A DIGITAL PRESCRIPTION REFILL SYSTEM BASED ON HEALTHCARE STANDARD IN THAILAND

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ABSTRACT

The digital trend is growing rapidly. The Thai government has released the digital economy policy since 2014. The policy does not specify about medical information technology. The most common health problem is Non-communicable disease (NCD). The challenge is the improvement of medical care service for NCD patients. The repeated medication is normal for NCD patients if their clinical symptoms are stable, which is concept of the prescription refill. We offer the new innovation of a digital prescription refill (DPR) to promote the convenient and efficient system. Patients are allowed to refill their medication at pharmacy stores instead of hospitals. Healthcare standard is used for interoperable communication between hospital and pharmacy store. HL7 is the high quality standard for exchanges the electronic health information, including prescription data. The results of the survey show most of stakeholders agree and satisfy with DPR system and expect the DPR system should be implemented..

Keywords: medication refill, prescription refill, healthcare, HL7

1. INTRODUCTION

The digital trend is growing rapidly. As a result, the digital computing technologies are used for improving information system efficacy in various fields, given as banking, transportation, education and also health. The information technology (IT) can drive and support the business process and organization that contribute to quality and sustainability system. Due to the benefits of digital technology, the government of Thailand has a national policy that supports the digital economy since September 2014 [1]. To align with the digital economy policy, we suggest the strategy to achieve agility and responsiveness in medical by integration between IT and medical care service. It is intended to be a new innovation for health system, and a chance to improve quality of patient care, increase patients/ customers' satisfaction and make ready for increasing demand in the future.

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[3]. NCDs are health conditions that are not infectious or transmissible diseases. Chronic disease defines as persistent health conditions that can be controlled but not cured. Examples of diseases are included heart diseases, diabetes, asthma, cancer, etc. The risk factors are aging that mean the patients will be increased every year [4]. As a consequence, the accumulation of patients raises the demand of healthcare service. However, Thai public health service is limited in some rural area and quality of care may be different. The Thai patients would rather go to the big hospital in the city, contribute to unbalance of demand and supply for medical service. We try to find the digital solution for this problem that not impact on the diseases treatment.

Managements of NCDs and chronic disease are similar, which are life style modification and medication treatment [5]. The patients are typically prescribed a various medication and monitored by physician for their lifelong. These patients frequently have to follow-up with physician and are dispensed a lot of medication in each hospital visit. Most of their prescriptions are repeated if the disease condition is stable. The replayed process makes high cost, time, staff workload and also medical care demand. Due to many hospitals visiting, patients have to pay cost for transportation and take time for waiting. These are reasons why some Thai patients buy their medication at pharmacy store near their accommodation and loss the physician follow-up. Some hospital providers perform the refill prescription clinic to serve more convenient. The concept of prescription refill is allowing the patient to refill prescription a few times without returning to see their physicians [6]. Therefore, the prescription refill service is proper for sharing the patient demand from hospital to other healthcare facilities such as the pharmacy store. To enhance the quality, we can integrate IT to prescription refill service.

The Thai Food and Drug Administration (FDA) and the Health insurance of Thailand have the policy to promote the pharmacy stores into health insurance system [7]. At that time, Thai pharmacy council needed to improve quality of drug stores, and then the accredited pharmacy stores are integrated into health insurance system by prescription refills service. The refills service covered especially for some chronic diseases, such as diabetes mellitus, hypertension, and dyslipidemia. The result of this policy had shown the comparable clinical outcome between the patient with medication refills service and conservative treatment (only physician handles the treatment). Most of patient satisfied the medication refills

service by accrediting the pharmacy store. It found that the service shared the workload from hospital, and promoted working as multidisciplinary team. Prescription refills service reduced overall healthcare expenditures [8]. In agreement of the results, National Health security Office of Thailand (NHSO) supports the accredited pharmacy to perform the medication refill services in chronic diseases. Unfortunately, the refill service is limited between hospitals and contracted pharmacy store with paper based documentation. Accessing medical information is complex and difficult in Thailand. There is no IT standard for health informatics and some facilities still use legacy system or paper-based system. To improve prescription refill service, electronic system should be used. The proposed solution is to build an interoperable system, connecting among healthcare facilities (hospital, clinic and pharmacy store) base on the healthcare standard. We expect the effective and efficient communication of digital prescription refill system. This will make more convenient, save and compliance.

We conduct this study according to the digital economy and prescription refill policy. The primary objective is to design and demonstrate the digital prescription refill (DPR) system based on implementation view of healthcare standard for communicating medical information between healthcare facilities in Thailand. The secondary is to survey the stakeholders' perspective on the DPR service.

2. HEALTHCARE STANDARD

Healthcare standards are developed to improve the quality and performance in health informatics service. Healthcare standard concerns in privacy, security, electronic use of information, and electronic communication in healthcare. There are many healthcare standards, which have been used for different purposes. We focus on the communication standard, because our objective is to create the DPR system for sharing and exchanging the medical information among the healthcare facilities. The communication standard is relevant to interoperability, maintaining privacy and security of data [9]. Interoperability means the ability of health information systems to work together within and across organizational boundaries in order to improve the effective delivery of healthcare for individuals and communities [10].

2.1 Health Level 7 (HL7)

HL7 is developed by The American National Standards Institute (ANSI); non-profit organization. HL7 provides a comprehensive framework and related standards for the exchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the management, delivery and evaluation of health services [11]. HL7 covers all specification of healthcare domains. Pharmacy and medication order are included in HL7. Hence, HL7 is proper for transfer of prescription data in DPR system.

The goal of HL7 is interoperability. Data exchange schema and standards should allow data sharing across healthcare facilities such as hospital and pharmacy. Although, they have various electronic medical record (EMR) formats. HL7 is divided into many categories, but we select the messaging standard. Capability of messages is real-time or near real-time information that supports the ongoing process. Messages are appropriated for active communication like the medication order in DPR system. HL7 provides message format, structure and data types for integration form system to another. HL7 version 3 (HL7 V3) is more stable than previous version and serves XML (Extensible Markup Language) as message syntax and encoding methods. HL7 messages are allowed to transmit via network between client and server [11], [12]. HTTP, which is low level transport protocols, is used for communication of HL7 message [11].

FHIR (Fast Healthcare Interoperability Resources) is standards framework for implementation purposes and development under HL7. HL7 FHIR provides simplicity, flexibility, and manageable resources. Formats of FHIR are given as XML and JSON. HL7 V3 methodology and code system, supporting the HTTP, are also included in FHIR [13]. Therefore, the resources of FHIR are proposed for our study.

3. METHODS

3.1. The review of the current refills prescription service in Thailand (AS IS)

The Thai government releases the digital economy policy is the driver, the public healthcare should be agile for this challenge. The patients' demand for medical care is increasing but health providers unable to supply enough service with many limitations. In Thailand, the pharmacy store is easier to access and more convenient than the hospital. According to, Thai NSHO collaborates with Thai FDA for prescription refill services by accredited pharmacy store [7]. Refill prescription service has been performed in some hospital and limited within facility. The information accessibility and data fragmentation are constraints. There is still no health informatics technology using in refill prescription system. Conservative documentation method defined as paper-based, has been used for communication between hospital and pharmacy. The new innovation of DPR system with HL7 is opportunity to create seamless communication. The healthcare standards enhance service's value. The risk is unclear patient education. Patients' counselling is required for eliminating the unaware threats.

3.2. The design of a new Digital Prescription Refill (DPR) system (TO BE)

We create the process of DPR based on standard clinical practice in Thailand and success refills clinic from literatures review [6], [14], [15]. The process is aligned to the policy and regulation. HL7 messaging standard is adopted in communication and application design.

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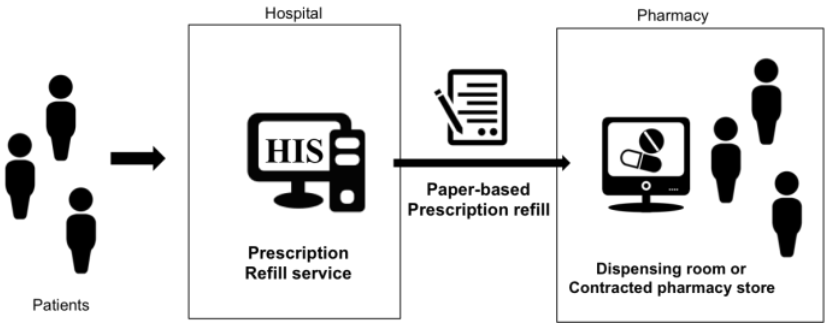

Figure 1. The information flow of conventional prescription refill service.

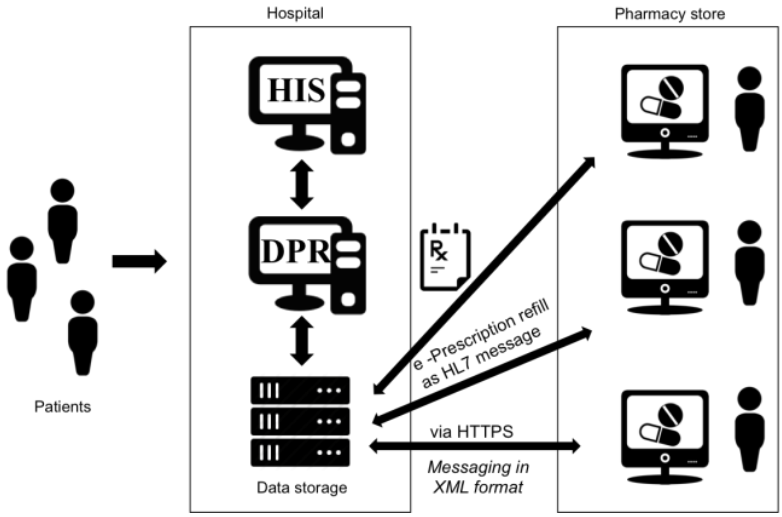

Figure 2. The information flow of DPR system.

3.2.1 Patient enrollment

The service starts with the patient enrollment. We aim to involve the patient in treatment decision. Patient is allowed to request for refill service. The inclusion criteria is only stable condition of NCDs or chronic diseases outpatient allowance by physician. Health condition that effects to communication skill such as psychiatric disorder must be excluded. Patients have to sign informed consent to protect unawareness and disclose the related medical information.

3.2.2 Medications for refills

Conforming to Thai FDA's law and regulation, we do not permit some prohibited medication to refill because these medications can lead to harmful and addiction. Prohibited medications include narcotics, opioid derivative, and other controlled substances such as sleeping pill. Other serious medications 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 DPR system. The six months is maximum allowance for a prescription refill. After prescription refill is completed, patients must return to see their physicians. Patients can request reasonable duration for refilling such as every month, or every few months.

3.3.3 The community pharmacy store

To qualify the pharmaceutical care service standard. The pharmacy store requires "Good Pharmacy Practice", accredited by the Pharmacy Council of Thailand [8]. The registered pharmacists, satisfying a DPR training program, must deliver the refill service.

Table 1: The comparison of conventional prescription refill process and a new DPR

Conventional Prescription Refill (Paper-based)	**Digital Prescription Refill** (Electronic-based)
1. Register the refill service. Physician prescribes the medication.	1. Register the refill service. Physician prescribes the medication.
2. Physician writes the refill prescription or pharmacist transcribes the refill prescription. The refill schedule is appointed. The paper-based refill prescription is given to patient. • Staff makes the physician appointment for next visit	2. Refill medication data is inputted into system, whereas the refill medication ID is generated. • Other information is transferred to system. National ID is used for linking information to system. • System generate "Refill medication sheet" which may give to patient.
3. There is no notification system. The patients must remind themselves. The pharmacists must prepare enough inventories for refill service by purchasing from pharmaceutical companies. • On due date, the patients go the selected pharmacy store and refill their medications.	3. 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.
4. After refill process is finished, the paper-based refill prescription is kept at pharmacy store and sent back to hospital.	4. Refill data and log, being usable for hospital information system (HIS), are transferred back to system.

3.3.4 Electronic data communication

Data are exchanged and shared across the system in XML format base on HL7 messaging standard [11]. We divide the information in DPR system into 2 parts. The first is demographic data including: national ID number, hospital number, given name - surname, date of birth, age, sex, diagnostic disease and drug allergy (if known). Underlying disease is useful information for patient counselling and evaluation the treatment or side effect. The second is refill part including: prescription ID, medication orders, visiting date, appointment date, attending physician, amount of pills and time of refill. We select the National ID for linking data because Thai people have their own unique ID, having one pattern for person identifier. In contrast with the hospital number, having various formats, is not proper for multiple facilities.

The conventional service uses the paper-based prescription, show in figure 1. The medical information is handwriting that prone to error. Some providers may be use the computer-based system however the paper-based refill prescription is still given to patients. The DPR is paperless system that is shown in figure 2. All information stores in the data storage that link by national ID via network. The data storage locates in hospital. Patient can contact the pharmacy store on the due date with notification system.

The refill medication sheet consists of ID, refill date, next physician appointment date, pharmacy contact details and medication list. It is useful for patient education.

We have simulated our case study of exchanging medical information with HL7. HL7 FHIR testing server (http://spark.furore.com/fhir) is used for data storage as hospital information system (HIS) [13]. After completed the patient enrolment and verification step, the prescriptions data is inputted to the server (HIS). Related patient information is automatically received from HIS. Both prescription and patient information are converted into HL7 FHIR message with XML format. HL7 messaging standard with FHIR offered RESTful API to exchange resources via standard HTTP. The exchange process is shown in Figure 3. We customize the XML schema from FHIR's resources [16]. Information is exchanged between hospital and pharmacy store via RESTful over HTTP. The example of medication order as FHIR HL7 message shows in Figure 4.

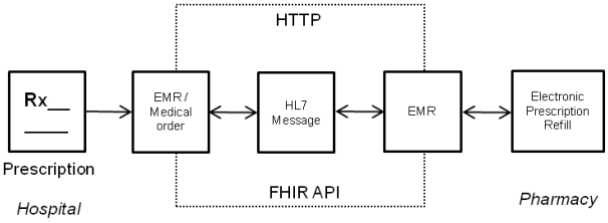

Figure 3. Information exchanging and communicating with HL7 FHIR API.

```
<MedicationPrescription xmlns="http://hl7.org/fhir">
  <dateWritten value="2015-04-17" />
  <status value="active" />
  <patient>
    <reference value="Patient/spark44" />
    <display value="Roe1" />
  </patient>
  <prescriber>
    <reference value="Practitioner/f002" />
  </prescriber>
  <medication>
    <reference value="Medication/spark9" />
    <display value="SIMVASTATIN" />
  </medication>
  <dosageInstruction>
    <text value="SIMVASTATIN 10MG" />
    <method>
      <coding>
        <code value="10000004" />
        <display value="SIMVASTATIN 10MG (TABLET) - 1 TAB at Bedtime" />
      </coding>
    </method>
  </dosageInstruction>
</MedicationPrescription>
```

Figure 4. HL7 messages format with the prescription data.

3.3 The Stakeholders

We can define the key stakeholders, focusing on operational level as healthcare providers and customers. The healthcare providers are physician, hospital pharmacist and community pharmacist, who work at pharmacy store. The customers are patients that include their caregivers.

3.4 A survey

The main objective of this survey is measurement of stakeholders' perspectives on DPR system. We develop a survey questionnaire for stakeholders hearing. Target groups are key stakeholders, which are physicians, pharmacists and NCDs/ chronic disease patients in Thailand. We focus the healthcare staffs in operational level because they perform the service. We do not include the policy maker or decision maker on this survey. The questionnaires focus on acceptability, accuracy, efficacy, applicability and satisfaction [6], [14], [15]. Five-point scales (strongly disagree to strongly agree) are used for answering [17]. We used Taro Yamane method to estimate the sample size. The minimum of 100 sample sizes was required for generating 90% confidence level with ±10% of margin of error [18].

3.5 Cost and time saving analysis

According to economic evaluation of the new service, cost benefit analysis should be concerned. Because of high cost of the infrastructure, the benefit should more than cost. Previous data shows refill prescription clinic is convenient result in cost and time saving. We can measure the benefit on customers' (patients) view in term of cost and time saving.

Thai patients take high effort when they go to the hospital. They have to spend a lot of money and time. Most patients go to hospital with caregiver that may take a leave from work. It leads to higher cost and more effort for hospital visiting. In DRP system, we allow patients to select conveniently pharmacy store.

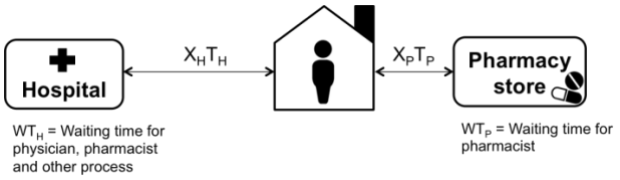

Figure 5. The pharmacy stores locate around hospital.

With these reasons, patients will choose pharmacy where locate near their house. It is clearly to save transportation cost and time. Moreover, workload of physicians and hospital pharmacists shall be reduced because we share workload to pharmacy store for refilling the prescription. As a result in the waiting time for medication also reduces. To confirm our assumption, we develop the formulation of cost/time saving, including transportation cost, show in (1). From (2), time saving, also includes the time spending for transportation and the waiting time between hospital and pharmacy store.

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

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

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

Where,

X_H = Cost of transportation form house to hospital;

X_P = Cost of transportation form house to pharmacy store;

T_H = Time for transportation form house to hospital;

T_P = Time for transportation form house to pharmacy store;

WT_H = Waiting time at hospital;

WT_P = Waiting time at pharmacy store;

n = Number of transportation

To prove our assumption with cost/time saving formulation. We have randomly collected data about time and cost from a big hospital in Bangkok. We have collected waiting time for physician and medication in hospital. Time spent per prescription has been collected from accredited pharmacy store nearby the hospital. We have limited area of survey within Thonburi district. Unit of cost is Thai baht (THB) and unit of time is minute.

4. RESULTS

4.1. The survey

In data survey, with the responding questionnaire by 130 persons (90% confidence level with ± 10% of margin of error), the responders consist of 39 physicians (30%), 54 pharmacists (42%) and 37 patients (28%). The result is shown in figure 6.

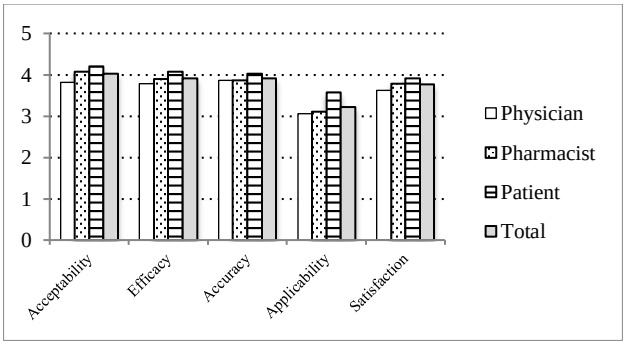

Figure 6. The comparison of survey results in each topics.

It is shown that system acceptability is 80% of total answer scale, and satisfaction is 75.4%. The 78.2% of responders expect the accuracy of system. The 78.4% believe that the effectiveness of DPR service is resulting in time and cost saving. The 64.4% agree with the system and should be implemented. Patients give the highest acceptant score comparing with pharmacist and physician by the score of 4.20, 4.07, and 3.82, respectively. Patients also give the highest score in the rest topics, which are efficacy, accuracy, applicability, and satisfaction, although physicians give the lowest score in every topic. The possible reason is prescription refills service improves patient's convenience. The lowest score is system applicability from physicians (3.05). Some physicians give criticize that patients can easily loss the follow-up with the medication refill service. Besides, physicians concern about patient safety, if pharmacists handle the management. With this concern, we ensure the quality of pharmaceutical service by accredited pharmacy and staff training.

4.2. Cost and time saving analysis

We collected data by interview method. The patients and pharmacists have been interviewed. Time and cost for transportation are estimated by interviewing patient. Some patients have taken by taxi but the others have taken by public bus. We have gathered waiting time for physician and medication dispensing at hospital. Waiting time at pharmacy stores was estimated by interviewing community pharmacists. We give the example prescriptions to community pharmacists and collect process time. The pharmacy store's processes include preparing medication and dispensing.

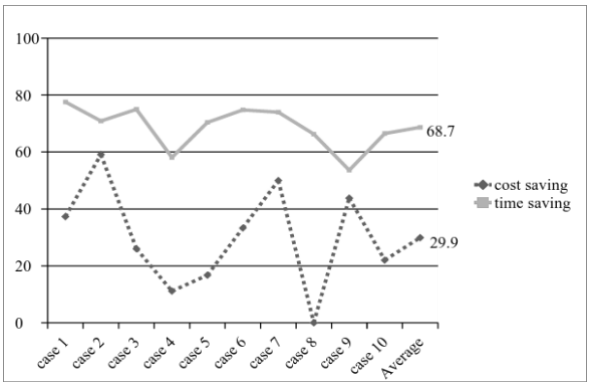

Figure 7. The percent of cost saving shown in dot line and the percent of time saving shown in gray line.

The 10 cases study consist of patients with NCDs and chronic disease. The underlying diseases are hypertension, heart disease, end stage kidney disease, diabetes mellitus, and dyslipidemia. They have the average 8 medication items. The result can be summarized that we can save time for 910 min, and cost for 263 THB per 10 cases (average time saving is about 91 minutes/case, and cost saving is about 26.3 THB/case). The average percentage of cost and time saving are 29.9 and 68.7, respectively. (shown in Figure 7) By the results, we have noticed the waiting time at pharmacy store depending on number of medications. But hospital waiting time does not depend on the number of medications, it is influenced by many factors, given as: the number of crowded patients, the number of on-service-physicians, time spent in other process, and so on. Another related factor is the transportation method. In one case, the refill service does not save transportation cost however, the waiting time for medications are reduced.

5. DISCUSSION

Our research likes a feasibility study in initial step of a new IT service innovation. We can show and prove the concept of integration between digital solutions and medical filed, providing more benefits and satisfactions. The data collection of cost/time saving are used for proving the formulation and our assumption. It may not represent the general population because we limited area of data collection. According to time saving, stakeholders (physicians and pharmacists) believe that DPR system could eliminate the old patients' hospital visits, and also reduce the hospital staffs' workload. For this point, we can assume that hospital's service quality would be improved especially outpatient care service. Hospital can serve the new patient more efficiency. Moreover, chronic disease patients usually visit hospital with the caregivers. Medication refill service could save caregiver's time and cost. Patient education is another advantage and increase patient's awareness. This is because the hospital pharmacists, handling the complex responsibility and community pharmacist at pharmacy store, can perform efficiency for drug counseling without interruption by other workload. The pharmacy store can give flexible

service time for the refill, not limit on official working hours.

Most of stakeholders accept and satisfy the service and system. However, some stakeholders still concern about data accuracy and privacy. The convenient of the medication refilling system is the major reason that makes patients preferred. Another importance factor is aligning with national health policy, which can prevent conflict between stakeholders. Integration of medical knowledge, pharmaceutical knowledge and technology need for successful of electronic refill medication.

Healthcare standards are required for effective prescription refill system. HL7 standard is an option for implementation. HL7 promotes the medical data communications seamlessly, and enhances the system efficiency. Medical information as HL7 messages can share between client and server via network and exchange in the real time process. HL7 FHIR resources are appropriate for implementer, because of flexibility and manageability. System security is concern for protecting patient's privacy. Hypertext Transfer Protocol Secure (HTTPS) may be used. Authentication and access control must be raised in security policy of the system.

6. LIMITATION

In the survey for large population, 400 sample sizes are required to create 95% confidence level ± 5% of margin of error and standard normal distribution. We have too small responders and generate 90% confidence level ± 10% of margin of error because we have limited of survey time. We do not include the decision maker in this survey. The policy makers or executive boards are key persons for implementing.

In real situation, more stakeholders would involve in the prescription refill. Other stakeholders could be nurses, physician's assistants, other healthcare staffs, and hospital's officers. All stakeholders must be clarified in further study.

These cost/time saving results are shown the data based on a patient's perspective. We do not include cost/time from other processes, given as: patient registering, nursing, lab monitoring, etc. For more precise results, we should include every hospital process time and wages of healthcare staffs in further study.

Infrastructure specification of the system is not clarified in this study. We have to plan the infrastructure and its cost before the real implementation.

7. CONCLUSION

The digital prescription refill system is a new innovation for public healthcare system. The integration of information technology and medical can improve the quality of patient care service. Understanding of medical, technology and also management is required for implement a new digital prescription refill. Although, medication refill policy is not in Thailand's health standard. We hope our study can ensure the policy maker to consider this system. Our study shows benefits of refills prescription system between hospital and pharmacy. The system provides the convenience for stakeholder especially patients. With the results of low transportation cost and time saving, the system makes most of stakeholder satisfaction and acceptability. The other benefit is also sharing the patients and workload from hospital to pharmacy stores.

The communication among healthcare facilities is the core for prescription refill system. Implementation of exchanging electronic health information standard is key solution for interoperability. HL7 is a good standard for the electronic refills prescription system to transmit data. Resources, provided by HL7 FHIR, are effective.

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