physical examination about 55 min. A pharmacy waiting time was about 75 min. Time spent of hospital process was totally 130 min. A transportation cost by taxi was 75 THB and took 13 min without traffic jam.

$$\text{Cost saving} = n(X_H - X_P) \quad (1)$$

$$= 2(75 - 47) = 56 \text{ THB} \qquad n = 2 \text{ (for round trip)}$$

$$\text{Time saving} = (T_H - T_P) + (WT_H - WT_P) \quad (2)$$

$$= (13 - 5) + (130 - 27) = 111 \text{ min}$$

For this scenario, we can save 56 THB and 111 min per a refill prescription. This result shown cost and time saving base on patient's perspective. We did not include cost/time from other hospital processes given as patient registering, nursing, lab monitoring and etc. For more precise results, we should include every processes time and wages of healthcare staffs in further study.

According to time saving, stakeholders (physicians and pharmacists) believe that medication refilling system could eliminate old chronic patients' hospital visits, and also reduce hospital staffs' workload. For this point, we can assume that hospital's service quality would be improved. Patient education is another advantage. This is because the hospital pharmacists, handling the complex responsibility and community pharmacist at pharmacy store, can perform efficiency for drug counselling without interruption by other workload.

Using HL7 standard is tools for implementation. HL7 promotes data communications seamlessly and enhance system efficiency. A case study with FHIR exchanged resources via standard HTTP, proved that data exchanges are accurate.

Impact analysis should perform to get rid of concerning about policy's effect. Defining key stakeholders and making them understands benefits are important. Integration of medical knowledge, pharmaceutical knowledge and technology need for successful of medication refilling information system policy.

Infrastructure of the system is not mentioned in this study. We have to plan infrastructure specifications and its cost before real implementation. Application development is next step. Requirement analysis should be done. System security is another concern for protecting patient's privacy. HTTPs protocol may be used. Authentication and access control must be raised in security policy.

4. Conclusions

This study show benefits of refills prescription policy between hospital and pharmacy. Exchanging electronic health information standard is key solution for interoperability among healthcare facilities. HL7 is a good standard for the electronic medication refilling system to communicate data. Resources, provided by FHIR, are effective framework for implementation of HL7 concept. With the results of low transportation cost and time saving, the system makes stakeholder satisfaction and acceptability.

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