DEVELOPMENT OF AN ENHANCE ADHERENCE MESSAGING SYSTEM FOR PATIENTS WITH PARKINSON'S DISEASE

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Thesis
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DEVELOPMENT OF AN ENHANCE ADHERENCE MESSAGING SYSTEM FOR PATIENTS WITH PARKINSON'S DISEASE

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ABSTRACT

Patients with Parkinson's disease (PD) usually have a problem of forgetting to take their daily medication. One reason is that they have multiple doses of oral medication each day. The objective of this study was to develop a two-way communication medication reminder system using a short messaging system (SMS) sent to patients' mobile phones to enhance medication adherence.

The system was developed as an automatic generator sending a specific medication reminder SMS for each patient. A predefined time schedule was set and the reminder SMS was sent to the patients' mobile phones. Each patient was asked to respond by typing the "personal code", which was provided each time they took the medication. The second reminder was either a follow-up SMS or the researcher made a telephone call. This was done when the system did not get a response within 15 minutes. Twenty-seven patients with PD participated in this study. To examine the system utility and feasibility, the Morisky Medication Adherence Scale (MMAS) and a set of questionnaires were distributed and collected.

This study found that most of participants were satisfied with the reminder system (77.2%). The easy to understand reminder message was sent at the actual prescribed time (100%). After implementation, the total MMAS score showed a significant improvement ($p < 0.01$). Positive feedback reveals the utility of this reminder system. The system helps patients with PD to improve their medication adherence. With the complexity of the PD symptoms, this preliminary system should be further developed to create an easier SMS response regimen after receiving the reminder message.

KEY WORDS: PARKINSON'S DISEASE/ SHORT MESSAGING REMINDER SYSTEM/ MEDICATION ADHERENCE

84 pages

การพัฒนาระบบการส่งข้อความเตือนเพื่อเพิ่มความสม่ำเสมอในการรับประทานยาสำหรับผู้ป่วยโรคพาร์กินสัน
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บทคัดย่อ

ผู้ป่วยพาร์กินสันมักมีปัญหาเรื่องของการลืมรับประทานยาเนื่องจากผู้ป่วยพาร์กินสันต้องรับประทานยาหลายมื้อในแต่ละวัน รวมถึงมีตารางการรับประทานยาที่ค่อนข้างซับซ้อน การศึกษานี้มีวัตถุประสงค์เพื่อพัฒนาระบบการส่งข้อความเตือนการรับประทานยาโดยใช้ระบบการส่งข้อความสั้นส่งไปยังโทรศัพท์มือถือของผู้ป่วยเพื่อเพิ่มความสม่ำเสมอในการรับประทานยา

ระบบได้พัฒนาเป็นระบบอัตโนมัติเพื่อส่งข้อความสั้นเตือนการรับประทานยาที่มีข้อความเฉพาะสำหรับผู้ป่วยแต่ละราย ผู้ป่วยแต่ละรายจะต้องยืนยันการรับประทานยาโดยการพิมพ์รหัสส่วนตัว ที่ได้กำหนดให้ ในข้อความเตือนการรับประทานยา หากผู้ป่วยไม่ตอบกลับระบบภายใน 15 นาที ระบบจะส่งข้อความเตือนการรับประทานยาอีกครั้งหนึ่ง หรือผู้วิจัยจะติดตามการรับประทานยาผ่านทางโทรศัพท์เพื่อยืนยันการรับประทานยา การศึกษาวิจัยครั้งนี้มีผู้ป่วยพาร์กินสันเข้าร่วมโครงการทั้งสิ้นจำนวน 27 ราย เพื่อประเมินความร่วมมือในการรับประทานยาและความพึงพอใจต่อการใช้ระบบการส่งข้อความเตือนการรับประทานยา โดยการเก็บข้อมูลด้วยแบบประเมินความร่วมมือในการใช้ยา และชุดแบบสอบถามเกี่ยวกับการรับประทานยาและการใช้งานระบบ

ผลการศึกษาพบว่า ผู้เข้าร่วมโครงการส่วนใหญ่พึงพอใจต่อระบบเตือนการรับประทานยา (77.2%) และข้อความเตือนนั้นสามารถอ่านเข้าใจได้ง่ายและถูกส่งตรงตามเวลาที่กำหนด(100%) หลังจากที่การทดลองใช้ระบบพบว่าคะแนนความร่วมมือในการรับประทานยาทั้งหมดแสดงให้เห็นถึงการเปลี่ยนแปลงอย่างมีนัยสำคัญทางสถิติ ($p < 0.01$) ผลตอบรับเชิงบวกจากผู้เข้าร่วมโครงการแสดงให้เห็นถึงประโยชน์ของระบบ ระบบนี้ช่วยให้ผู้ป่วยพาร์กินสันรับประทานยาได้ถูกต้องและตรงเวลา ด้วยความซับซ้อนของอาการพาร์กินสัน การออกแบบระบบนี้ควรจะพัฒนาต่อไปให้สามารถตอบกลับข้อความเตือนการรับประทานยาได้ง่ายยิ่งขึ้น

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CHAPTER I
INTRODUCTION

1.1 Rationale and Justification

Parkinson's disease (PD) is one of the most common neurodegenerative disorders, affecting more than 6 million of the global population [(1)]. It has a prevalence of approximately 0.5 to 1.0 % among persons 65 to 69 years of age, rising to 1 to 3% among persons 80 years of age and older[(1)]. Its cardinal manifestations include the presence of clinical features of parkinsonism, including bradykinesia, rest tremor, rigidity, and postural instability[(2)]. Pathologically, it is primarily characterized by the loss of dopaminergic neurons in the substantia nigra pars compacta and connected structures [(1)]. In Thailand, the crude prevalence of Parkinson's disease is 95.34 per 100,000 population whereas the age-adjusted prevalence is 424.57 per 100,000.[(3)]

Parkinson's disease is a chronic and progressive neurological disorder. Patient needs to be adhering on medication treatment continuously, which aims to alleviate the symptoms. Continuous titration of the medication and addition of therapies are required to control symptoms affected from Parkinson's disease. As the disease progress, increasing complicated titration and dosing schedule are required to prevent the worsening of motor symptoms. Patients, who have had a long-term of levodopa, may develop motor complications associated with therapy and correlate with reduce medication adherence. This variability in motor response is correlated with the fluctuation in plasma concentration of levodopa (related to oral intermittent delivery and irregular gastric emptying) and consequently with the level of pulsatile stimulation of dopamine receptors in the striatum.[(4)] As the disease progresses, the therapeutic window is narrowed in such a way that reduces the response time "on" increases the off time and is easily reached the threshold for dyskinesias. Motor complications and non-motor complications are being accentuated with the worsening of the disease and therefore impacts the quality of life of patients [(5-7)].

Non-adherence to prescribed drug schedule may not relieve motor symptoms of Parkinson's disease. Elderly patients with Parkinson's disease often have been prescribed a complicated dosing or titration schedules and multiple medication administration. In addition, neuropsychiatric disturbances and cognitive impairment, which are found as the disease progress, can affect their medication adherence.[8] One study[9] found that 51.3% of patients missed to follow prescribed medication at least one dose per week, and 20.5% of them missed three or more doses per week. Mistiming of doses was reported by 73% of patients but 82.1% had recorded these mistimed doses.[9] In Thailand, one study[10] reveals that majority of the pattern of non-adherence 56.8% to medical treatment among patients with Parkinson's disease was "sometime forgetful to take drugs".

Patient adherence to a medication regimen affects to treatment outcomes, quality of life, and healthcare expenditure. To achieve optimal adherence in patients with Parkinson's disease, a combination of pharmacological and non-pharmacological approaches appears to be the most effective strategies. Examples of these strategies include a strong provider-patient relationship, educational intervention by phone or face-to-face contact, simplified dosing and administration schedules, management and understanding of medication adverse events, and the use of adherence aids such as pill boxes and hour-by-hour organizational charts.

The growth of mobile phone technology has become easily available and highly popular. Ninety percent of developed countries population and 33% of developing countries population has mobile phone.[11] The short message service (SMS), in which text message are sent and received through mobile phone has been increasingly used.[12] Three consistent success indicators for SMS messaging are[13] cost effectiveness and interoperability of the wireless infrastructure, the high penetration of mobile phone and the relatively low cost of the SMS messaging service. Text messaging on mobile phone also has been used in health care communicates as well for patient reminders, psychological support, chronic disease management, behavior modification, reporting of critical medical events or laboratory results and even for surveys.[12] Therefore, this study was conduct by using this two ways communication text messaging system for medication reminder to enhance medication adherence in patients with Parkinson's disease. The system is an automatic generator,

to send the medication reminder SMS for each patient. A predefined time schedule was set and the reminded SMS was sent to patient's mobile phone. Each patient was asked to respond each time they took the medication. The system may improve adherence to Parkinson's medications and ultimately improve symptom control which maximizing the efficacy of existing therapies.

1.2 Purposes of the study

The purposes of the study are as follows:

General Purpose:

To develop a two-way communication medication reminder system to enhance adherence to prescribed medication for patients with Parkinson's disease.

Specific Purposes:

1) To define messaging system of the prescribed medication reminder.
2) To develop a mobile phone communication system for prescribed medication reminder.
3) To design the utility system to enhance adherence to treatment messaging system.

1.3 Scope of the study

The participants in this study were the Parkinson's disease patients with medical non-adherence who attend Parkinson's disease and Movement Disorders Outpatient Clinic, King Chulalongkorn Memorial Hospital. Caregiver of patient with Parkinson's disease were invited to participate, if any.

1.4 Definitions of key terms

Two-way communication medication reminder system is text messages that remind time of medication intake which patients receive reminders message from healthcare providers at predefined time via personal mobile phone. Patients will reply

the response message back to the system confirmed they received the reminder message.

Medication reminder message is text messages that composed of patient's name, medication's name and dose in each prescribed medication administration schedule.

Adherence to medication treatment is extent to which patients take medications as prescribed by their health care providers. The adherence can be assessed by the 8-item Morisky Medication Adherence Scale.

Patients with Parkinson's Disease are male or female patients age over 30 years old with Parkinson's disease who were non-adherence to prescribed medication at Parkinson's disease and Movement Disorders Outpatient Clinic, King Chulalongkorn Memorial Hospital.

Caregiver is people responsible in managing prescribed medication and assisting the patient with his/her activity daily living.

SMSID is a unique number of reminder messages for each patient. Patient need to use this number to response back to the system in this study.

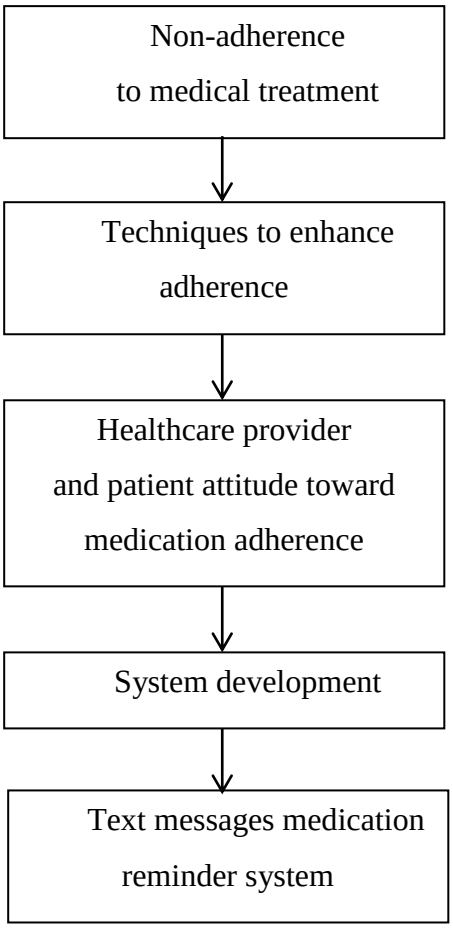


Figure 1.1 Conceptual Framework

From previous study [10] reveals that patient's with Parkinson's disease (56.8%) was sometime forgetful to take drugs. Non-adherence to prescribed drug schedule may affects to treatment outcome. There are many adherence tools and strategies included pharmacological and non-pharmacological approaches to improving adherence in patients with Parkinson's disease. According to the widely used of mobile technology, text-messaging application service for medication reminder is one of the strategies that used in healthcare-management practices which improving individual and population health outcomes. Therefore, this study was conduct to develop the two ways communication text messaging system for medication reminder to enhance medication adherence in patients with Parkinson's disease.

CHAPTER II
LITERATURE REVIEW

The chapter presented the reviews in pharmacological treatment and medication adherence in patients with Parkinson's disease. There are many treatment options and adherence strategies to improving adherence. Mobile health technology, text message applications and software development were reviewed as the strategies that widely used in health service delivery and public health systems which improving individual adherence and health outcomes.

2.1 Pharmacological treatment for Patient with Parkinson's disease

Parkinson's disease (PD) is a chronic and progressive neurological disorder. The cardinal manifestations include the presence of clinical features of parkinsonism, including bradykinesia, rest tremor, rigidity, and postural instability.[2] The main pathological features of PD are a preferential loss of dopaminergic neurons in the substantia nigra parscompacta (SNc) , the presence of intracellular inclusions, called "Lewy bodies" in the remaining neurons, and a reduction in striatal dopamine[14,15] Presently, there is no disease-modifying treatment of proven clinically efficacy. The main PD treatments remains symptomatic. These include pharmacotherapy, and surgical approaches, such as deep brain stimulation (DBS).[16]

There are many pharmacotherapy for PD, including Levodopa, Dopamine agonist,Catechol-O-methyltransferase (COMT) inhibitor, Monoamine oxidase B (MAO-B) inhibitor, and Anticholinergics.

Levodopa[14] is the most reliable and effective treatment for Parkinson's disease symptoms. Levodopa in pill form is absorbed in the blood from the small intestine and travels through the blood to the brain, where it is converted into dopamine. Once the brain converts levodopa into dopamine, it is stored in the neurons until needed by the body for movement. However, patients will develop motor

complications with long-term levodopa therapy. After 5 years of treatment, about 50% of patients taking levodopa develop motor fluctuations, and 30% develop dyskinesias. Levodopa is now routinely co administered with a decarboxylase inhibitor, either carbidopa or benserazide. They block peripheral degradation of levodopa to dopamine, allowing more levodopa to cross the blood-brain barrier and helps reduce the side effects of nausea and vomiting. Carbidopa/levodopa tablets are available in immediate-release and slow-release forms as well as dissolvable tablets.

Dopamine agonists[14] have ability to directly stimulate dopamine receptors. which contrasts with levodopa that need to be transformed into L-dopamine in presynaptic terminals. There are currently 5 dopamine agonists marketed in Thailand, One is ergot derivative (bromocriptine) and the four are non-ergot derivatives (pramipexole, piribedil ,ropinirole and rotigotine).The efficacy of dopamine agonists used as monotherapy in early Parkinson's disease. Dopamine agonists is usually sufficient but when disease progresses, it becomes necessary to add levodopa, which has a better effect on symptoms.

Catechol-O-methyltransferase (COMT) inhibitor[14] are only effective when used in combination with levodopa.COMT-inhibitors block the COMT enzyme from converting levodopa into a useless form, thus making more levodopa in the brain available and helping to reduce Parkinson's disease symptoms. Entacapone is the only COMT-inhibitors in Thailand.

Entacapone is prescribed with each dose of levodopa. Several controlled studies demonstrated that adding COMT inhibitor is useful and has been shown to reduce "off" time by approximately 1.3 hours per day with entacapone. Patients should be advised that they may develop dyskinesia within one or two days of adding COMT inhibitor and that a 20% to 30% reduction in levodopa dose may be required. There is also a combination of carbidopa, levodopa and entacapone(LCE). Patients who are stable on levodopa and entacapone given separately can be converted straight over to the equivalent dose of LCE. LCE should not be cut or crushed; only one should be taken at each dose time and this agent must not be combined with additional entacapone.

Monoamine oxidase B (MAO-B) inhibitor[14] block the MAO-B enzyme from converting levodopa into a useless form, thus making more levodopa in the brain

available and helping to reduce Parkinson's disease symptoms. There are currently 2 MAO-B inhibitors marketed in Thailand, selegiline and rasagiline. MAO-B inhibitors are usually used as early monotherapy or as an add-on medication to drugs such as levodopa in more advanced Parkinson's disease to decrease "off" time.

Anticholinergics[14] can be helpful for tremor and may ease dystonia associated with wearing-off or peak-dose effect. The anticholinergics in Thailand are including trihexyphenidyl and benztropine. Anticholinergics do not act directly on the dopaminergic system, it decrease the activity of acetylcholine, a neurotransmitter that regulates movement. Potential adverse effects include blurred vision, dry mouth, constipation and urinary retention.

Medication Adherence in Patient's with Parkinson's disease

Adherence to a regular PD medication schedule is important for every patients in achieving optimal symptom control. Physicians modify drug schedules in response to their patients' clinical responses. Drugs may require differing dosage schedules or escalation/manipulation adding considerable complexity. To maintain treatment effect in advanced PD more frequent and intricate titrations are required to maximize 'On' time.[17] Advanced PD patients may be taking up to ten daily doses to manage fluctuations.[18] Failure to relieve patients' symptoms or the emergence of drug-related side effects may reflect non-adherence to a prescribed drug schedule rather than incorrect therapeutic physician decisions. The abrupt interruption of medication administration or changes in medication schedules may result in reduced comfort, prolonged recovery, and increased morbidity rates, length of stay, and the cost of care. [19]

Most frequent problems involving medication administration [20] is noncompliance primarily because the patient did not understand the medication instructions. The patients with Parkinson's disease usually missed their daily medication at prescribed time and dose because of multiple administrations and complicated titration and dosing schedule of medication.

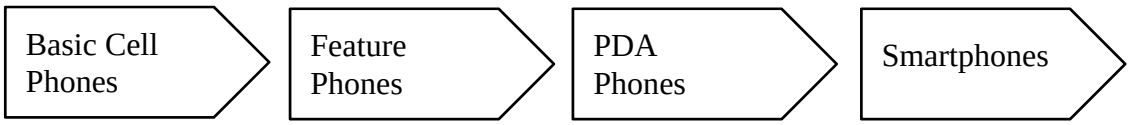
However, there is no standard method of assessing adherence. Both direct and indirect methods are used to measure adherence. Direct methods include observation, serum drug concentration, and biochemical assays. Although direct methods offer increased accuracy, they are often impractical and costly to use. Indirect

methods of measuring adherence include pharmacy refill records, patient self-reports, clinical response, and electronic monitors. [21, 22]

2.2 Mobile Technology for Healthcare Services

The rapid expansion of mobile information and communications technologies (ICT) within health service delivery and public health systems has created a range of new opportunities to deliver new forms of interactive health services to patients, clinicians, and caregivers. Mobile health or mHealth[23] defined as health-related services to patients, clinicians, and caregivers through mobile technology platforms on cellular or wireless networks. With mHealth, healthcare providers, caregivers, and patients could have an opportunity to continuously monitor health conditions and access health information outside of the physician's office, and outside of the patient's home. The mHealth interventions expand access to health information and services that promote personal wellness, preventive care, and chronic disease management, promoting efficiencies in care-management practices, and improving individual and population health outcomes.

Presently, mobile phone handsets are the most popular mobile device. In the U.S., mobile phone penetration is close to 90% of the population. [24] Among older adults, 78% of adults aged between 50 – 64 years and 82% of those between 65 and 74 years of age have a mobile phone.[25]



Functionality: • Voice communications • Short Message Service (SMS) texting	Functionality: • Basic Cell Phone capabilities • Camara, mp3 player, low-resolution video, downloadable game	Functionality: • Feature Cell Phone capabilities • Web-browsing • Organizing functions • Runs on proprietary operating system	Functionality: • PDA capabilities • Runs on cross platform operating system • Downloadable apps • Video conference • GPS functionality

Figure2.1 Spectrum of phones functionality[26]

Most of mHealth interventions have been developed for use with basic cell phone devices that tend to be voice-centric with data-enabled capabilities such as short message service (SMS) or text messages. Health-related functions of SMS include health behavior reminders, prompts to schedule or confirm an appointment, notifications of a laboratory result or health status report, requests for data, encouragements or motivations to sustain a positive behavior, and educational and information resources to improve self-efficacy.[12]

Compared to basic and feature cell phones, PDA phones and smartphones offer more advanced multimedia functions, such as video, web browsing, and health-related software applications. Ownership of smartphones with advanced data-enabled communication capabilities beyond voice- and SMS-based interventions, such as accessing the Internet or providing location-based services, is growing in the general U.S. population,[26] but ownership among adults over the age of 50 is more limited (7% as of 2010). [25]

However, when looking at what technologies are preferred, mobile messaging is easily to access for adults over the age of 50 since the available of the basic cell phone. Text messaging can be used as one way communication to giving information such as alert, reminder and two-way communication such as question and answer which the receiver need to respond. Mobile phone text messaging has proved to be a powerful tool for many tasks in health care. It is affordable and instant way for communication between health care personnel and patient, enabling control and monitor application, improving adherence in self-management of chronic disease or healthy lifestyle program.[25]

2.3 Text messaging application in Healthcare

Bäck and Mäkelä [27] reviewed text messaging application in health care, there are many text messaging applications used to improve the adherence. In a feasibility study of Hanauer and colleagues [28], participants received text message reminders responded more often than those receiving email reminders in blood glucose measurement. Harris and colleagues [29], examined the overall usability of a pager-based text messaging system designed for improving medication adherence

among the HIV-positive patients. The results revealed that the majority of the participants were satisfied with the medication reminders, which were found helpful. Dunbar and colleagues [30] presented a two-way messaging system to enhance antiretroviral adherence of HIV positive persons. In this automated messaging system, the participants received multiple short daily messages designed to remind, educate, encourage adherence and solicit responses concerning side effects and self-reported adherence. The participants could use the system to report e.g. about missing doses or side effects. Woolford and colleagues [31] used tailored text and multimedia messages for increasing adherence in a weight-management programme. The participants of the programme mostly found the text message service as personally relevant, and improved the participants' adherence to healthy lifestyle practices. In the work of Gerber et al.[32], text messages were used to support weight loss maintenance program among African-American women. The messages included tips on health eating and physical activity. A similar kind of approach was employed also by Joo and Kim [33] and Kornman et al. [34], in which text messages were used to deliver short messages about diet, exercise and behavior modification for the participants of an anti-obesity program. The text messages have also been used in smoking cessation interventions. Whittaker et al. [35] report about their mobile phone– based cessation program that was targeted to young people. Keith J. Petrie and colleagues [36] reported that text messages improved adherence in young adult asthma patients. Text messages intervention to increase adherence around 10% in the intervention group. The text message also resulted in a significantly higher percentage of the intervention group achieving the 80% or greater adherence level.

2.4 Software development for healthcare communications

Text messaging in healthcare communications delivering proactive support, where information is pushed to the user rather than being actively sought. Importantly, it is inexpensive and therefore offers an efficient means of supporting patients in the context of limited heath service resources. [37] Software development for human-computer interaction, users are stronger focus and involved in designing and evaluation at every stage of design process. The "User-centered design" (UCD) is

a broad term to describe design processes in which end-users influence how a design takes shape. The term “user-centered design” originated in Donald Norman’s research laboratory at the University of California at San Diego (UCSD) in the 1980s and became widely used after the publication of a co-authored book entitled: User-Centered System Design: New Perspectives on Human-Computer Interaction (Norman & Draper, 1986). Norman built further on the UCD concept in his seminal book The Psychology Of Everyday Things (POET)[38]. In POET, he recognized the needs and the interests of the user and focuses on the usability of the design. He offered four basic suggestions on how a design should be:

- Make it easy to determine what actions are possible at any moment.
- Make things visible, including the conceptual model of the system, the alternative actions, and the results of actions.
- Make it easy to evaluate the current state of the system.
- Follow natural mappings between intentions and the required actions; between actions and the resulting effect; and between the information that is visible and the interpretation of the system state. [38]

The user-centered design began with a requirements gathering to identify the needs and establish requirements. Once the requirement have been identified, designers can develop alternative design solutions to be evaluated by the users. As the design cycle progresses, prototypes can be produced. The development lifecycle of the prototype was based on the interaction design process proposed by Preece et al. [39] (Figure 2.2).

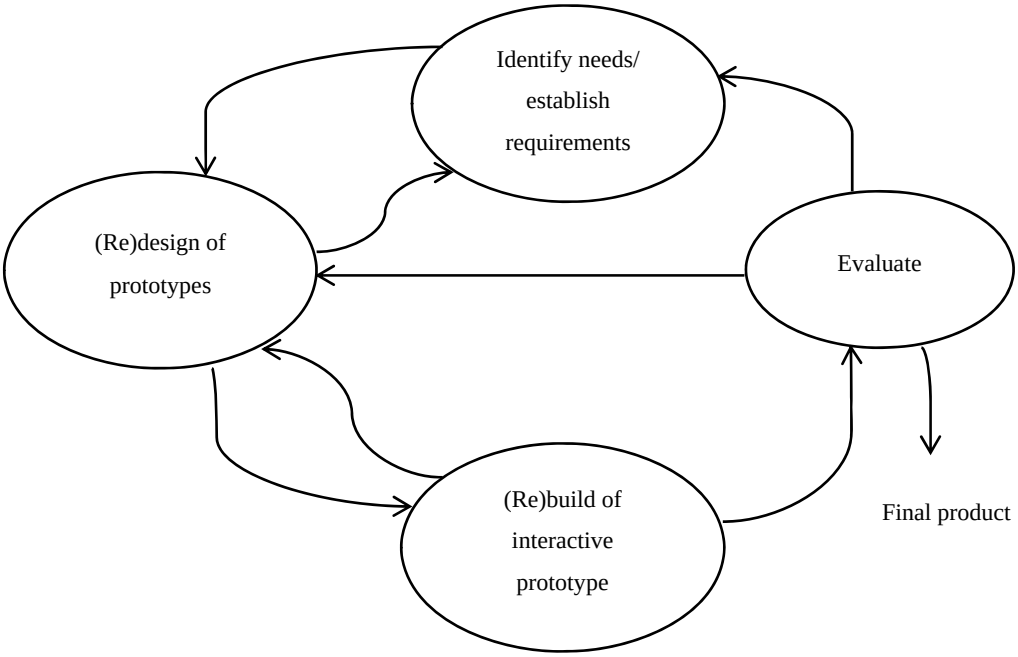


Figure 2.2 The design process for interactive prototype by Preece et al.[39]

After prototyping, the evaluations by the users will help identify usability criteria such as the effectiveness, efficiency, safety, utility, learnability of the product and users' subjective satisfaction. Usability testing, according to Dumas & Redish[40], aims to achieve the following five goals:

- Improve the product's usability
- Involve real users in the testing
- Give the users real tasks to accomplish
- Enable testers to observe
- Record the actions of the participants and enable testers analyze the data obtained and make changes accordingly.

Usually testing is done with users and with experts through expert reviews. Experts can comment on usability issues while users can point out small problems related to tasks.[41] Interviews and user satisfaction questionnaires is one technique in usability testing which enable designers to evaluate the users likes and dislikes about the design and to gain a deeper understanding of any problems.

Table 2.1 Involving users in the design process [39]

Technique	Purpose	Stage of the Design Cycle
Background Interviews and questionnaires	Collecting data related to the needs and expectations of users; evaluation of design alternatives, prototypes and the final artifact	At the beginning of the design project
Sequence of work interviews and questionnaires	Collecting data related to the sequence of work to be performed with the artifact	Early in the design cycle
Focus groups	Include a wide range of stakeholders to discuss issues and requirements	Early in the design cycle
On-site observation	Collecting information concerning the environment in which the artifact will be used	Early in the design cycle
Role Playing, walkthroughs, and simulations	Evaluation of alternative designs and gaining additional information about user needs and expectations; prototype	Early and mid-point in the design cycle
Usability testing	Collecting quantities data related to measurable usability criteria	Final stage of the design cycle
Interviews and questionnaires	Collecting qualitative data related to user satisfaction with the artifact	Final stage of the design cycle

The major advantage of the user centered design approach is that a deeper understanding of the psychological, organizational, social and ergonomic factors that affect the use of computer technology emerges from the involvement of the users at every stage of the design and evaluation of the product. The involvement of users assures that the product will be suitable for its intended purpose in the environment in which it will be used. The major disadvantage to user centered design is that is can be

quite costly. It takes time to gather data from and about users. The process requires resources, both financial and human. User-centered design teams generally benefit from including persons from different disciplines, particularly psychologists, sociologists and anthropologists whose job it is to understand users' needs and communicate them to the technical developers in the team. The downside of this approach is that members of the team have to learn to communicate effectively and to respect each other's contributions and expertise. This can be time consuming and hence adds costs to the process.[39]

One of text messaging system is "Sweet talk" [42] which designed to deliver individually targeted messages and general diabetes information that developed by The Ninewells Paediatric Diabetes Research Team and the Medical Informatics Group in Dundee University's School of Computing. The design and development of a prototype system was undertaken, following the user-centered design approach. The overall aim of the design project was to provide a prototype system that could be evaluated as a 'proof of concept'. In order to determine if a full industrial scale application was worth developing, the system had to provide at least the core functionality needed to realize the relative worth of such a system. The system was to be used by a paediatrician who required the software for her doctoral research and a successful outcome was therefore essential: the project thus lent itself to a participatory design approach.[43] The design process was iterative and took place mainly in the clinic setting (contextualization) and involved the cooperation of both designers (the computing student and the paediatrician). Paper-based and computer prototypes were used to evaluate (experiment with) various ideas. Because the project focused on the design of the system, the development lifecycle of the prototype was based on the interaction design process proposed by Preece and colleagues. [39] (Figure 2.2). The project began with a requirements gathering exercise to identify the needs and establish requirements. These requirements were refined using paper-based prototypes. The paper-based prototypes led to the development of a web-based evolutionary prototype, which was modified and refined during further design sessions. A working prototype was finally evaluated and the refined prototype became the blueprint for the implementation of "Sweet Talk", which was used in a randomized clinical trial.[42]

2.5 Development of core messages

Messages are information which is passed from one person or from a group of people to other people. Basic messages were created as following, [44]

1) Stress one major idea.
2) Describe or sketch the preliminary illustrations or story lines.
3) Write down the theme lines/statements and the key words that express the ideas or information to be conveyed by the message.
4) Offer benefits and practical solutions that meet the needs of the interaction group.
5) Emphasis these features of the idea that satisfy interaction group's needs.
6) Keep messages clear, simple, lean and tight.
7) Ensure that the message is comprehensible.

Messages are presented in various formats or combinations of formats. Depending on the specifications of the message, Enhance adherence in medication taking message should be in combinations of Information and Motivation format. Information format presents format presents straight facts without an explanation of their relevance. Motivation format uses a combination of emotional and rational appeals to persuade and promote action among the interaction groups. It also tries to enhance the image of the innovation by attaching a pleasant emotional connotation to it. The message creates a mood for the innovation.

2.6 User interface design

The user interface is a part of the computer system that enables interaction between users and the system. A good user interface design encourages an easy, natural, and engaging interaction between a user and a system, and it allows users to carry out their required tasks. User-centered design (UCD) is an approach to user interface design and development that involves users throughout the design and development process. User centered design not only focuses on understanding the users of a computer system under development but also requires an understanding of

the tasks that users will perform with the system and of the environment (organizational, social, and physical) in which they will use the system. Human-Centered Design Processes for Interactive Systems, [45] provides guidance on and lists the main principles and essential activities for human - centered design, for achieving usability in systems.

There are four main principles of human centered design[45]:

1) The active involvement of users
2) An appropriate allocation of function between user and system
3) The iteration of design solutions
4) Multidisciplinary design teams

The four essential human-centered design activities are

1) Understand and specify the context of use
2) Specify the user and organizational requirements
3) Produce design solutions (prototypes)
4) Evaluate designs with users against requirements

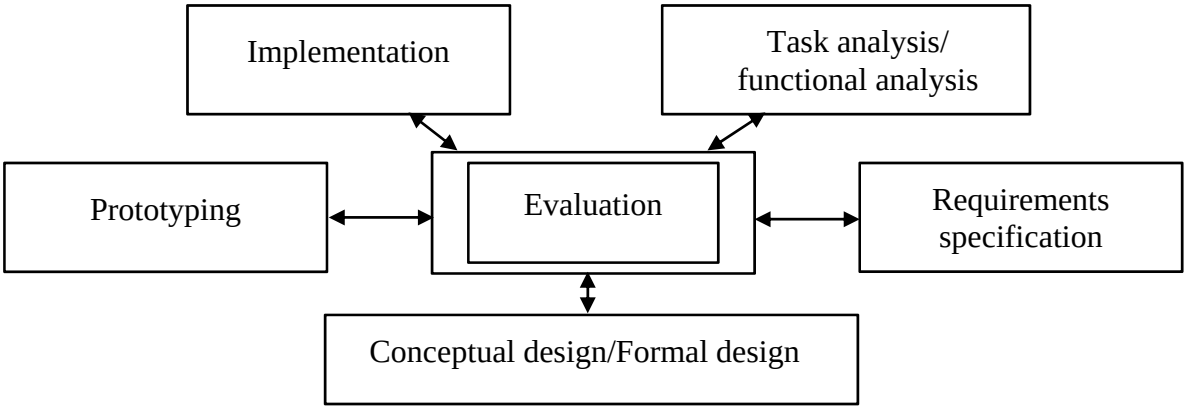


Figure 2.3 The star lifecycle approach [45]

The way to be user-centered is to involve users and to pay attention to their views. This can include a variety of approaches, from simply observing users' working practices as part of collecting system requirements, to using psychologically based user modeling techniques, to including user representatives on the design team. More important, users should be involved in the testing and evaluation of the system during its design and development.

A star life cycle model proposed by Hix and Hartson[45]. It is encourages iteration. The central point of the star is evaluation, which is viewed as being relevant at all stages in the life cycle. Evaluation is concerned with gathering data about the usability of a design by a specified group of users for a particular activity within a specified environment or work context. These include interviews with users and others, observing users in their workplace, and getting users' opinions from questionnaires or other types of surveys. Users should be involved in every part of the user interface design and development life cycle.

In design process, users could help in defining the requirements for the system by contributing a specification or by testing early mockups. Users can get involved by allowing themselves to be observed and giving feedback about the problems of the current system.

During prototyping, to test designs and options. Users could test versions of the interface to provide feedback and make suggestions to the designers. Before delivery of the product, users again could test the product by using it or completing surveys about the various features. Minimal change is allowed.

During training/after delivery of the system. Again, users would use the product and give their opinions and detail any problems. Revisions at this stage would be included in the next version.

There are several kinds of evaluation. First, observation or monitoring of the way in which users interact with a product or prototype. The observation may take place informally in the field or in a laboratory as part of more formal usability testing. Second, interviewing users to find out what they think about using the technology. Surveys using questionnaires and interviews provide ways of collecting users' attitudes to the system. Third, making predictions. The aim of this kind of evaluation is to predict the types of problems that users will encounter without actually testing the system with them.

In designing the interface, data manipulation within medical informatics software interfaces is typically complicated and requires significant training. [46, 47] The purpose of building a prototype is to provide an early model of the product so that the design can be evaluated and refined in consultation with the end-user.[48,49]

However, there is no study in automated text messaging medication

reminder system in Parkinson’s disease patients which have complicated dosing or titrations schedules and have multiple administration of medicines. So the researcher would like to develop the text messaging medication reminder system to enhance medication adherence in Parkinson’s disease patient. This system could potentially benefit to patient’s quality of life.

CHAPTER III
METHODOLOGY

The chapter presented the system development techniques used to structure, plan, and control the process of developing an enhance adherence messaging system for patients with Parkinson's disease. A methodology is also including clinical study design to examine feasibility and utility of the system by patients with Parkinson's disease.

3.1 Technical Development

3.1.1 Overview of system

An Enhance Adherence Messaging System for Patients with Parkinson's disease is a computer system designed to help the patients with Parkinson's disease for medication administration by using a simple web interface to set the reminder messages. This system allows for reminder message to be sent to the patients and the patients able to send back the message to confirm the medication administration.

A System was designed to get the advantage of the currently increasing of text messaging on mobile phone in order to increase adherence from medication administration of patients with Parkinson's disease.

3.1.2 System Analysis

At Parkinson's disease Out-patient Clinic, after physician prescribed the medicine for the patient, nurses have to write down all prescribed medicines into patient personal Parkinson's disease booklets. This booklet is containing the medication table which composed of medication's name, dose, and time of intake. This is one technique that they used to remind patients for proper medication taking.

However, there is no any system to check the medication adherence in patient with Parkinson's disease.

Table 3.1 Example of patient's medication schedule at Chulalongkorn hospital

Time / Name	7.00	11.00	16.00	20.00	Remark
Madopar 50/200	1	½	1	½	1st week
	1	1	1	1	2nd- 4th week
Comtan	½	½	½	-	
Madopar HBS	-	-	-	1	

3.1.3 System Design

3.1.3.1 Operational Design

The system was developed to deliver medication reminder message to patient with Parkinson's disease. The study followed iterative software development cycle of gathering requirement, prototyping, implementation and evaluation. The user-center designed was used efficiently by developer and healthcare provider team. A web-based interfaced was used because it allowed access to the system from varieties of location. After the initial prototype design, SMS vendor which provides SMS Solution & SMS Aggregator service managed with the ability for send text message to patient and send text message back to the system. The system is able to send the text messages automate at predefined time and send confirmed message when the patient respond back. The system will automatically send the second reminders to patients once the system didn't get the response from the patients. Healthcare providers will get the message from the system once the patients didn't response the second reminder.

The primary user of the system would be the health care providers who would be responsible for the management of patient records. The patients would determining the content and functionality of the text messaging reminder system.

3.1.3.2 Information Design

Close-ended and open-ended questionnaire was developed to gathering information and attitude toward medication adherence and concerned from health care providers (physicians, nurse, pharmacist) and Parkinson's disease patients. After data collection, another questionnaire was designed to gather information for system requirement and design

3.1.3.3 Tools and Instrument

1) Pre-Study Questionnaire (Appendix A)
2) Post-Study Questionnaire (Appendix B)
3) Case Record Form (Appendix C)
4) Morisky Medication Adherence Scale (Appendix D)

A self-reporting questionnaire is the most convenient and cheapest way to assess medication adherence. A new 8-item self-reported Morisky Medication Adherence Scale (MMAS) has been developed by Morisky et al.[50] The MMAS comprises 8 items had a sensitivity of 93% and a specificity of 53%, respectively. The reliability value of the 8-item Morisky scale was 0.83. Sakthong P. et al [48] was assess the validity, including convergent known-groups and construct validity, and the reliability, including internal consistency and test–retest reliability, of the MMAS in Thai type 2 diabetic patients. Internal consistency reliability was moderate (Cronbach's $\alpha = 0.61$), whereas the test–retest reliability of the MMAS was excellent (intraclass correlation coefficient = 0.83; $p < 0.001$). The sensitivity, specificity, positive predictive value, and negative predictive value of the MMAS were 51%, 64%, 71%, and 43%, respectively.

5) Inform consent Form
6) Text messaging medication reminder system

3.1.4 System Development

3.1.4.1 Communication Development

First of all, health care provider has to fill in the patients' characteristic and medication schedule of patient into the database. The patient phone number was used to inform and notify for text message medication reminder. System sends the text message to remind patient at the time of medication taking. The patient

or caregiver needs to reply the reminder sent by system. When the system identified the respond message from patient, the message stored in the database. The system will automatically send the second reminders to patients once the system didn't get the response from the patients after 15 minutes from the first reminder. Healthcare providers will get the message from the system once the patients didn't response the second reminder.

3.1.4.2 Information System Development

The initial requirement leads to the development of the prototype. The prototype was created in web based interface designed. Health care providers have to log into the system via secure website with their username and password. The website provided a screen for healthcare providers to customize patient's information including their demographic data and medication schedule for reminder message. The system was automating generated text messages at predefined time and send confirmed message when the patient respond back. The system will automatically send the second reminders to patients once the system didn't get the response from the patients. Healthcare providers will get the message from the system once the patients didn't response the second reminder.

3.1.4.3 Development of message

In depth interview from healthcare providers was used to develop a group of message to identify the need of the users to stimulate the uniqueness of the conversation.

3.1.4.4 Database design

In depth interview from healthcare providers was used to gather all information that required to record in the database. The database was creating with PHP MySQL and database component was accessed using MySQL commands.

The main element included:

1) Patient's demographic data
2) Parkinson's disease medication
3) Parkinson's disease medication time table
4) Response to medication reminder message
5) Administration

The gathering information was divided into table and columns. Primary keys were defined and the relationships between each table had set up. Normalization rules were applied to clarify that the table are structure correctly.

The patient medication information transferred to the SMS vendor in a proper format before sending SMS medication reminder to the patients. An application programming interface (API) used to communicate between application and SMS system was provided from the SMS vendor.

3.1.4.5 User Interface design

In depth interview was used in designing the interface for text message medication reminder system. The design of the screen layout ensured ease of use to patient's information and data management. Prototype was developed to provide easy understanding among users for evaluated the system.

The requirement led to development of the prototype. The prototype was created and implement the basic structure to allow user see how the system work.

3.1.5 Strategies Implemented in system

Healthcare providers are able to set the times and date that they would like reminders to be sent to patients via website. The reminder messages sent to patient's mobile phone with detailed of medication administration and the response that the patient should send back is in a number that required (11+space+personal code). The system was automatically sending the second reminders to patients once the system didn't get the response from the patients. Healthcare providers will get the message from the system once the patients didn't response the second reminder.

3.2 Study design

3.2.1 Research Design Overview

The study is a 4-week, quasi experimental design one group pretest-posttest study. The study involved a feasibility study with patients recruited from

Parkinson's disease and Movement Disorders Outpatient Clinic, King Chulalongkorn Memorial Hospital

3.2.2 Population and Sample

Population:

Parkinson's disease patients whom non-adherence to medication treatment at Parkinson's disease and Movement Disorders Outpatient Clinic, King Chulalongkorn Memorial Hospital who met the criteria.

In this study, the non-adherence to medication treatment is defined by the score of Morisky Medication Adherence Scale (MMAS) that lower than 6.[50]

Subject Selection:

Inclusion Criteria

1) Patient with Parkinson's disease age of 30 or older.
2) Non-adherence to medication treatment (The score of Morisky Medication Adherence Scale (MMAS) that lower than 6.)
3) Patient received the medicine at least 1 lists of Parkinson's disease medicine.
4) Patient attend to clinic at least 1 month before enter to the study.
5) Patient or caregiver able to be reached on for text-messaging mobile phone.
6) Patient or caregiver able to read and write Thai language
7) Patient is willing to participate in the study.

Exclusion Criteria

1) Patient would like to attend in the study, but caregiver doesn't agree.

Discontinuing Criteria

1) Inability to follow-up, by phone or in person, in one month from enrollment.

Sample:

The 27 participants were enrolled to the study. Participant was informed about the study, all questions were answered before signed inform consent.

The sample size was calculated using formula as follows:

Sample Size Calculation

$$n = \frac{(Z_{1-\alpha/2} + Z_{1-\beta})^2 \sigma^2}{d^2}$$

$$n = \frac{(1.96 + 0.842)^2 * (1.5)^2}{(0.806)^2} = 27.19$$

From Mores S.[10], the mean of non-adherence score in Parkinson's disease patients is 6.2 with standard deviation(σ) of 1.5 and the change in average of non-adherence is 0.806. Twenty seven subjects is need to detect difference in mean non-adherence score between pre and post implementing the system with 0.05 level of significance and 80% power of the test.

3.2.3 Operational sequences

1) Healthcare provider log in the system.

2) Healthcare provider enter patient information and prescribed medication information into the database.

3) The system generated the reminder message text in a proper format and uploaded reminder message to SMS vendor system.

4) Reminder message for each patient was sent at pre-define times.

5) Patient received a reminder message via his mobile phone and he need to confirm medication taken by response back to the system with provided code.

6) Response status was recorded in the database. Date and time of respond was recorded in the database and show green label in the report to confirm that patient responded to system.

7) If there is no response from the patient, red label will show in the report and the second reminder will be send after 15 minutes from the first reminder.

8) If there is no response from the second reminder, text sms will send to the healthcare provider to notified that the patient doesn't respond to the system.

9) After the healthcare provider received the sms, the healthcare providers may call to patients to ensure the medication intake.

3.2.4 System Implementation and Evaluation

This study was quasi-experimental study: pretest and posttest to be carried out for 4 weeks. To evaluate the system feasibility and utility. Requesting permission document for data collection at Parkinson's disease outpatient clinic from Faculty of Graduate Studies, Mahidol University was submitted to Director of Chulalongkorn hospital and Director of Chulalongkorn Comprehensive Movement Disorders Center for the permission.

This study was reviewed and approved according to the Standard Operating Procedures of the Ethic Review Committee for Human Research, Faculty of Medicine, Chulalongkorn University. The study was approved on 7 August 2012, COA No. 543/2012. (Appendix F)

This study was also reviewed and approved according to the Standard Operating Procedures of the Ethic Review Committee for Human Research, Faculty of Public Health, Mahidol University. The study was approved on 17 September 2012, COA No. 2012-196. (Appendix G)

Each participant was approached during clinic visit from Parkinson's Disease Outpatient Clinic to determine if he is interested to participate in the study. The study protocol is explained to patients in detail and then patients should have ample time to ask any questions and make decision and freely agree to participate the study by signing in informed consent form.

After each participant signed inform consent, demographics data will be collected. The participants were interviewed about their medication adherence and their attitude toward the medication reminder system before using the medication reminder system (Appendix A). The participant was received medication as physician's prescribed. Each pill bottle will be labeled with medication name, dosage and instruction. Each participant was free to organize the pills, whether that is in pillbox or making lists or neither. The participant was instructed to take the medication as prescribed.

During the 4 weeks of study, the study group was received text messaging to reminder for medication taken at pre-defined time. After the participant receiving the message, they have to response to the system that he/she take the medicine or not. If the medicine was not taken or no response from the participant, the system will

generate the second reminder after 15 minutes from the first reminder. If the system didn't get the response from participants, the system will show red label in the monitor and nurse might call for participant.

After using the system, participants was interviewed for the feedback concerning their use of the system (Appendix B). Medication adherence was assessed at the follow up visit.

3.2.5 Data Analysis and Evaluation

Qualitative responses from open-end questions on questionnaires (Appendix B) as well as one-to-one interview was organized to evaluate the system. Theme of evaluation is composed of messaging system, mobile communication system, utility system and overall system.

The qualitative and quantitative data are collected comparing between pre and post study. The data was tabulated and reported as percent. As appropriate, nonparametric statistics was analyzed with $\alpha = 0.05$

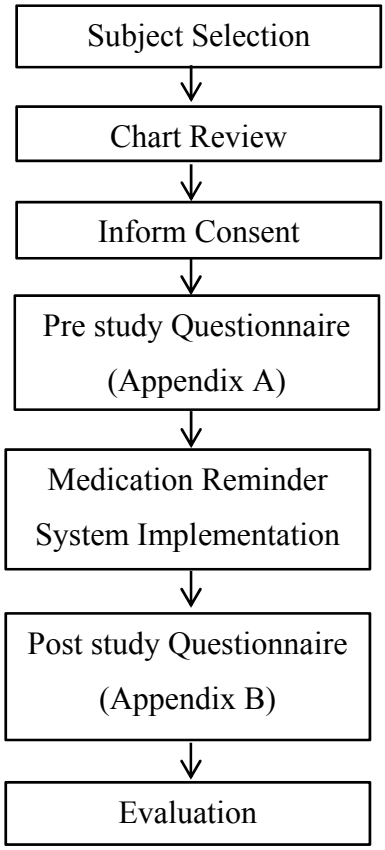


Figure 3.1 Study Process

3.3 Components of system

System was designed by using PHP language and MySql database. The system run on window 2008 server. Messages are sent and received using the service of SMS vendor.

3.3.1 The system process

3.3.1.1 Background

The website is not the major component of the system. Other components are the programs that were written to send reminders and receive data sent back to the system from SMS. The connection between system database and SMS vendor was made through API that provided from SMS vendor. The server needs to run the job schedule every minute to update the response from the patients.

3.3.1.2 Generate text message

After healthcare provider enter patient's demographic data and prescribed medication to the database, they need to confirm that all information is correct and the system generated the text message. Each message is specified to each patient and each time of medication taking that represent by SMSID. Patients need to response those SMSID back to the system.

3.3.1.3 Sending reminder

All messages were generated and sent to SMS vendor. The reminder sent at the predefined time and date either it is the current time or has already passed. The process determines that a reminder was sent, it then checks that any responses from patients. If a valid code that has been received during 15 minutes of the time of reminders supposed to be sent, the time of response will be record in the database. A second reminder sent to the patient in next 15 minutes after the first reminder to confirm patient response and medication administration. Third reminder sent to healthcare provider in next 15 minutes after the second reminder to confirm that there is no responds from patient.

3.3.1.4 Printing SMS responses report

The option to print the SMS responses is in the report section. Healthcare providers able to review the patient's response by select the start date and stop date that the SMS were sent to patients.

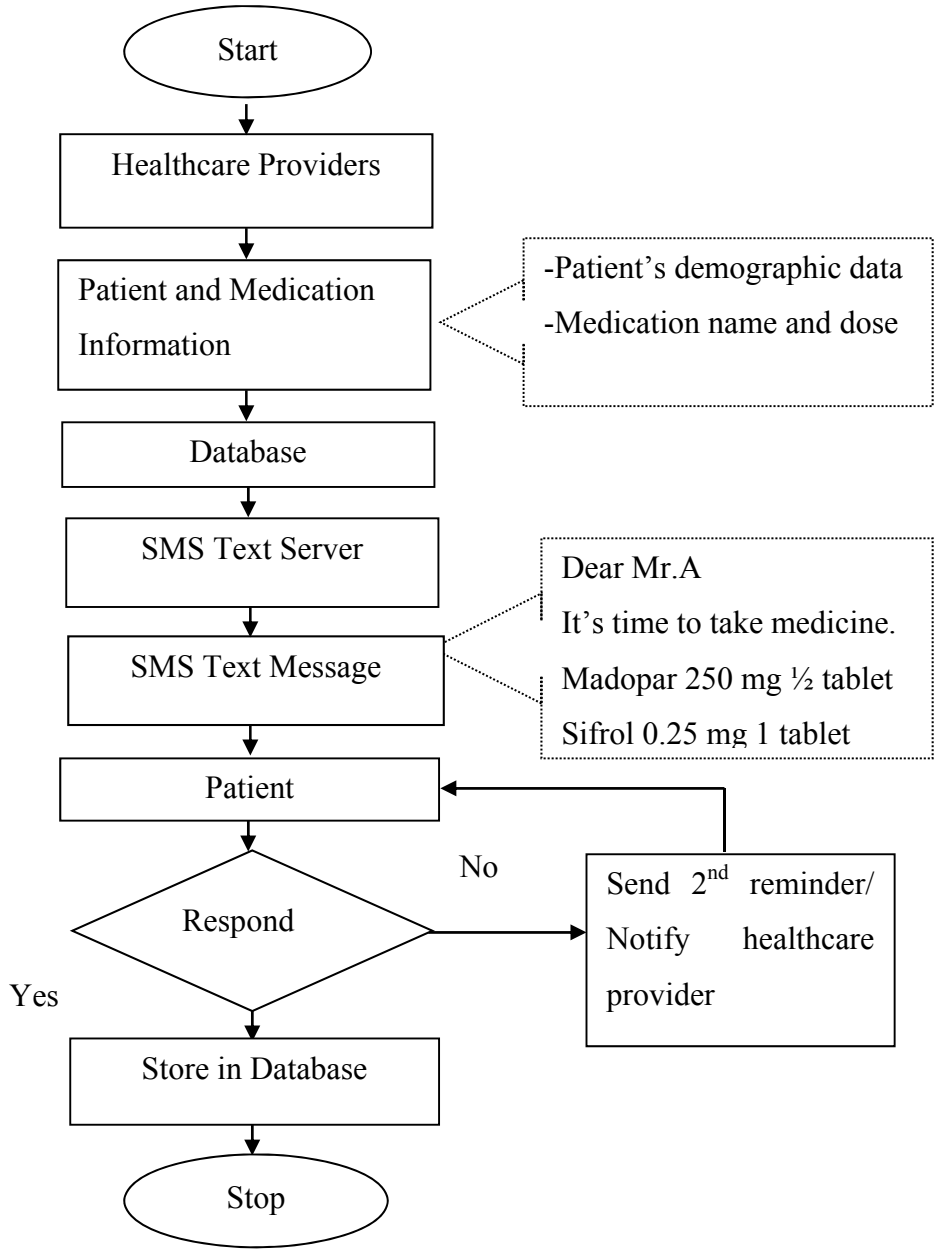


Figure 3.2 System Flow

3.4 Design Process

3.4.1 Use Case Diagram Template

Participant actor: Healthcare provider, SMS provider, Patient

Entry condition: Healthcare provider need to login into the system by their username and password

Flow of events:

1) User login into the system.
2) User key in Patient's information.
   (HN, Name-Surname, Address, Mobile phone no, age, gender)
3) User key in prescribed medication for patient.
   (Medication-Tradename, dose, time,start date)
4) User send these information to SMS provider which connect to SMS gateway.
5) SMS send to patient at prescribed time.
6) Patient response to system by send SMS code back to SMS provider.
7) SMS send the respond back to SMS provider.
8) SMS provider sends response status to server database which update real time automatically.
9) User confirms the medication taken respond from patient.

Exit Condition: User exit the system

Special requirements:

1) User need to login to the system to manage all data.
2) User able to confirm the medication taken respond from patient anytime. (Respond will be update real time automatically)
3) If patient didn't respond back to SMS provider, the second SMS will be send automatically.
4) If patient didn't respond back with the second reminder, SMS Provider will send the SMS to Healthcare provider's mobile phone to remind the patient didn't respond back to the system.

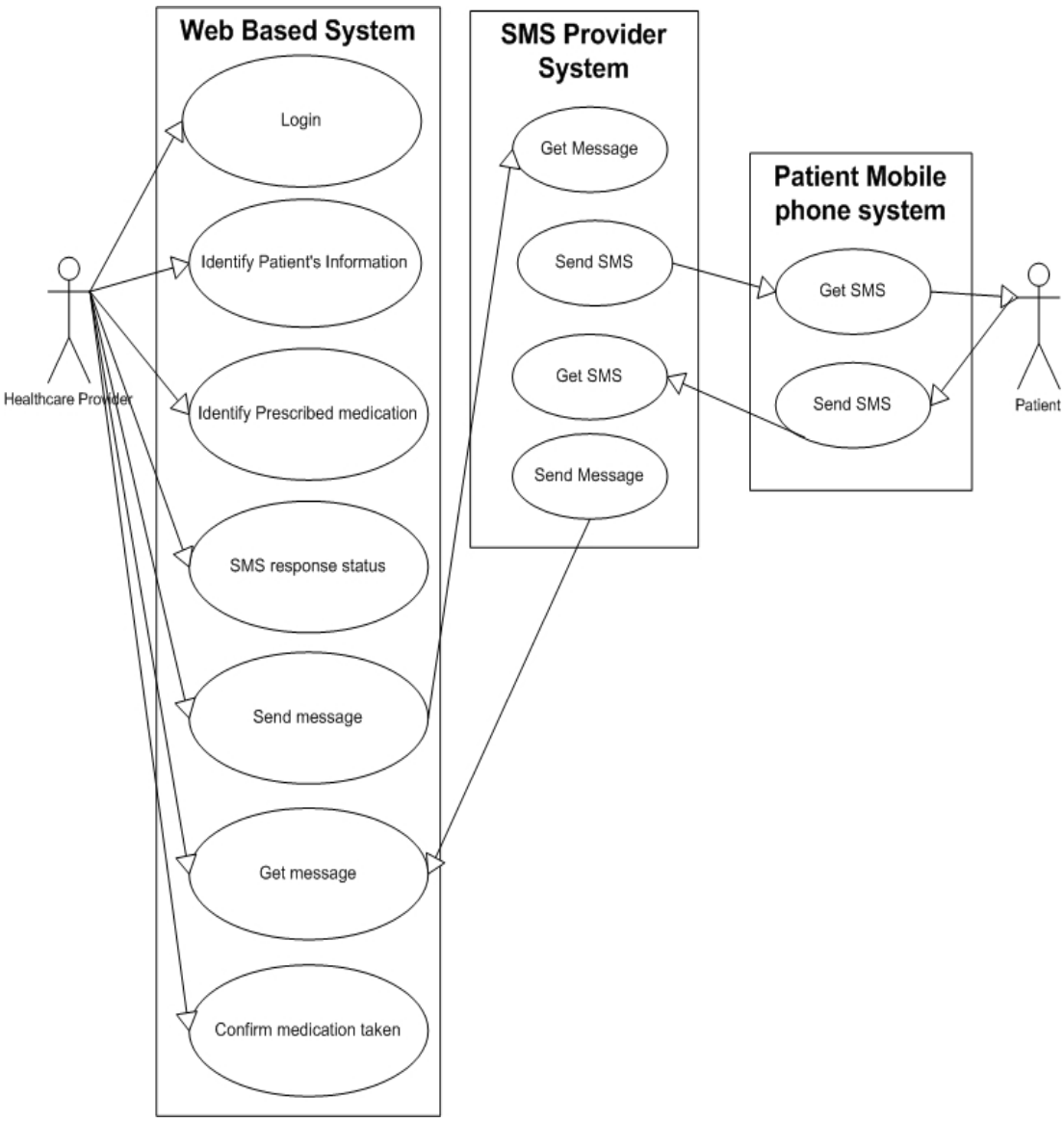


Figure 3.3 Use Case Diagram

3.4.2 Activity Diagram

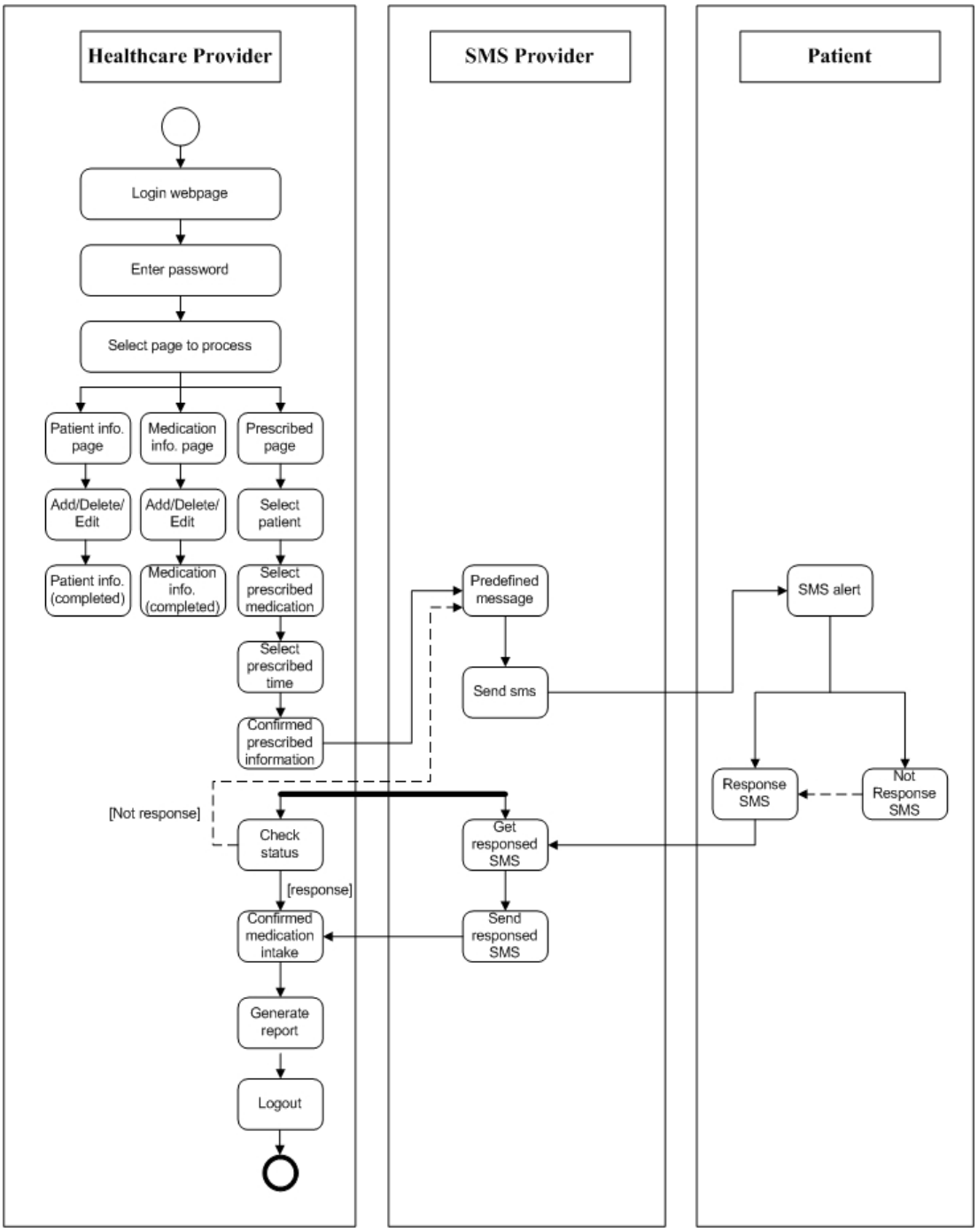


Figure 3.4 Activity Diagram

3.4.3 Database Design

The database is creating with MySQL database. The tables are as the following:

1) User table is the table that collects the information about username and password of system administrator or healthcare provider to identify the person who login the system and set the reminder message for the patient.

2) Patient table is the table that collects Patient's demographic data such as name, surname, age, sex, hospital number, mobile phone number, etc. for patient who receiving the reminder message.

3) Medication table is the table that collects medication data such as medication name, medication number, price, etc. for the prescribed medication.

4) Schedule_Med table is the table that collects the data of prescribed medicines for each patient. The data are included patient number, medication number, date that patient will initiate to take the medicine and date that patient discontinue taking medicine and the confirmation status to initiate the reminder message.

5) Schedule_Time table is the table that collect the data of the prescribe time, prescribed dosed of medicine for each patient and date and time that the reminder message will send to patient.

6) SMS table is the table that collect the data of reminder message that send to each patient and response status from the patient. Date and time of the response is also collected. If the patient didn't response back to system, the second reminder will generate as a confirm message and send to patient again.

Primary keys were defined and the relationships between each table had set up. Normalization rules were applied to clarify that the table are structure correctly. The details of each table are as appendix E.

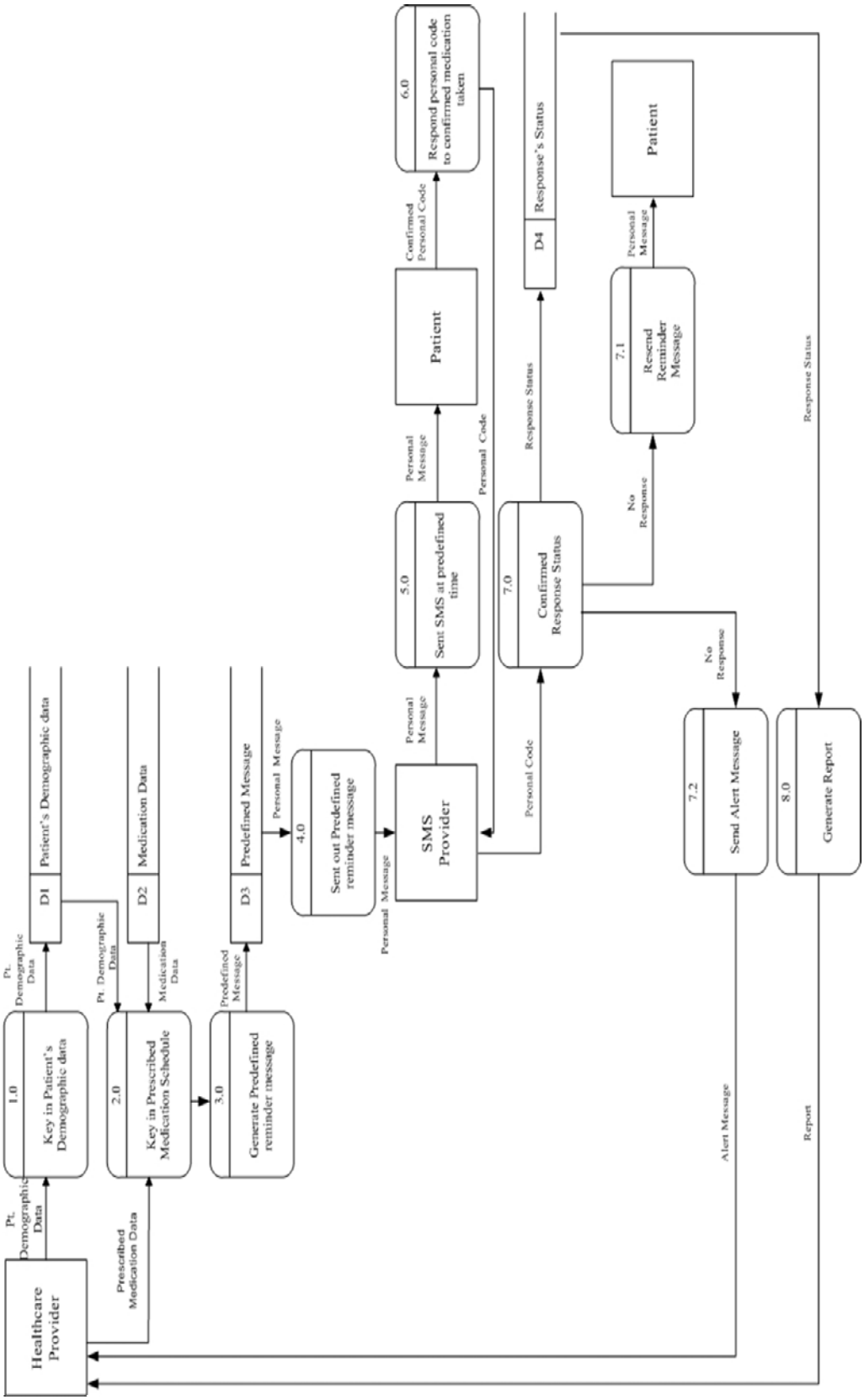


Figure 3.5 Data Flow Diagram

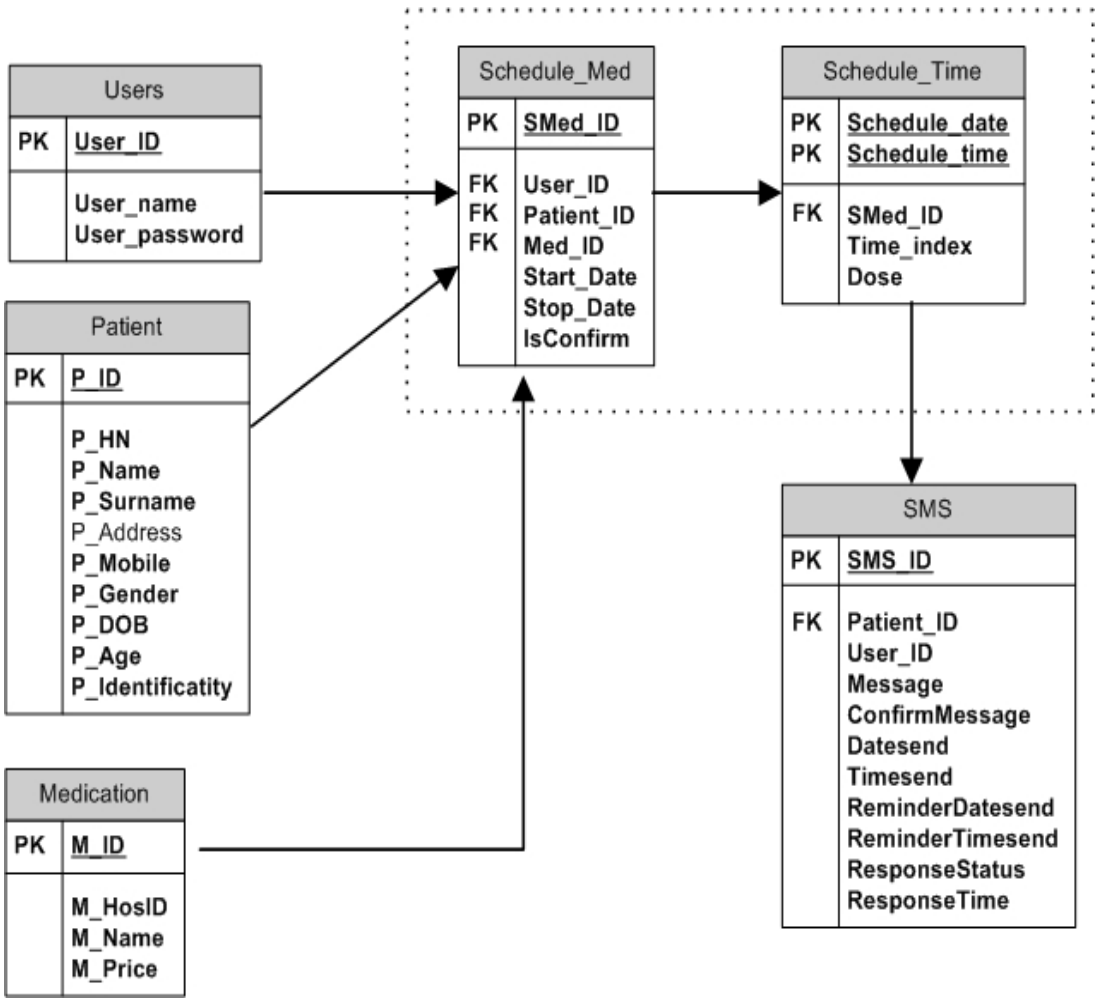


Figure 3.6 Entity-Relationship Diagram

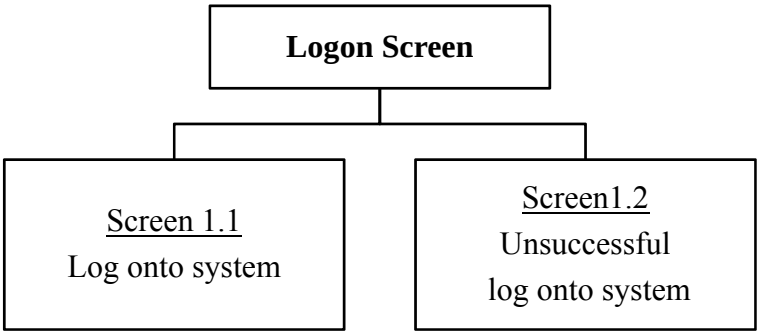
3.4.4 User Interface design

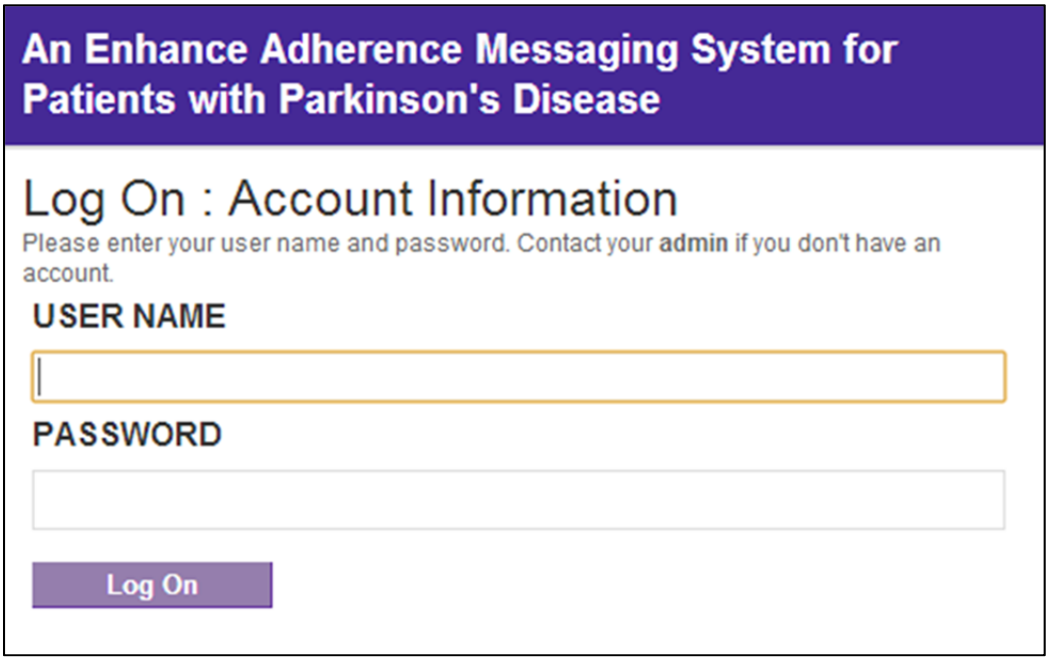
The screen will be composed of

1) Logon screen

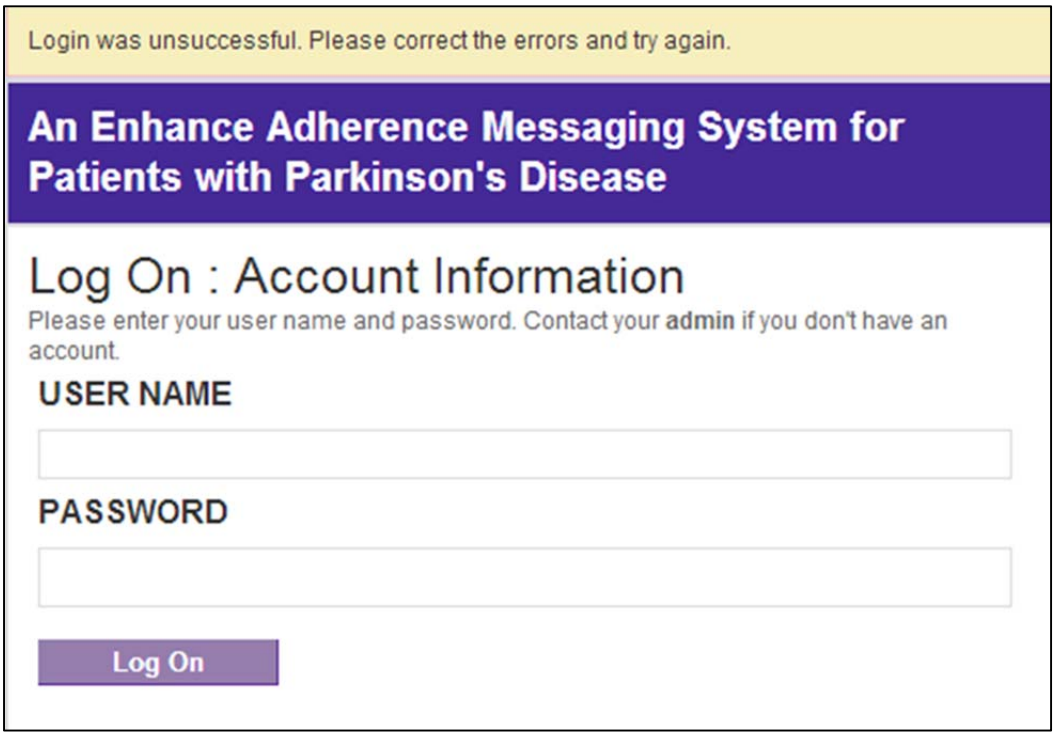
A User first access the system to manage the patient demographic data, medication information and prescribed medication by enter the website. The design is simple with the security function that only authorized users could set up patients and medications information.

To log onto the system, the user need to enter their username and password that provided from system administrator. If user enters incorrect username and password the warning note will show "Login was unsuccessful. Please correct the errors and try again." If user forgot their username or password, they need to contact their system administrator to set up new username and password.





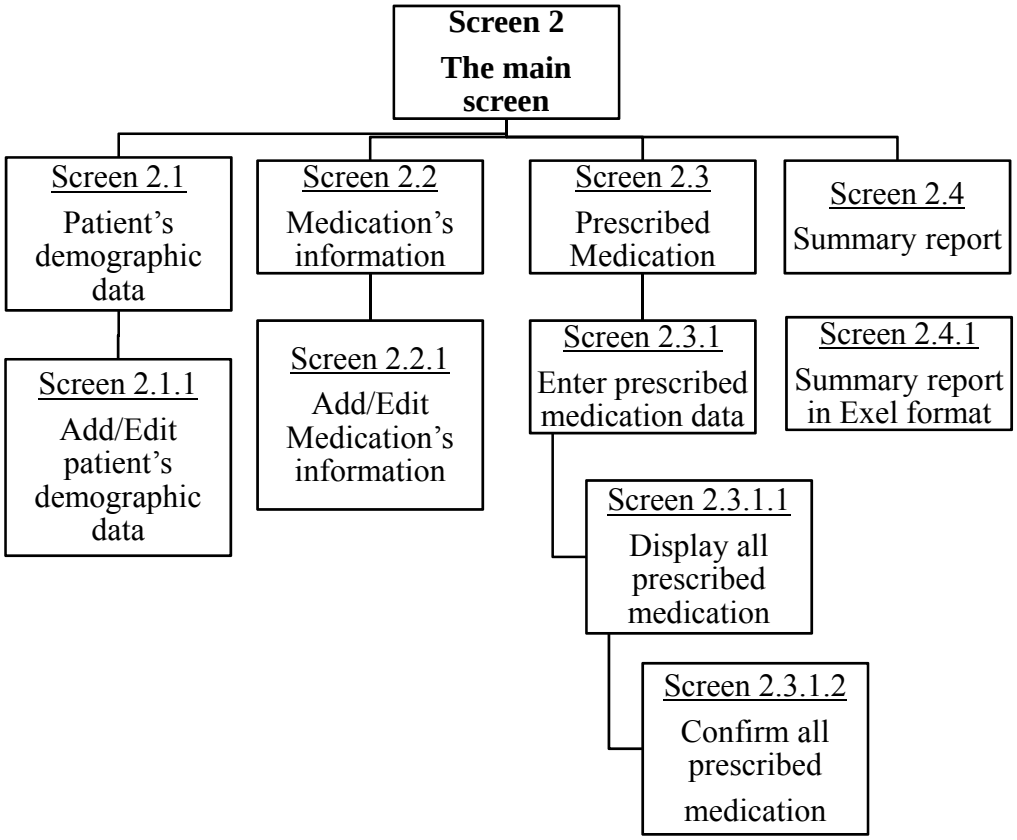
Screen1.1 The screen where user log onto the system

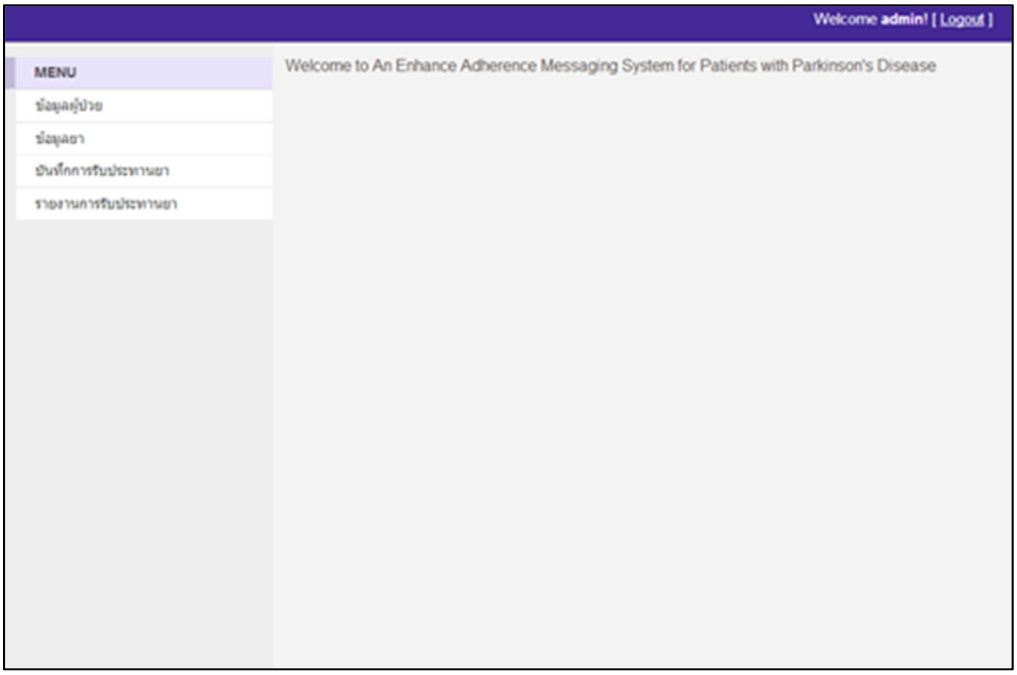


Screen 1.2 The screen where user unsuccessful log onto the system

2) The Main screen

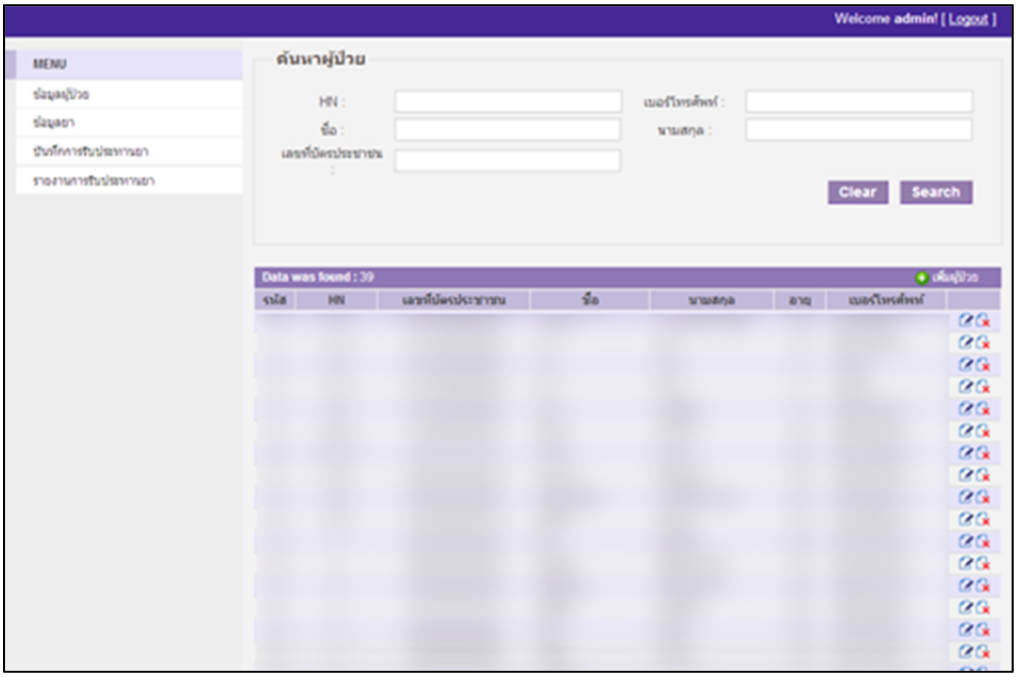
After successful Log on, the link bring up the new page with a menu options. The menus are composed of Patient's demographic data, medication information, prescribed medication and summary report of SMS response. The screen displays the welcome message to the system and states the name of authorized user, in this example is admin. The logout button is providing at the upright corner of the webpage.





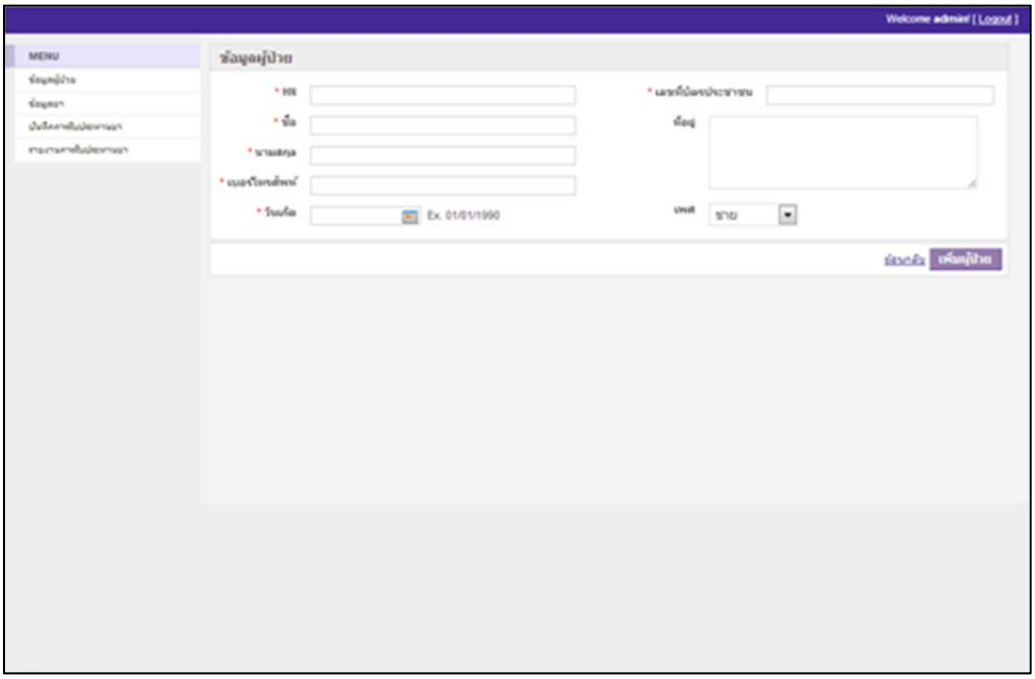
Screen 2 The main screen after the user logon to the system

After clicking Patient demographic data menu, the link bring up new page with provide field to search patient's record. The screen will display every patient's record in a row. Data is able to edit or delete by the user.



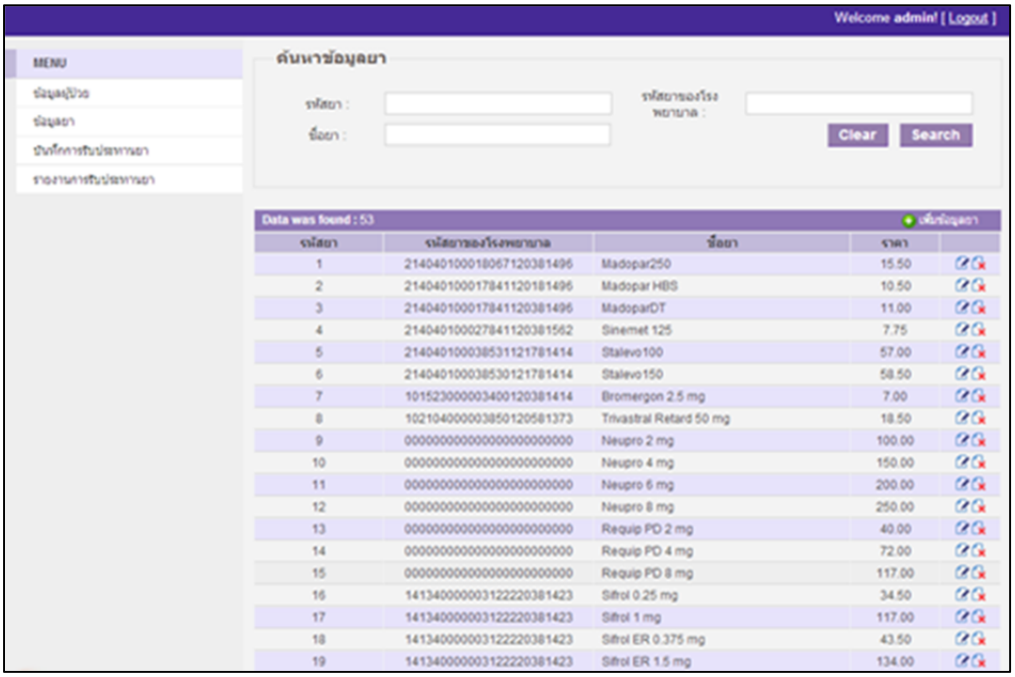
Screen 2.1 Screen for Patient's demographic data

To enter the new patient to the system, the user has to click “add patient” button and enter patient’s information. The provide field to enter the patient information such as hospital number(HN.), name –surname, identification number , date of birth, sex, address and phone number . This screen also use to edit the patient’s data.



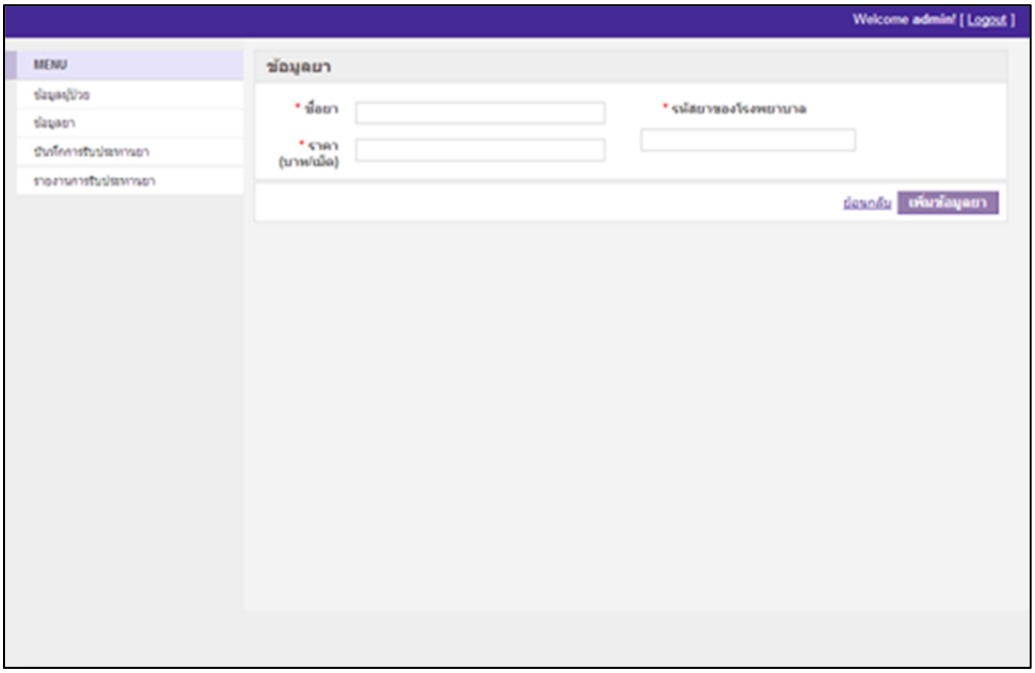
Screen 2.1.1 Screen for add or edit patient’s demographic data

After clicking medication information menu, the link bring up the new page with provide field to search the medication’s record. The screen will display all medication’s record in a row. Data is able to edit or delete by the user.



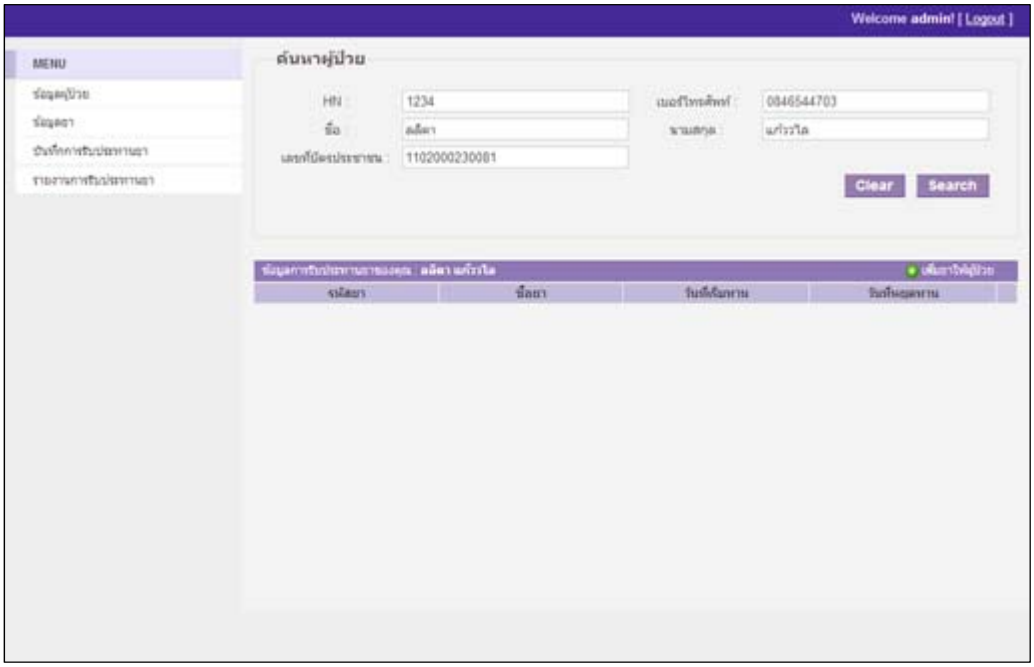
Screen 2.2 Screen for Medication's information

To enter the new medication to the system, the user has to click "add medication" button and enter medication's information. The provide field to enter the medication information such as medication trade name, medication code and price



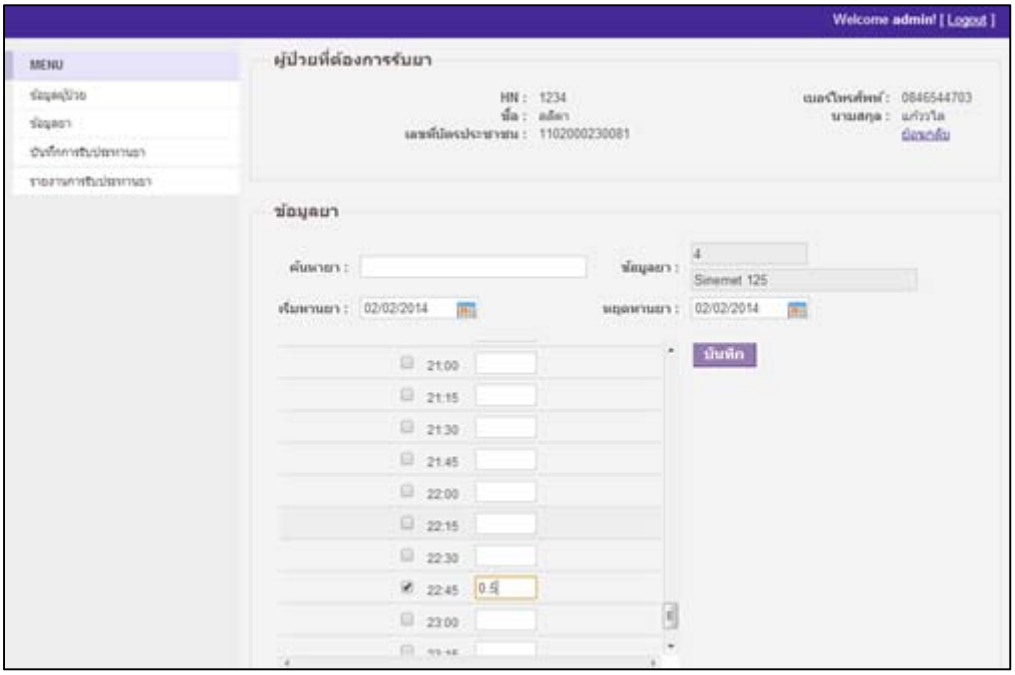
Screen 2.2.1 Screen for add/edit medication's information

After clicking prescribed medication menu, the link bring up the new page with search field, to search patient that user would like to set the SMS reminders as physician's order. User need to click "add prescribed medication" button to set SMS reminders



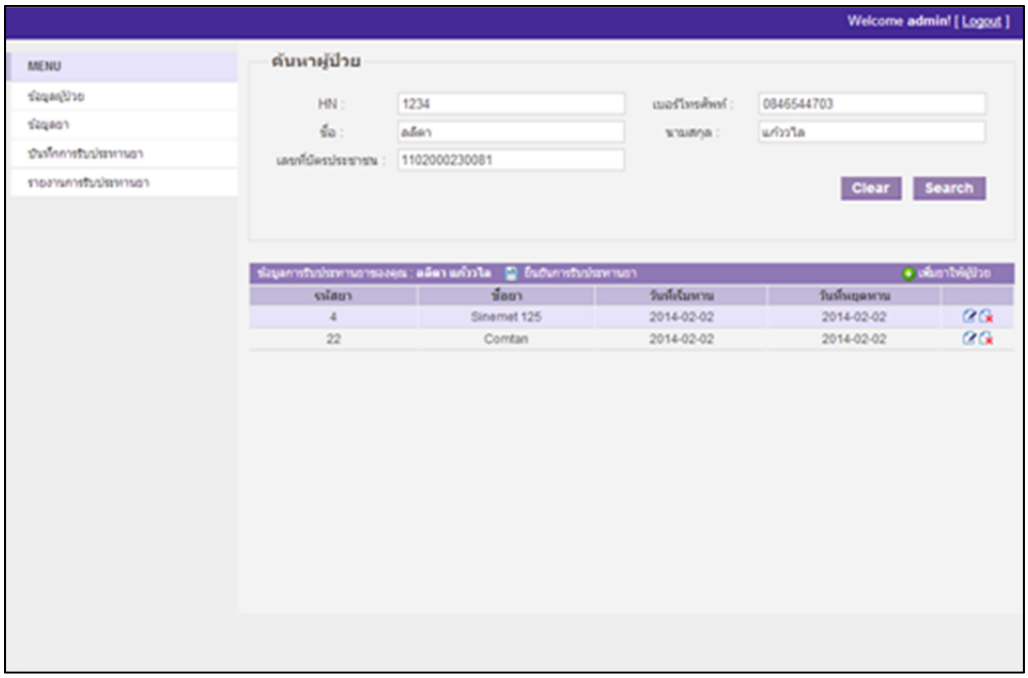
Screen2.3 The screen where user has to select patient for prescribed medication

After click "add prescribed medication" button, user need to enter medication name, start date and stop date in the field. Then select time of medication and enter the dose as physician prescribed then press "save" button to record each medication. The time of medication is designed in check box because each patient has different time of medication taking and the physician always adjust the time of medication depend on patient's symptoms. If user would like to add other medication, user has to press "add prescribed medication" button and repeat the step until the last prescribed medication.



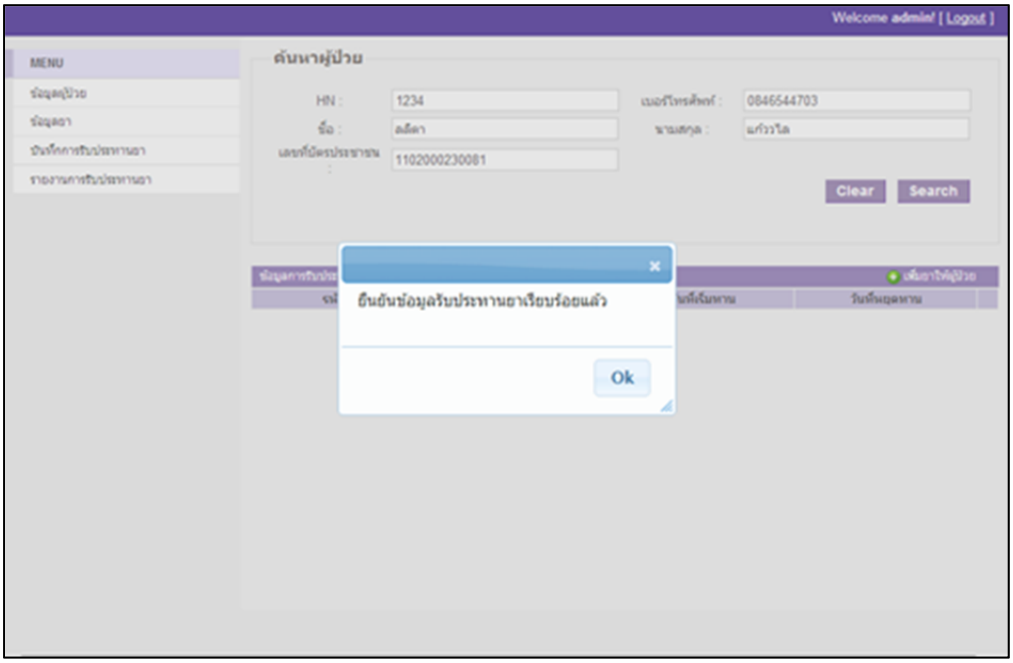
Screen 2.3.1 The screen where user able to enter prescribed medication

The summary of all prescribed medication are include medication code, medication name, date of first and last medication intake. All records are able to edit or delete.



Screen 2.3.1.1 The summary screen to confirm the prescribed medication

After user recheck that all information is correct. Use need to press “confirm prescribed medication” button and the box will show the message “Confirmed prescribe medication” as figure below



Screen 2.3.1.2 The screen displayed message when user confirmed all prescribed medication

After user confirmed all prescribed medication the application will generate the reminders and send to SMS vendor to manage with the SMS sending process. After the process is complete, the confirmed message will display.

Database of the system is connected with the SMS provider database via providing API. The generated SMS will be sent to patient at the prescribed time, the server was set job schedule on Window Task Scheduler to repeat task every 1 minute to check the respond status from the patient. The SMS provider will confirm that patient respond to the system or not by confirm SMSID, date and time of response to database. If the response status show “1” in the database mean the patient is response back to the system. If the response status show “0” in the database mean the patient didn’t response to the system and the second SMS will be send to reminder the patient again after 15 minutes from the first reminder (Figure 3.7).

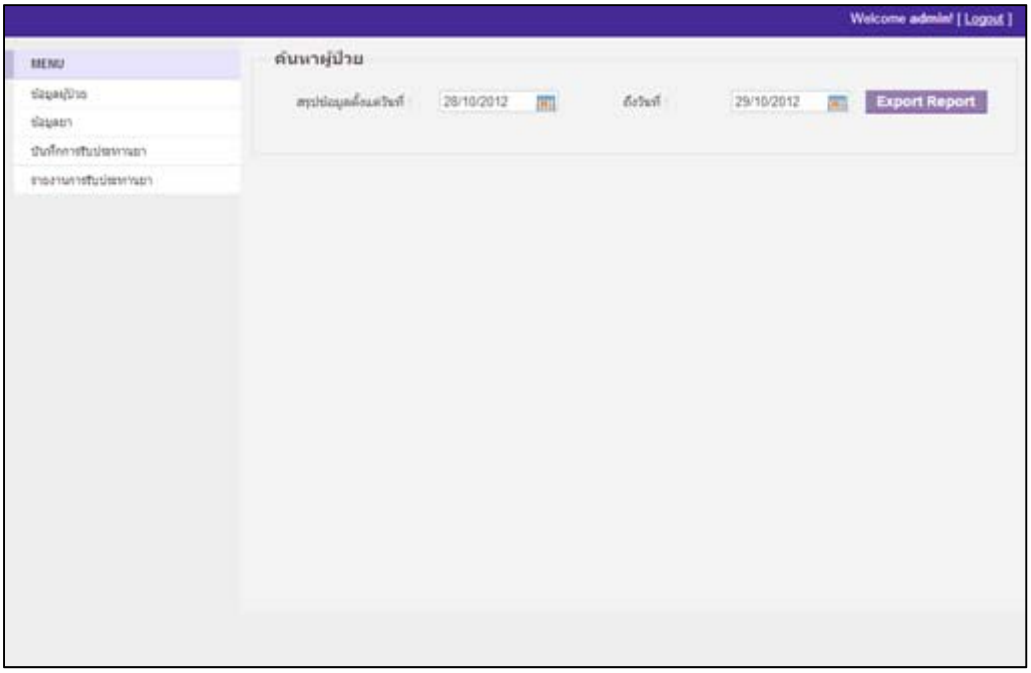
After the second reminder (Figure 3.8) is sent to the patient, the SMS provider will confirm that patient respond to the system or not by confirm SMSID, date and time of response to database. If there is no response, the third reminder (Figure 3.9) will be sending to healthcare provider.

Figure 3.7 The first medication reminder text message

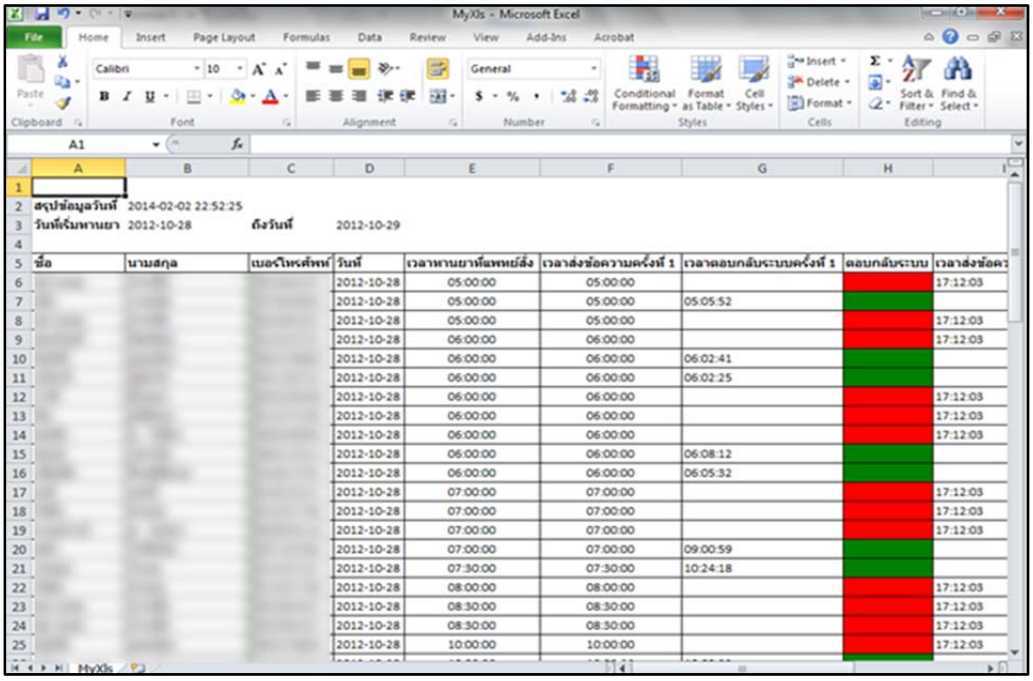
Figure 3.8 The second medication reminder text message

Figure 3.9 The third reminder text message

User able to generate the SMS response report by selects the report menu. Start date and stop date of the reminder have to define by user. After user press "Export report" button, the system will export information in excel format.



Screen 2.4 The screen where user can generate the SMS response report



Screen 2.4.1 The summary report of SMS response in excel format

The report represent information included patient's name and response status. The response statuses are show in color symbol. The green color box means patient was response back to system and red color box means patient wasn't response back to system and second SMS was generated. The prescribed time, date and time that SMS was send and date and time that SMS was responded back to system were report both in first reminder and second reminder.

CHAPTER IV
RESULTS

The chapter presented the results of the model development of a two-way communication medication reminder system to enhance adherence of patient with Parkinson's disease. The results compared outcomes related to examine feasibility, utility and medication adherence score before and after implemented the system.

4.1 Data collection time frame

This study was quasi experimental design study in patient with Parkinson's disease at Parkinson's disease and Movement Disorders Outpatient Clinic, Chulalongkorn Memorial Hospital. The main objective of this study is to develop a two-way communication medication reminder system to enhance adherence of patient with Parkinson's disease. All data were obtained by close-ended and open-ended questionnaire which developed to gathering information and attitude towards medication reminder system from healthcare providers and patients from 15 August 2012 to 15 November 2012. Twenty-seven subjects met the criteria and were enrolled to the study. Twenty-two individuals completed the study process with 18% of attrition rate.

4.2 Baseline characteristics

Patients were approached by physicians and nurses to assess their interest to participate in the study. All participants were informed about the study and voluntary to join in the study.

Table 4.1 Patient characteristic of subjects in this study

Patient characteristics	
Male/Female (N, %)	12(54.5%)/10(45.5%)
Age (mean ± SD)	59.23±9.29
Age at diagnosis (mean±SD)	51.19 ±10.52
Duration of disease (mean ± SD)	7.81 ± 6.73
Hoehn and Yahr staging(mean ±SD)	2.36 ± 0.74
Motor complication (%)	77.3
Wearing off(%)	58.8
Dyskinesia(%)	5.9
Wearing off and dyskinesia(%)	35.3
Number of medication per day (mean ± SD)	3.55±1.63
Number of medication administration per day(mean ± SD)	3.68±1.21
Number of tablet per day (mean ± SD)	9.05±5.73
Number of the most administration tablet (mean + SD)	3.15±1.50

4.3 Healthcare Provider's attitude toward medication reminder system

At Parkinson's disease and movement disorders clinic, Chulalongkorn Memorial Hospital both physician and nurse are concern that patients need to take the medication correctly to control their symptoms. At the clinic, they provided parkinson's disease handbook for patient to provide knowledge about medication and self-care for patient. Every time that patient visit to the clinic, they need to bring this handbook with them and the nurse will write down and explain how to take medication by introduce name , characteristic of the medicine , dose and time of medication taking to patient. Sometime nurse may ask patient to repeat what she had explain and let's patients ask questions to reassure the understanding of the patients. The important reason that patient did not take medication as prescribed is come from misunderstanding about Parkinson's disease symptoms, motor complication e.g. wearing off and dyskinesia and side effects, sometimes patient the might adjust the dose by themselves without consulting with the physician. So healthcare provider always give a suggestion that if patient has any problem with medication taking, they can make a phone call via hotline to consult with the healthcare provider or patient can come to the clinic before the appointment date. The healthcare providers have positive

attitude toward the medication reminder system because the system help to remind the patients to take medication on time with correct medication and dosage.

After running the system, the nurse faced the problem that she could not able to make a phone call every times that the SMS alert to call back to the patient because she is busy doing others things so she might call back later than 30 minutes from prescribed time. She had mentioned that some patient is unable to reply the SMS correctly so when she call back, the patient said he took the medicine and reply the SMS already then she need to identify the cause of error and explain the replying methods to patient by phone which is quite difficult in patient whom is not familiar with the SMS function. One of the nurse said that it would be more useful if the SMS is able to show the symbol or medication photo because some patient didn't know the name of the medication. Physician and nurses had mentioned that this system was useful and able to adapt to use as a model in patient care such as sending the patient's activities schedule in each week to the patients to promote and encourage the patient to join the activities, sending a reminder appointment date in next visit to patient or sending a tip of self-care in Parkinson's disease.

4.4 Patient's attitude toward medication reminder system

From the questionnaire to assess the patient's medication taking behavior found that most of patients (90.9%) prepared the medication by themselves and 72.7% of patients prepared the medicine in a pillbox for 1-7 day supply. 54.5% of patients feel bored with medication taking and 77.3% of patients said that they forgot to take medicine during last month. The main reasons provided for not taking the medication were that patients were busy doing others things (59.1%). Most of patient (86.4%) said that when they forgot to take medicine, they take the medicine as soon as they remember. Most of patients have their own method to reminder themselves for the time of medication taking such as prepared the medicine in the pillbox, set the alarm clock, caregiver reminded of medication time. All patients have positive attitude toward medication reminder system.

The post study questionnaire was used to interview the patient to evaluate the system function in 4 aspects including message, time, response to system and

satisfaction. In the message aspect, all patients said that the content is suitable and easy to understand. The detail of medication treatment for each patient is correct as prescribed. Three patients found that the SMS is unable to read properly. One of them reported that the monitor show the text message is loaded. One patient found that the SMS text is error for one time. And one patient said that the content of SMS is separated in two SMS according the limitation of the alphabet. In the time aspect, all patients reported that the SMS is send to them at the prescribed time. In the response to system aspect, all patients reported that there is a second reminder sends to them if they are not response back to the system. Five patients reported that the nurses didn't call back to remind the time of medication taking every time that they are not reply back to the system. Seven patients in this study will not receive the phone call from nurse for the third reminder because five of them are unable to type the SMS back to the system and two of them are unable to send back to the system according to the sender number is 999. Eight subjects reported that even they reply back to the system but the second reminders were sent to patients. This problem might occur in case of the patient reply to the system incorrectly such as typo error of the medication code, space button is not press. All patient reported that they never reply the SMS without read the reminder SMS. 50% of patient reported that they face the problem with the replying message. This problem may come from unfamiliar with the SMS function, the monitor show the text message is loaded and the sender number is 999. 77.2% of patients were satisfied with the system in good level. If there is an implement of the system in the future, most patients are willing to pay 30-50 Baht/month for the service fees.

Most patients have positive feedback to the system. They mentioned this system is nice. They feel happy that they have another person caring of them and remind them to take the medicine on time. However, some patients feel that it is some burden for them to reply back to the system. They would prefer to get the reminder SMS only without reply back to the system. The cost of replying back to the system is one of the considerations for the patient. They feel that it is too expensive to pay 3 baht/SMS to reply back to system. If they take medicine many times/day, they have to pay a lot of money per day. Two patients reported that they feel bored to reply the SMS every time. Two patients reported that they used to reply back to the system

without taking the medication. The reminder SMS were sent in pre-defined time and the patient knowing that they need to take the medicines but they still doing some activities and forget to take the medicines.

Table 4.2 Evaluation of the system

Evaluation of the system	Yes (N)	No (N)
Message Aspect		
1.The content of the SMS is easy to understand	22	0
2.The detail of medication treatment for is patient is correct as prescribed	22	0
3. Have you ever found the problem with unable to read SMS	3	19
Time Aspect		
4. The reminder SMS sent at the prescribed time	22	0
Response to the system		
5. If you didn't response back to the system, the system sent the second reminder to you	22	0
6. If you didn't response back to the system in the second reminder, the healthcare provider called you to remind the time of medication	12	10
7. Have you ever found that the second reminder was sent to you even you responded back to the system. (*Exclude five patient, who unable to type the SMS back to system)	8	9
8. Have you ever response back to the system without read the SMS	0	22
9. Have you ever face the problem in response back to the system	11	11

4.5 Usage of the system

Twenty seven subjects were enrolled to the study. Five subjects were drop out from the study because their cellphones are unable to get the reminder SMS from the system. The patients report that their phone number were blocked from advertise SMS such as horoscope SMS, news SMS which their mobile phone service providers will detect the sender number as Spasm SMS. The patients were ask to contact the mobile phone service providers to unblocked the system, however their feel discomfort to contact with the call center and would not like to participate in the study. Twenty two subjects were complete the study process. Most of them have trouble in replying SMS in the first few days after that they are familiar with the system and can reply to the system easily. Seven out of Twenty two patients were unable to reply to the system. Two of them reported that the sender no. is show as 999 so they were unable to reply back to the system. One of them reported that the SMS is unable to read, the monitor show the text message is loaded. He couldn't get the SMS code to reply back to the system. Five of them report that they don't know how to reply the SMS back to the system even the author was explained and demonstrated to the patients. However this group of patient would like to participate in the study and receive the reminder SMS so the system was set up to send the reminder SMS to them and the patients need to check in the medication diary to monitor the medication taken.

4.6 Medication adherence

The author use 8-Items Morisky Medication Adherence Scale (MMAS) to evaluate the medication adherence in the patient. Adherence level was classified by MMAS score. Low adherence to medication treatment, MMAS score is less than 6
Moderate adherence to medication treatment, MMAS score is between 6 to 7.
High adherence to medication treatment, MMAS score is equal to 8.

Pre-Study assessment

The author use 8-Items Morisky Medication Adherence Scale (MMAS) to evaluate the medication adherence in the patient. 77.3% of patients has low adherence in medication treatment (MMAS score less than 6). Mean score of MMAS is 4.50 ± 1.47.

Table 4.3 Level of medication adherence (Pre-Study)

MMAS Score	Number of patient	Percentage
Low adherence to medication treatment (MMAS score less than 6)	17	77.3%
Moderate adherence to medication treatment (MMAS score between 6 to 7)	5	22.7%
High adherence to medication treatment MMAS score equal to 8	0	0%
Mean $\pm$SD = 4.50 $\pm$ 1.47		

All patients said that sometime they didn't take medication on time or forgot to take medication. 54.5% of patients didn't fully meet the prescribed medicine and felt distressed for strictly following medication treatment and 40.9% of patients used to adjust the dosed of the medication or discontinued the treatment without consulting with the physicians. 31.8% of patients forgot to take their medication during travel or leave home.

Post-Study assessment

8-Items Morisky Medication Adherence Scale (MMAS) were used to evaluate the medication adherence in the patient after implement the system. 54.6% of patients have moderate adherence to medication treatment. (MMAS score between 6 to 7) and 36.4% of patient have high adherence to medication treatment. Mean score of MMAS is 6.95 $\pm$ 1.09.

Table 4.4 Level of medication adherence (Post-Study)

MMAS Score	Number of patient	Percentage
Low adherence to medication treatment (MMAS score less than 6)	2	9.0%
Moderate adherence to medication treatment (MMAS score between 6 to 7)	12	54.6%
High adherence to medication treatment MMAS score equal to 8	8	36.4%
Mean $\pm$SD = 6.95 + 1.09		

Paired samples Test method was apply to analyze the Total MMAS score before and after implemented the system. The result shows that Total MMAS score is increase significantly difference. (t_{21}= 11.390, $p<0.01$)

The comparison of patient's medication adherence between pre study and post study in each item are as Table 4.5

Table 4.5 Comparison of patient's medication adherence score between pre study and post study in each item

	Pre study-Yes		Pre study-No		P-Value
	Post study-Yes	Post study-No	Post study-Yes	Post study-No	
1. Forgot taking medication. (Missed time/Missed dose)	5	17	0	0	<0.01
2. Did not take medication in the last two weeks.	0	7	0	15	0.005
3. Stop taking medication or decrease the dose without warning doctor.	1	8	0	13	0.008
4. Forgot to take medication when travel or leave the house.	4	3	1	14	0.625
5. Take medication yesterday.	12	0	8	2	0.008
6. Stop taking medication when symptoms are controlled.	0	5	0	17	0.021
7. Felt distressed for strictly following treatment.	8	4	1	9	0.375
8. Difficulty to remember taking medication.	1	4	0	17	0.125

From this study, we found that a two-way communication medication reminder system is increase adherence of patient with Parkinson's disease. This system is one of the adherence tools which is effectively remind the patient to take the medication on time. However, the understanding about disease, treatment, attitude toward medication treatment and adherence should be mentioned regularly to patient to increase the awareness of medication taking behavior. The treatment plan should be discuss in the collaboration between healthcare provider team, patient, caregiver and family to find out the method to decrease non adherence to medication treatment to get the best treatment outcome and increase quality of life of patient.

CHAPTER V
DISCUSSION AND CONCLUSIONS

The chapter presented benefit and limitation of An Enhance Adherence Messaging System after implemented in patient with Parkinson's disease. The recommendation for system developers, healthcare providers and patients are provided for further development of adherence tools.

5.1 Discussion

This study is based on the An Enhance Adherence Messaging System. This system send the specific medication reminder SMS for each patient at predefined time schedule to patient's mobile phone. Personal code in each SMS was used as a code to respond each time when they took the medication. The second reminder, or the researcher made a telephone call, was done when the system could not get the response within 15 minutes. This reminder system is aimed at patients with suboptimal levels of adherence who could benefit most from reminder system for improving adherence. However, the identification of this group of patients appears to be difficult because text messaging is less frequently used by older age groups and an expense incurred is a barrier to lower income groups. However, it has been proved that selection criteria have selected a group of patients for whom a text messaging reminder system can be beneficial.

There are several technical lessons from this study to concern for the future development of more effective reminder methods to increase adherence. The idea that mobile phone is an "anywhere, anytime" device was supported by this study. However, some patients participated in this study didn't have their mobile phone with them everywhere and every time so the reminder SMS might be ignored. The mobile phone signal might be extremely weak, network busy or the sender number might be

blocked from network service provider so the patient might get delayed reminder SMS or lost reminder SMS.

The text message technology itself also has several limitations. The length limitation of Thai language is 70 alphabets, constraining the information that can be transmitted. Some patients whom taken many kinds of medication per time were got at least 2 reminder messages to complete all prescribed medications. The content of reminder messages might be separated and caused confusing for the patients.

Entering a text messaging on a phone can be somewhat cumbersome, the code to respond back to system should be simplified to decrease the typo error in reply the text message back to the system. A response code as press11+ space + personal code which used in this study are unfriendly with patients. Some patients didn't able to put the space button between 11 and personal code so when they reply back to the system, the data is missing. A message could be formatted appropriately and send via SMS to serve. Long and difficult code caused error message which resulting in unconfirmed medication taken.

The use of SMS by patients is lower than expected; it is possible that this was due to ages of the subjects recruited. Most patients who have been using SMS are the people ages between 35-60 years old. An elderly person is not familiar with SMS function and mobile phone technology.

The motor symptoms such as tremor, stiffness and bradykinesia of patient with Parkinson's disease are one of the concerning issue that the symptoms might affect the ability of typing the text message. However, the patients are able to type the text message back to the system.

The strengths of An Enhance Adherence Messaging System include a two way communication which the system immediate capturing and upload of response data onto a server for viewing and a personal code which help to confirmed that text message were opened and read by patients.

A limitation of text messaging reminder system is that it cannot be confirmed that the medication is actually taken or that no more or no less than the prescribed dose is taken. Some patients reply back to the system and continuing doing other activities so they forgot the take the medication.

In addition, patients don't have direct access to the system, they cannot log onto the system to define time for remind medication use by themselves. Some patients are preferred to adjust the reminder time by themselves and some patient would like to get only one reminder without any respond back to system. Furthermore, there is no automating calling back system to confirm medication taken when the system could not get the response from patient and staff couldn't reach the patient immediately after the system alert due to staff insufficiency.

However, the feedback from the usability and satisfaction portion of the survey was positive and the adherence score were increase significantly from baseline score. It is possible that most participants did utilize the text message service as intended.

5.2 Conclusions

This study illustrates that the use of text message is effective as a reminder tool in patients with Parkinson's disease. The recent technology of mobile phones is a pathway for patient-healthcare providers communication. The implications of the possible impact of this intervention on clinical outcomes in this patient population should be confirmed by a randomized controlled trial. Further research is also needed to explore the possibility of incorporating text message into various chronic diseases patients for disease management and support patients in their medication use and improve their adherence. The integration of text messaging reminder system must begin to utilize this technology into other health informatics systems to facilitate delivery of education and healthcare. The detailed cost-effectiveness of text messaging reminder system should be assessed.

5.3 Recommendations for system developer

This study demonstrated that participatory design methods can help to develop a reminder system with functionality and usability. Close collaboration

between the developer and healthcare provider throughout the cycle of design and evaluation resulted in an acceptable prototype which was easily implemented in routine practice.

Mobile phones are widely used for communications so there is less of a technology barrier. However, text messaging is less frequently used by older age groups so would perhaps not be as suitable for these groups at the moment, although this may change in future. Expenses incurred could prove a barrier to lower income groups when sending messages, but should not impact upon receipt of a message. The application for smartphone should be consider developing in the future to reduce cost of the reminder service once the older age groups are familiar with the technologies and have access to smartphone.

Line application is one application for instant messaging on smartphones and PCs to exchange text messages, graphics, video and audio media, make free calls, and hold free audio or video conferences. It could be useful if the reminder message can sent via this application which can reduce the barrier for the sending message cost. However, the problem with internet connection ability need to considered.

There are many potential for feature development to improve communication between patients and physicians. The examples are as the following:

1) Reminders Service; The medication reminder help ensure that the medication is taken however, it could be add a symbol or photo of each medication for more understanding because some of patients can't remember the name of the medicine or can't read the medicine's name but they can tell about the characteristics of the medicine. Using text messaging also helps ensure that the appointment is more likely to attend.

2) Wellness and Motivation; Text messaging can be used as an adjunct to conventional care for delivering patient education. Delivering education through text messaging may help patients to learn more about their disease and self-care behavior.

The reminder SMS could be add a self-care tip for patient such as exercise, nutrition etc. to promote healthy behavior for patients. The self-care tip is one of method to give patient recognition and encourage the patients.

3) Test Results; Routine test results that require no further advice or context from healthcare providers could be sent directly to patient's mobile phone.

4) Network; Text messaging can maintain a network to motivate people to maintain wellness. Text messaging can use as a tool for polling or voting on any change on the service.

In addition, those text messaging services should allow people to subscribe to receive information specifically relevant to them without any further effort on their part as can be sent or calling back to patient automatically until they request to unsubscribe.

5.4 Recommendations for healthcare provider

In the treatment of patients with Parkinson's disease, it is essential to understanding the therapeutic response and consequent management decision from their medication taking behavior**.** Achieving to adherence to medication treatment is very challenging to patients, because their regimens have complex dosing schedules and may cause food interactions and side effects that result in poor adherence.

Strategies for improving adherence, healthcare providers should have a awareness of the possibility of poor adherence when a patient's condition is not responding to therapy. Methods that can be used to improve adherence such as, patient education, improved dosing schedules; and improved communication between healthcare providers and patients. Educational interventions involving patients, their family members, or both can be effective in improving adherence. Strategies to improve dosing schedules include simplifying the regimen to daily dosing and cues to remind patients to take medications. Those methods can use in combination to increase adherence to medication treatment. Enhancing communication between healthcare providers and the patient is a key and effective strategy in boosting the patient's ability to follow a medication regimen.

Healthcare providers should confirm that the patients and caregiver understand about their disease, treatment and the importance of medication adherence to increase the awareness of medication taking behavior. Healthcare providers need to prepare for potential side effect and reassure the patients that side effect can be managed and coped correctly by the physicians. The patient should not discontinue the treatment or adjusted the doses of medication by themselves. To increase adherence

in patient should emphasize on the attitude of patient toward medication treatment in the collaboration between healthcare provider team, patient, caregiver and family to find out the method to decrease non adherence to medication treatment to get the best treatment outcome and increase quality of life of patient.

5.5 Recommendations for patient

Consistent control of Parkinson's symptom requires adherence to medication treatment. Patients are ultimately responsible for taking their medications. The patient must actively participate in the selection and adjustment of drug treatment and in changes in lifestyle in order to maximize the usefulness of the therapeutic
When inadequate adherence to medication has been identified, the available strategies for improving adherence should be considered.

Numerous devices and strategies have been developed to help patients keep track of their medications that help patients organize medication and/or remind when to take medication with visual and sounding alarms. The strategies included; use of pillboxes to organize daily doses, alarm clocks, diaries, calendars, stickers, reminders call and text SMS. It always helps to have a caregiver present who can ensure that someone is taking his prescriptions on time and on dose.

Patients need to become more actively involved with their treatment but doesn't deciding things based on erroneous beliefs or limited information. The proper communication of patient and healthcare providers for therapeutic strategies should be confirmed.

Text message for medication reminder services for patients with Parkinson's disease has already been running as a pilot study with success. Although this system created specifically for Parkinson's disease medication management, the concept could be apply in others chronic disease such as diabetes, hypertension or any conditions that need long term medications which the reminders would be useful. It is very likely that we will see further work around expanding the use of text messaging in larger scale versions of existing ideas and in further piloting of increasingly innovative and engaging applications.

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APPENDICES

APPENDIX A
PRE-STUDY QUESTIONNAIRE

แบบสัมภาษณ์สำหรับผู้ป่วยพาร์กินสัน (ก่อนการใช้ระบบ)

ชื่อโครงการวิจัย การพัฒนาระบบการส่งข้อความเตือนเพื่อเพิ่มความสม่ำเสมอในการรับประทานยาสำหรับผู้ป่วยโรคพาร์กินสัน

วันเดือนปี ที่สัมภาษณ์ .....

บทสัมภาษณ์ของงานวิจัย

1. โดยปกติแล้ว ใครเป็นผู้จัดยาให้ท่าน
   ☐ ผู้ป่วยจัดยารับประทานเอง ☐ ผู้ป่วยและผู้ดูแลร่วมกันจัดยารับประทาน ☐ผู้ดูแลจัดยาให้รับประทาน
2. ท่านได้จัดยาพาร์กินสันเพื่อรับประทานล่วงหน้าหรือไม่
   ☐ ไม่ได้จัดยาไว้ล่วงหน้า ☐ จัดยาไว้ล่วงหน้า ..... วัน, วันละ .....มื้อ
3. ท่านมีความรู้สึกเบื่อกับการรับประทานยาครั้งละหลายๆเม็ดหรือไม่
   ☐ ใช่ ☐ ไม่ใช่
4. ในช่วง 1 เดือนที่ผ่านมา ท่านเคยลืมรับประทานยาตามที่แพทย์สั่งหรือไม่
   ☐ เคย (ลืมทานยา.....ครั้งใน 1 เดือน) ☐ไม่เคย
5. อะไรเป็นสาเหตุที่ทำให้ท่านลืมรับประทานยา
   ☐ การเดินทางไปนอกบ้าน ☐ การทำกิจกรรมช่วงเวลายา ☐ นอนหลับ ☐ อื่นๆ .....
6. เมื่อท่านลืมรับประทานยา ท่านทำอย่างไรเมื่อท่านนึกขึ้นได้
   ☐ รับประทานทันทีที่นึกขึ้นได้ ☐ รอมื้อต่อไป
7. ท่านและผู้ดูแลมีวิธิการอย่างไรที่จะไม่ลืมรับประทานยา
   .....
8. หากมีระบบเตือนการรับประทานยาโดยการส่งข้อความทางโทรศัพท์มือถือ เพื่อเตือนเวลารับประทานยาของท่าน ท่านคิดว่าระบบนี้มีประโยชน์หรือไม่
   ☐ มี ☐ ไม่มี

แบบสัมภาษณ์สำหรับผู้ให้บริการทางการแพทย์ (ก่อนการใช้ระบบ)

ชื่อโครงการวิจัย การพัฒนาระบบการส่งข้อความเตือนเพื่อเพิ่มความสม่ำเสมอในการรับประทานยาสำหรับผู้ป่วยโรคพาร์กินสัน

วันเดือนปี ที่สัมภาษณ์ .....

ผู้ให้สัมภาษณ์ ☐แพทย์ ☐พยาบาล ☐ เภสัชกร

บทสัมภาษณ์ของงานวิจัย

1. ท่านมีวิธีการอย่างไรในการให้คำแนะนำผู้ป่วยในการรับประทานยาให้ถูกต้อง

   .....

   .....

2. ท่านคิดว่าอะไรคือสาเหตุสำคัญในการรับประทานยาที่ไม่ถูกต้องของผู้ป่วย

   .....

   .....

3. หากมีระบบเตือนการรับประทานยาโดยการส่งข้อความทางโทรศัพท์มือถือ เพื่อเตือนเวลารับประทานยาของผู้ป่วย ท่านคิดว่าระบบนี้มีประโยชน์หรือไม่ อย่างไร

   .....

   .....

4. ท่านคิดว่า ตัวอย่างข้อความที่ส่งไปเพื่อเตือนการรับประทานยาของผู้ป่วย ดังต่อไปนี้ เหมาะสมหรือไม่

   สวัสดีค่ะ คุณ เอ ขณะนี้ถึงเวลารับประทานยาแล้ว ยาของท่านได้แก่ 1. มาร์โดปา (125 มก.) จำนวน 1 เม็ด และ 2. ซิฟรอล (0.25 มก.) จำนวน ½ เม็ด (ข้อความการรับประทานยาสำหรับผู้เข้าร่วมโครงการวิจัยจะแตกต่างกันไป ขึ้นอยู่กับชนิดของยา ปริมาณยา และเวลาการรับประทานยาตามที่แพทย์สั่ง)

   ☐ เหมาะสม ☐ ไม่เหมาะสม

   หากไม่เหมาะสมควรปรับปรุงอย่างไร

   .....

   .....

5. หากข้อความเตือนการรับประทานยาได้ถูกส่งไปยังผู้ป่วย แต่ผู้ป่วยไม่ตอบกลับระบบ ระบบควรจะส่งข้อความเตือนไปยังผู้ใด เพื่อให้ท่านทราบว่า ผู้ป่วยไม่ได้รับประทานยาตามที่แพทย์สั่ง

   ☐แพทย์ ☐พยาบาล ☐ เภสัชกร

APPENDIX B
POST-STUDY QUESTIONNAIRE

แบบสัมภาษณ์สำหรับผู้ป่วยพาร์กินสัน (หลังการใช้ระบบ)

ชื่อโครงการวิจัย การพัฒนาระบบการส่งข้อความเตือนเพื่อเพิ่มความสม่ำเสมอในการรับประทานยาสำหรับผู้ป่วยโรคพาร์กินสัน

วันเดือนปี ที่สัมภาษณ์ .....

บทสัมภาษณ์ของงานวิจัย

ประเมินด้านข้อความ

1. เนื้อหาของข้อความอ่านแล้วเข้าใจง่ายหรือไม่ ☐ ใช่ ☐ ไม่ใช่
2. เนื้อหาของข้อความระบุข้อมูลการรับประทานยาของท่านได้ถูกต้องหรือไม่ ☐ ใช่ ☐ ไม่ใช่
3. ท่านประสบปัญหาว่าข้อความที่ได้รับ ไม่สามารถอ่านได้หรือไม่ ☐ ใช่ ☐ ไม่ใช่

ประเมินด้านเวลาในการส่ง

4. ข้อความเตือนการรับประทานยาได้เตือนเวลาการรับประทานยาตรงกับมื้อยาของท่านหรือไม่ ☐ ใช่ ☐ ไม่ใช่

ประเมินด้านการตอบกลับระบบ

5. หากท่านไม่ตอบกลับระบบเมื่อได้รับข้อความเตือนการรับประทานยา ระบบได้ส่งข้อความเตือนการรับประทานยา เป็นครั้งที่สองหรือไม่ ☐ ใช่ ☐ ไม่ใช่
6. หากท่านไม่ตอบกลับระบบเมื่อได้รับข้อความเตือนการรับประทานยาทั้งสองครั้ง ท่านได้รับโทรศัพท์จากเจ้าหน้าที่เพื่อเตือนการรับประทานยาหรือไม่ ☐ ใช่ ☐ ไม่ใช่
7. ท่านประสบปัญหาว่าท่านตอบกลับระบบแล้ว แต่ระบบยังคงส่งข้อความเตือนหารับประทานยาครั้งที่สองหรือไม่
   ☐ ใช่ ☐ ไม่ใช่

8. ท่านเคยตอบกลับระบบ โดยที่ไม่อ่านข้อความเตือนการรับประทานยาว่า มื้อยานี้มีต้องรับประทานยาชนิดใดบ้าง หรือไม่ ☐ เคย ☐ ไม่เคย
9. ท่านประสบปัญหาในการตอบกลับระบบหรือไม่ ☐ ใช่ ☐ ไม่ใช่

<u>ประเมินด้านความพึงพอใจในการใช้ระบบ</u>

10. โดยรวมแล้ว ระบบเตือนการรับประทานยา ช่วยให้ท่านรับประทานยาได้อย่างถูกต้องและสม่ำเสมอหรือไม่

|-----มากที่สุด-----มาก----ปานกลาง-----น้อย-----น้อยที่สุด-----|

11. ท่านคิดว่าระบบควรได้รับการปรับปรุงในเรื่องใด

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12. หากในอนาคตมีการนำระบบมาใช้ ท่านคิดว่าอัตราค่าบริการต่อเดือนควรมีราคาเท่าใด <u>(สำหรับเป็นข้อเสนอแนะหากมีการนำระบบการเตือนการรับประทานยามาใช้จริงในการติดตามการรับประทานยา)</u>

☐ ถูกกว่า 30 บาท ☐ 30-50 บาท ☐ 50-100 บาท ☐ มากกว่า 100 บาท ☐ <u>ไม่ยินดีจ่ายเงิน</u>

แบบสัมภาษณ์สำหรับผู้ให้บริการทางการแพทย์ (หลังการใช้ระบบ)

ชื่อโครงการวิจัย การพัฒนาระบบการส่งข้อความเตือนเพื่อเพิ่มความสม่ำเสมอในการรับประทานยาสำหรับผู้ป่วยโรคพาร์กินสัน

วันเดือนปี ที่สัมภาษณ์ .....

ผู้ให้สัมภาษณ์ ☐แพทย์ ☐พยาบาล ☐ เภสัชกร

บทสัมภาษณ์ของงานวิจัย

1. ท่านคิดว่าอะไรคืออุปสรรคของท่านในการใช้ระบบการเตือนการรับประทานยา

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2. ท่านคิดว่าผู้ใด ควรเป็นผู้ใช้ระบบการเตือนการรับประทานยา เพื่อการบริหารยาสำหรับผู้ป่วย

   ☐แพทย์ ☐พยาบาล ☐ เภสัชกร

3. ท่านคิดว่าระบบนี้สามารถเป็นโมเดลต้นแบบในการพัฒนาระบบการดูแลผู้ป่วยในเรื่องใดบ้าง

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APPENDIX C
CASE RECORD FORM

แบบบันทึกข้อมูลผู้เข้าร่วมโครงการวิจัย

1. **<u>ข้อมูลทั่วไป</u>**

   เพศ ☐ ชาย ☐ หญิง

   อายุ ……...ปี

   ท่านจำเป็นต้องได้รับการช่วยเหลือจากบุคคลอื่นในการทำกิจวัตรประจำวัน เช่น อาบน้ำ แต่งตัว การรับประทานอาหารและ การรับประทานยา หรือไม่

   ☐ ใช่ ☐ ไม่ใช่

2. **<u>ข้อมูลเกี่ยวกับโรคพาร์กินสันและการรักษา</u>**

   อายุที่ได้รับการวินิจฉัยโรคพาร์กินสัน……..ปี

   ระยะเวลาของการเป็นโรคพาร์กินสัน……..ปี

   ระดับความรุนแรงของโรค

   Modified Hoehn and Yahr Staging ☐ 0 ☐ 1 ☐ 1.5 ☐ 2 ☐ 2.5 ☐ 3 ☐ 4 ☐ 5

   ปัญหาการตอบสองต่อยาไม่สม่ำเสมอ ☐ ไม่มี ☐ มี

   ได้แก่ ☐Wearing-off คิดเป็น ……% / วัน

   ☐Dyskinesia คิดเป็น ……% / วัน

3. **<u>ข้อมูลเกี่ยวกับการรับประทานยารักษาโรคพาร์กินสัน</u>**

   จำนวนรายการยาทั้งหมดที่ผู้ป่วยรับประทาน……...รายการ

   ความถี่ในการรับประทานยาสูงสุดต่อวัน……ครั้ง

   จำนวนเม็ดยาทั้งหมดที่ผู้ป่วยรับประทานต่อวัน……เม็ด

   จำนวนเม็ดยาสูงสุดต่อมื้อที่ผู้ป่วยรับประทาน……..เม็ด

รายการยาพาร์กินสันที่รับประทาน

เวลา / ชื่อยา								

APPENDIX D

8-ITEM MORISKY MEDICATION ADHERENCE SCALE

แบบประเมินความร่วมมือในการใช้ยา No. _____

8-Item Morisky Medication Adherence Scale (MMAS)

คำชี้แจง : กรุณากาเครื่องหมาย ✓ ลงในกล่อง ❒ ในคำถามต่อไปนี้ให้ตรงกับความเป็นจริง

1. มีบางครั้งที่คุณลืมรับประทานยาใช่หรือไม่ (ผิดเวลา/ขาดยา)	❒ ใช่	❒ ไม่ใช่
2. บางคนไม่ได้รับประทานยาด้วยเหตุผลต่างๆนอกเหนือจากลืม คุณคิดทบทวนว่าในช่วง 2 สัปดาห์ที่ผ่านมา มีบางวันที่คุณไม่ได้รับประทานยา	❒ ใช่	❒ ไม่ใช่
3. คุณเคยเปลี่ยนแปลงวิธีรับประทานยา (เพิ่มขนาดยา/ลดขนาดยา/หยุดยา) เนื่องจากรู้สึกแย่เวลารับประทานยา โดยที่ไม่ได้บอกแพทย์	❒ ใช่	❒ ไม่ใช่
4. เมื่อคุณออกจากบ้านหรือเดินทางไกล มีบางครั้งที่คุณลืมพกยาติดตัวไปด้วย	❒ ใช่	❒ ไม่ใช่
5. เมื่อวานนี้ คุณรับประทานยาครบ ใช่หรือไม่	❒ ใช่	❒ ไม่ใช่
6. เมื่อคุณรู้สึกว่าอาการของโรคที่คุณเป็นควบคุมได้แล้ว บางครั้งคุณหยุดรับประทานยา	❒ ใช่	❒ ไม่ใช่
7. การรับประทานยาทุกวันอาจไม่สะดวกสำหรับบางคน คุณเคยรู้สึกอึดอัดที่ต้องรับประทานยาอย่างเคร่งครัดหรือเข้มงวด ใช่หรือไม่	❒ ใช่	❒ ไม่ใช่
8. คุณรู้สึกว่ามีความยุ่งยากบ่อยเพียงใด ในการจดจำยาทั้งหมดที่ต้องรับประทาน (กาเครื่องหมาย ✓ ลงในกล่อง ❒ **โดยเลือกเพียง 1 ข้อเท่านั้น**)		
❒ 8.1) ไม่รู้สึกหรือแทบจะไม่รู้สึกว่ามีความยุ่งยากในการจดจำยาที่ใช้ (หรือมี 0 ถึง 1 ครั้งต่อสัปดาห์ที่จำไม่ได้ว่ายาตัวไหนทานอย่างไร)		
❒ 8.2) รู้สึกว่ายุ่งยากบ้างเล็กน้อย ในการจดจำวิธีทานยาแต่ละอย่างให้ถูกต้อง (หรือมี 1 ถึง 2 ครั้งต่อสัปดาห์ที่จำไม่ได้ว่ายาตัวไหนทานอย่างไร)		
❒ 8.3) รู้สึกว่ายุ่งยากปานกลาง ในการจดจำวิธีทานยาแต่ละอย่างให้ถูกต้อง (หรือมี 3 ถึง 4 ครั้งต่อสัปดาห์ที่จำไม่ได้ว่ายาตัวไหนทานอย่างไร)		
❒ 8.4) รู้สึกว่ายุ่งยากเป็นประจำ ในการจดจำวิธีทานยาแต่ละอย่างให้ถูกต้อง (หรือมี 5 ถึง 6 ครั้งต่อสัปดาห์ที่จำไม่ได้ว่ายาตัวไหนทานอย่างไร)		
❒ 8.5) รู้สึกว่ายุ่งยากทุกครั้งหรือตลอดเวลา ในการจดจำวิธีทานยาแต่ละอย่างให้ถูกต้อง (มีความยุ่งยากทุกวัน จำไม่ได้ว่ายาตัวไหนทานอย่างไร)		

APPENDIX E
DEFINITION OF VARIABLES

1. Variable in user table

Variable name	Definition
User_ID	The identification number of the system administrator. The system administrator could be healthcare provider or system development.
User_name	The login name which generated by system administrator to login the system.
User_Password	The login password which generated by system administrator to login the system

2. Variable in medication table

Variable name	Definition
M_ID	The identification number of each medication. The number is generated automatically by the system.
M_HosID	The identification number of each medication which generated by the hospital. The number is provided by system administrator.
M_Name	The medication's trade name which the physician prescribed for the patients with Parkinson's disease.
M_Price	The medication's price per tablet. The price of each medicine is based on the price of Chulalongkorn hospital.

3. Variable in patient table

Variable name	Definition
P_ID	The identification number of each patient. The number is generated automatically by the system.
P_HN	The identification number of each patient which generated by the Chulalongkorn hospital. The number is provided by system administrator.
P_Name	Name of patient who participated in the study.
P_Surname	Surname of patient who participated in the study.
P_Address	Address of patient who participated in the study.
P_Mobile	Mobile phone number which the reminder message will send to patient's mobile phone.
P_gender	Gender of patient who participated in the study. (Male=1, Female=2)
P_DOB	Date of birth of patient who participated in this study.
P_Age	Age of patient who participated in this study
P_Identity	National identification number of patient who participated in this study.

4. Variable in schedule_med table

Variable name	Definition
SMed_ID	The identification number of prescribed medicine for each patient.
User_ID	The identification number of system administrator who set the medication reminder message.
Patient_ID	The identification number of each patient. The number is generated automatically by the system. (P_ID)
Med_ID	The identification number of each medication. The number is generated automatically by the system.(M_ID)
Start_Date	The date which patient was initiated to take prescribed medication.
Stop_Date	The date which patient will discontinue the prescribed medication.
IsConfirm	Confirmation status to initiate the reminder message. 0= The message is not generate. 1= The message in generate and send the data to SMS vendor.

5. Variable in schedule_time table

Variable name	Definition
Schedule_date	The date which the reminder will initiate and send to patient's mobile phone
Schedule_time	The time which the reminder will initiate and send to patient's mobile phone
SMed_ID	The identification number of prescribed medicine for each patient.
Time_index	The prescribed time of each medication which defined by number for each prescribed time. The number was set in every 15 minutes for 24 hours.
Dose	The prescribed medication's dose for each patient.

6. Variable in SMS table

Variable name	Definition
SMS_ID	The identification number of each SMS reminder.
P_ID	The identification number of each patient. The number is generated automatically by the system.
User_ID	The identification number of system administrator who set the medication reminder message.
Message	The first medication SMS reminder which composed of patient's name, Medication name and dose and SMS_ID which use as a code to respond back to the system.
ConfirmMessage	The second SMS reminder which will send after the first reminder for 15 minutes. The message is composed of reminder sentence and SMS_ID which use as a code to respond back to the system.
Datesend	The date which the first SMS reminder was sent to patient's mobile phone.
Timesend	The time which the first SMS reminder was sent to patient's mobile phone.
ReminderDatesend	The date which the second SMS reminder was sent to patient's mobile phone.
ReminderTimesend	The time which the second SMS reminder was sent to patient's mobile phone.
ResponseStatus	The status to confirm that patient responded back to system 0=Patient didn't response back to the system, the system will send out the second reminder. 1=Patient responded back to the system, date and time of respond status will record in database. 2=The system send the third reminder to system administrator or healthcare provider because the system didn't get any respond from patient.
ResponseTime	The time which the patient responded back to the system

APPENDIX F
ETHICAL CONSIDERATION

COA No. 543/2012
IRB No. 239/55

INSTITUTIONAL REVIEW BOARD
Faculty of Medicine, Chulalongkorn University
1873 Rama 4 Road, Patumwan, Bangkok 10330, Thailand, Tel 662-256-4455 ext 14, 15

Certificate of Approval

The Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand, has approved the following study which is to be carried out in compliance with the International guidelines for human research protection as Declaration of Helsinki, The Belmont Report, CIOMS Guideline and International Conference on Harmonization in Good Clinical Practice (ICH-GCP)

Study Title : Development of An Enhance Adherence Messaging Systems for Patients' with Parkinson's Disease.

Study Code : -

Principal Investigator : Miss Lalita Kaewwilai

Study Center : Department of Health Informatics, Faculty of Public Health, Mahidol University.

Review Method : Full board

Continuing Report : At least once annually or submit the final report if finished.

Document Reviewed :

1. Protocol Version 1.1 Date 09 July 2012
2. Protocol Synopsis Version 1.2 Dated 19 July 2012
3. Information sheet for research participant Version 1.1 Date 09 July 2012
4. Consent Form Version 1.1 Date 09 July 2012
5. Pre-Study Questionnaire Version 3.2 Date 08 July 2012
6. Post-Study Questionnaire Version 3.2 Date 8 July 2012
7. Case Record Form Version 2.1 Date 8 July 2012
8. 8-Item Morisky Medication Adherence Scale (MMAS)

Signature: ..... **Signature:** .....
(Emeritus Professor Tada Sueblinvong MD) **(Assistant Professor Prapapan Rajatapiti MD, PhD)**
Chairperson **Member and Assistant Secretary, Acting**
The Institutional Review Board **Secretary The Institutional Review Board**

Date of Approval : August 7, 2012

Approval Expire Date : August 6, 2013

Approval granted is subject to the following conditions: (see back of this Certificate)

APPENDIX G
ETHICAL CONSIDERATION

Certificate of Approval
Ethical Review Committee for Human Research
Faculty of Public Health, Mahidol University

COA. No. MUPH 2012-196

Protocol Title :	DEVELOPMENT OF AN ENHANCE ADHERENCE MESSAGING SYSTEMS FOR PATIENTS' WITH PARKINSON'S DISEASE
Protocol No. :	148/2555
Principal Investigator :	Miss Lalita Kaewwilai
Affiliation :	Master of Science in Health Informatics (International Program) Faculty of Public Health, Mahidol University
Approval Includes :	1. Project proposal 2. Information sheet 3. Informed consent form 4. Data collection form/Program or Activity plan
Date of Approval :	17 September 2012
Date of Expiration :	16 September 2013

The aforementioned project have been reviewed and approved according to the Declaration of Helsinki by Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University.

S. Nanthanongkolchai

(Assoc. Prof. Sutham Nanthanongkolchai)
Chairman of Ethical Review Committee for Human Research

(Assoc. Prof. Phitaya Charupoonphol)
Dean of Faculty of Public Health

420/1 Rajvithi Road, Bangkok, Thailand 10400

BIOGRAPHY

NAME	Miss Lalita Kaewwilai
DATE OF BIRTH	20 March 1985
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INSTITUTIONS ATTENDED	Assumption University, 2003-2006 Bachelor of Nursing Science Mahidol University, 2010-2013 Master of Science (Health Informatics)
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