

INTELLIGENT PILL BOX TO IMPROVE MEDICAL ADHERENCE IN ELDERLY WITH
HYPERTENSION : A RANDOMIZED CONTROLLED TRIAL

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บทคัดย่อและแฟ้มข้อมูลฉบับเต็มของวิทยานิพนธ์ตั้งแต่ปีการศึกษา 2554 ที่ให้บริการในคลังปัญญาจุฬาฯ (CUIR)
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กล่องยาอัจฉริยะเพิ่มความร่วมมือในการรับประทานยาในผู้สูงอายุที่มีความดันโลหิตสูง : การวิจัย
แบบสุ่มที่มีกลุ่มควบคุม



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรดุษฎีบัณฑิต
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นันทกาญจน์ สูงสุดาลัย วุดแฮม : กล่องยาอัจฉริยะเพิ่มความร่วมมือในการรับประทานยาในผู้สูงอายุที่มีความดันโลหิตสูง : การวิจัยแบบสุ่มที่มีกลุ่มควบคุม (INTELLIGENT PILL BOX TO IMPROVE MEDICAL ADHERENCE IN ELDERLY WITH HYPERTENSION : A RANDOMIZED CONTROLLED TRIAL) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ศ. นพ. สุรศักดิ์ ฐานิพานิชกุล, 216 หน้า.

ความเป็นมา การรับประทานยารักษาโรคความดันโลหิตสูงอย่างสม่ำเสมอมีความจำเป็นอย่างยิ่งในการบรรลุเป้าหมายของการรักษา คือผู้ป่วยสามารถควบคุมความดันให้อยู่ในเกณฑ์ปกติ ในพื้นที่ชนบทไทย ผู้สูงอายุมีความสม่ำเสมอในการรับประทานยา การวิจัยในครั้งนี้มีวัตถุประสงค์เพื่อศึกษาผลของโปรแกรมการเพิ่มความร่วมมือในการรับประทานยาอย่างสม่ำเสมอในผู้สูงอายุร่วมกับการใช้กล่องยาอัจฉริยะ ชื่อ กล่องยา ไทย อินเทลลิเจน ในการเพิ่มความร่วมมือในการรับประทานยารักษาความดันโลหิตสูงในผู้สูงอายุที่ไม่สามารถควบคุมความดันโลหิตได้ ในเขตพื้นที่ อำเภอเมือง จังหวัดบึงกาฬ ประเทศไทย

วิธีดำเนินการวิจัย การวิจัยเชิงทดลองแบบสุ่มและมีกลุ่มควบคุม โดยศึกษาในกลุ่มตัวอย่างจำนวน 200 ราย แบ่งออกเป็น 2 กลุ่มคือกลุ่มที่ได้รับโปรแกรมการสอนเรื่องการรับประทานยาความดันโลหิตสูงอย่างสม่ำเสมอ (กลุ่มควบคุม) และกลุ่มที่ได้รับโปรแกรมการสอนเรื่องการรับประทานยาอย่างสม่ำเสมอและได้รับกล่องยาอัจฉริยะ เป็นระยะเวลา 3 เดือน มีการสอบถาม วิเคราะห์ และรายงานผลทัศนคติและความพึงพอใจจากการใช้กล่องยาของผู้ร่วมวิจัย การวิเคราะห์ข้อมูลของงานวิจัยโดยหลักการ Intention to treat ทดสอบทางสถิติด้วย t-test and repeated ANOVA

ผลการวิจัย จากการศึกษาพบว่า หลังจากระยะเวลา 3 เดือนความสม่ำเสมอในการรับประทานยาความดันโลหิตสูงของผู้สูงอายุทั้งสองกลุ่ม มีความแตกต่างอย่างมีนัยสำคัญทางสถิติ ในกลุ่มที่ได้รับโปรแกรมการสอนเรื่องการรับประทานยาอย่างสม่ำเสมอและได้รับกล่องยาอัจฉริยะ มีระดับความร่วมมือในการรับประทานยาความดันโลหิตสูงสม่ำเสมอ เพิ่มขึ้นมากกว่ากลุ่มที่ได้รับโปรแกรมการสอนเรื่องการรับประทานยาอย่างสม่ำเสมออย่างมีนัยสำคัญ ความแตกต่างของค่าเฉลี่ย 4.72 (95%CI;0.61 - 8.85;p-value=0.025) ไม่พบความแตกต่างของค่าความดันโลหิตเมื่อหัวใจบีบตัวระหว่างกลุ่มที่ได้รับกล่องยาอัจฉริยะและไม่ได้รับกล่องยาอัจฉริยะ ความดันโลหิตเมื่อหัวใจคลายตัวพบความแตกต่างอย่างมีนัยสำคัญระหว่างสองกลุ่ม

บทสรุป กล่องยาอัจฉริยะช่วยเพิ่มความร่วมมือในการรับประทานยาอย่างสม่ำเสมอในผู้สูงอายุที่มีความดันโลหิตสูง ในเขตชนบทของประเทศไทย

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KEYWORDS: ELDERLY, HYPERTENSION, MEDICAL ADHERENCE, INTELLIGENT PILL BOX. / INNOVATIVE PILL BOX, ELDER, ANTIHYPERTENSION, REMINDER PILLBOX

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Background: Antihypertension medical adherence is important for controlling blood pressure in hypertension patients. Adherence to antihypertension medication among elderly Thai persons in the rural area is low, which contributes to uncontrolled blood pressure.

Objective: To examine whether an intreated education program and innovative pill box improves adherence to medications and to improve controlling blood pressure among Thai elderly persons with hypertension.

Methods: A randomized controlled trial. 200 elderly persons with hypertension who received at least one hypertension medication, at least once daily, were randomized into two groups. One group received the usual education program (control group) and the second group (intervention group) received education program and a Thai Intelligent Pill Box. Intervention continued for three months. The perception and satisfaction of using this pillbox was explored and reported in this study. Intention to treat analyses using t- test and repeat ANOVA to compare the difference between two groups.

Result: Antihypertension medication adherence after three months was statistically significant different between the intervention and control group. Intervention group showed adherence higher than in the control group; mean difference 4.72 (95% CI ;0.61 to 8.85), p-value <0.025). Systolic blood pressure was no different between two groups while diastolic blood pressure was statistically significant different between two group at three months post intervention. Participant's perception and satisfaction on functionality and features, as well as the design and size, were positive among participants.

Conclusion: This randomized controlled trial demonstrates that the integration of program to improve medical adherence and Thai- intelligent pill box improved medical adherence among Thai elderly hypertension patients in rural area.

Field of Study: Public Health

Student's Signature

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Advisor's Signature

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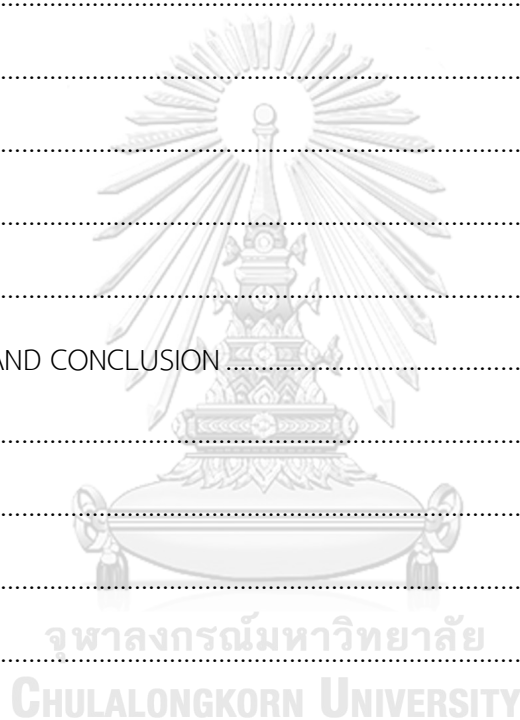
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Chapter I

1.1 INTRODUCTION AND RATIONALE

Hypertension is a major of public health problem and is responsible for millions of deaths worldwide. Each year worldwide, 45% of deaths are due to heart disease and 51% due to stroke cause by hypertension. Two thirds of these patients are in the developing countries. In the Southeast Asia countries, high blood pressure is the leading risk factor for death claiming 1.5 million lives each year(1) Moreover, hypertension is also a quiet sign of danger that causes death, as it commonly does not show signs and symptoms. Many people have hypertension and do not know they have it. Most of them do not receive any treatment which leads to 1.5 million deaths from hypertension each year in South East Asia Countries(2, 3).

Thailand also reports high prevalence of hypertension among its population In the 5th National Health Exam Survey in 2008-2009, the results show the prevalence of hypertension in Thailand was 24.7% especially among elderly group as the prevalence of conditions increased with age(4, 5). Aging is major influences of several morphologic and function features of human body. Age-related has a significant impact on the healthy elderly. Hypertension is one major disease that affects most elderly people, these individuals are more likely to have clinical cardiovascular disease (CVD)(6).The elderly population in Thailand aged 60 years and older has been rapidly increasing from a total of 5.87 million (9.5 % of total population) in 2000 to and 8.38 million (12.6 %) in 2010 and this is expected to increase to 12.39 million (17.8%) in 2020(7). Based on this rapid increasing of elderly population, the health care system plan at the all levels to make the health services suitable for elderly(8).

In elderly with hypertension, uncontrolled blood pressure is commonly reported. Poor medical adherence has been primary reason of hypertension patients do not achieve full treatment which leads to uncontrolled blood pressure(9). Retrospective analyses indicate that approximately 40% of patients with newly diagnosed hypertension will discontinue their antihypertensive medications during the first year of treatment. During 5 to 10 years of follow-up, less than 40% of patients may persist with their prescribed antihypertensive treatment(10, 11). Studies indicated that patients who are adherent to antihypertensive medications are 45% more likely to achieve blood pressure control. A 25% increase in medication adherence has also been associated with a 1.0 mmHg and a 1.2 mmHg reduction in systolic and diastolic blood pressures(12, 13). There are numerous factors that affect adherence at the individual level, including lifestyle, psychological issues, health literacy, support systems, and side effects of medications. Although the reasons for not being adherent are diverse, few of the most commonly reported barriers is forgetfulness, carelessness, changing medication schedule, busy life style and stopping medication due to improvement or deterioration in symptoms(14). Indeed, patients' personal attributes probably have the strongest influence on adherence(15).

Thailand national statistic 2013, report 41 % of elderly has hypertension and almost 50 % of this group are poor adherence and uncontrolled blood pressure(16). Study show that for this group after a year of being diagnosed and receive medication, almost half of them stop taking antihypertension drug due to no signs and symptoms. Then after two years, the study found more than half of drug adherence has been decreased and some of them completely stop taking medication(17).

Even though there are few methods are being implemented and examined its effect to improve antihypertension drug adherence in Thailand but there is still limit knowledge on innovative methods on how to improve medical adherence among elderly hypertension patients in the rural area. Studies suggested that home visit and pill count also show the positive impact as well as using reminder package(18). Few studies suggested promoting family in the medication management also provide positive outcome. However, the idea of family being involved in the hypertension drug adherence can only applied in some family but not for those families that working age family members work outside(19).

The change in physical functions associated with ageing leads to decreasing function in every organ and system in the elderly person's body. The effects of the brain function decreasing such as loss of memory, problem of hearing and seeing, may be the major cause of poor adherence in elderly(20).Being poor adherence to antihypertension in elderly can cause serious health problems such as stroke, disability, and death that will not affect only individual health problem but it will affect family and society. Evidence from studies suggested on strategy to improve medical adherence among elderly that using only theory and provide information is not enough to improve medical adherence. The integration of multi approaches with innovative and cost effective strategy should be implemented and researched(21).For this study, we integrate the usual chronic diseases education program on medical adherence with innovation reminder pill box. This integration is based on the Health Belief Model.The usual education program includes providing knowledge on the negative consequence of nonadherence of antihypertension and the benefit of being adherent and use of

the reminder pill box as cues to action. The Aging theory which focus on the change of physical function also incorporated into the design of the pill box.

In some western countries, the electronic pill box is commonly used to manage medication. There are private companies import these pills dispenses into Thailand but due to the expensive cost these pill boxes are not popular among Thai. The manual pill box is still popular among urban Thai due to its affordable cost but not in the rural area where people considered as low income. In rural area of Thailand, the innovative and cost-effective methods to help elderly manage their medication need to be developed and investigated.

In this study, we developed an innovative simple reminder pill box called the Thai-intelligent pill box, which aims to assist the elderly to improve antihypertension drug adherence. This Thai- intelligent pill box works as reminder packaging for certain individuals may represent a simple method to improve drug adherence. We design and develop this pill box based on user elderly perspective and their recommendation as well as health care provider recommendations. In additional we design pill box from incorporate idea from root cause for poor adherence in the real situation from the field. The innovative functions that brand-new design suitable for elderly and not duplicate with any existing pill box. The functions in the Thai- intelligent pill box include;

1. Nine compartments for medications.
2. Compartments difference sizes that suitable for different kind of pills, size of compartment start from 0.5 mm. to 13 mm.

3. Each compartment can contain medicine supply that take one tablet per day from 7 to 30 tablets.
4. Each of compartment can identify time to take medicine by reflective color tape that help patient identify which medicine to take at and when to take medicine. Orange for morning, dark blue for lunch, pink for evening and light green for before bed time.
5. The alarm could be set for 4 groups as a reminder in accordance with four time include morning, lunch, evening and before bed.
6. The alarm system has snooze function.
7. Slide murky glass door that can protect medicine from light.
8. On the slide glass door place sticker which lable name of medication, how many tablets to take, and when to take this for patients or care taker can recheck whether patient taking the right medicine, right dose and the right time.
9. In the body of the box have place to put name of patient.
10. Using simple and long lasting affordable battery (3V CR2025 or CR2030)

The Thai-intelligent pill box was aimed improve the individual's adherence to hypertension drug. This pill box is designed and built in Thailand which can reduce cost of import. This will help Thai people to have a device that has a positive effect to their health at affordable cost. The study was conducted in BuengKan Province. This province is in North East of Thailand, reported a high number of elderly with hypertension. The high percentage of poor adherence is a primary reason for selecting this area.

This study aimed to design and develop the Thai- intelligent pill box. As well as test the effect of the pill box in improve antihypertension drug adherence. The qualitative study, one group quasi experimental before and after intervention was conducted to test feasibility of the pill box and patients attitude and satisfaction. The result from the trial was incorporate to develop the final Thai-intelligent pill box before expand development of the pillbox to 100 boxes and conduct a randomized controlled trial to test the effect of the pillbox in improve antihypertension medical adherence. The primary objective of this true experiment study was to test the effect of the Thai-intelligent pill box on increasing medical adherence rate among elderly. In Additional, it will examine the effect of the Thai- intelligent pill box in helping elderly to control their blood pressure.

1.2 Research Gap

1. There is limited of formative research on innovative methods to improve hypertension medical adherence among elderly with hypertension patients in rural of Thailand.
2. There is limited knowledge on the effects of the use of an electronic reminder pill box on medical adherence in rural of Thailand.

1.3 Research Question

1. What are the effect of Thai- intelligent pill box on medical adherence among elderly with hypertension in Buengkan province, Thailand?
2. What are the effect of Thai- intelligent pill box on blood pressure among elderly with hypertension in Buengkan province, Thailand?

3. What are the attitude and satisfaction toward Thai- intelligent pill box among elderly with hypertension in Buengkan province, Thailand?

1.4 Research Objective

General Objective

1. To examine the effect of Thai-intelligent pill box on medical adherence in elderly with hypertension in Buengkan province, Thailand.
2. To examine the effect of Thai-intelligent pill box on blood pressure in elderly with hypertension in Buengkan province, Thailand.
3. To determine perception and satisfaction toward Thai-intelligent pill box among elderly with hypertension in Buengkan province, Thailand.

Specific Objectives

1. To compare medical adherence before and after implement the Thai-intelligent pill box in hypertension patients.
2. To compare blood pressure before and after implement the Thai- intelligent pill box in hypertension patients.
3. To compare the medical adherence between the usual health education program and usual health education program with Thai- intelligent pill box.
4. To compare patient's blood pressure between the usual health education program and usual health education program with Thai-intelligent pill box.
5. To determine the perception and satisfaction toward Thai-intelligent pill box among elderly with hypertension.

1.5 Statistical Hypothesis

H_0 = There is no difference in medical adherence and blood pressure in usual care with intelligent pill box and usual care program.

H_A = There is difference in medical adherence and blood pressure in usual care with intelligent pill box and usual care program.

1.6 Operational Definition

1. Intelligent pill box is the electronic medicine reminder that is designed for elderly with hypertension which can contain 9 medications supply for at least 7 to 30 days and alarming function that remind elderly hypertension patient to take medication in the right time. The labels over the clear tinted slide murky glass door help remind the right dose and right medication. The tinted murky glass door protects medicines from light or sun light exposure.
2. Medical adherence for this study refer to antihypertension medication adherence. It is the level which a person follows the recommendation from the health care provider in this study is refer degree of follow the hypertension prescription. The medical adherence in this study define and measure by pill count. Pill count is number of pills that absent in a given time period divided by the number of pills prescribed in the same period of time. For this study if it is greater or equal to 70 percent mean that the adherence to antihypertension is good according to review literature.

The percentage of antihypertension medical adherence will be classified into 5 levels as following;

Level 1 : 80.0-100.0	percent	=	Very good
Level 2 : 70.0-79.0	percent	=	Good
Level 3 : 60.0-69.0	percent	=	Acceptable
Level 4 : 50.0-59.9	percent	=	Poor
Level 5 < 50.0	percent	=	Non adherence

3. Elderly is a person male or female age equal and above 60 to 79 years old calculated from birthday until the day of collecting data for this study.

4. Blood pressure is pressure in blood vessel. It is created by the force of blood pushing against the walls of blood vessels (arteries) as it is pumped by the heart. For this study uncontrolled blood pressure is when diastolic blood pressure ≥ 140 mmHg and systolic blood pressure ≥ 90 mmHg.

5. Hypertension is a condition in which the blood vessels have persistently raised pressure. Blood is carried from the heart to all parts of the body in the vessels. Each time the heart beats, it pumps blood into the vessels.

1.7 Conceptual Framework

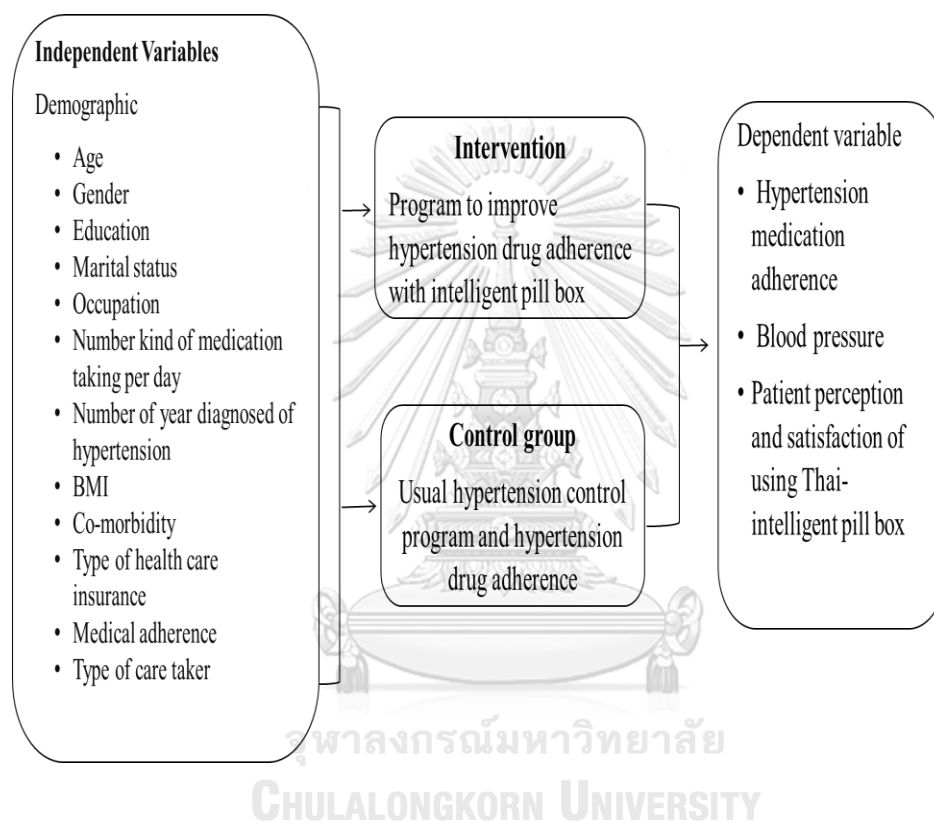


Figure 1- 1 Conceptual Framework

CHAPTER II

2. LITERATURE REVIEW

This chapter contains a review of the literature and explores facts and theories on hypertension and medical adherence. The content also provides an overview of knowledge sharing from evidence and research on hypertension, medical adherence and non-adherence, factors related to medical adherence, and nature medical adherence behavior. Related studies worldwide, including Thailand, are included in this chapter.

The facts, theories and relevant research were reviewed as follows;

2.1 Hypertension

1. Definition of hypertension

World Health Organization defines hypertension is one of the severe risk factor of cardiovascular disease when the blood pressure is above the threshold which refer diastolic blood pressure above 140 mm.Hg. and systolic blood pressure above 90 mm.Hg. (22).

Thomas D. Giles give the definition of hypertension as a progressive cardiovascular syndrome arising from complex and interrelated etiologies. Early markers of the syndrome are often present before BP elevation is sustained; therefore, hypertension cannot be classified solely by discrete BP thresholds. Progression is strongly associated with functional and structural cardiac and vascular abnormalities that damage the heart, kidneys, brain, vasculature, and other organs and lead to premature morbidity and death. Reduction of BP when target organ damage is

demonstrable or the functional precursor of target organ damage is present and still reversible generally reduces the risk for CV events(23).

Center of Disease Control and Prevention define hypertension as blood pressure is higher than normal. The DCD.

Blood pressure levels

- Normal systolic : less than 120 mmHg and Diastolic: less than 80 mmHg.
- At Risk (prehypertension: Systolic 120-139 mmHg and Diastolic 80-89 mmHg.
- High : Systolic 140 mmHg Diastolic or higher and Diastolic 90 mmHg or higher(24).

Hoeper MM,et.al define hypertension from a mean pulmonary artery pressure ≥ 25 mm Hg at rest, measured during right heart catheterization. (25).

American Heart Association give definition of hypertension as high blood pressure is the force of blood pushing against blood vessel walls. High blood pressure (HBP) means the pressure in arteries is higher than it should be when the diastolic blood pressure equal and above 140 mm.Hg and systolic blood pressure is equal and above 90 mm.Hg(26).

For the purpose of this study, we defined hypertension as high blood pressure when systolic ≥ 140 mm.Hg. and diastolic ≥ 90 mm.Hg. we will be using patients who have already been diagnosed with hypertension by their primary care physician or clinic and generally follow the guideline of consistent blood pressure higher than 140/90 mm.Hg.

2. Factors related to hypertension

While there are many factors related to causes of hypertension, the most common factors were defined. They include:

Age: The risk of high blood pressure increases as you age. Through early middle age, or about age 45, high blood pressure is more common in men. Women are more likely to develop high blood pressure after age 65. Study claimed that age is the main clinical determinant of large artery stiffness. A number of clinical studies have analyzed the effects of age on aortic stiffness. Increase of central artery stiffness with age is responsible for earlier wave reflections and changes in pressure wave contours. The stiffening of aorta and other central arteries is a potential risk factor for increased cardiovascular morbidity and mortality. Arterial stiffening with aging is accompanied by an elevation in systolic blood pressure (BP) and pulse pressure (PP).(27, 28).

Family history: High blood pressure tends to run in families. Systematic review and studies show significant association between family history and hypertension.(27).

Being overweight or obese: over weight causes blood need to supply oxygen and nutrients to tissues. As the volume of blood circulated through blood vessels increases, so does the pressure on artery walls(29, 30).

Lack of exercise: People who are inactive tend to have higher heart rates. The higher the heart rate is, the harder the heart must work with each contraction and the stronger the force on the arteries. Lack of physical activity also increases the risk of being overweight(31).

Tobacco use: Not only does smoking or chewing tobacco immediately raise blood pressure temporarily, but the chemicals in tobacco can damage the lining

artery walls. This can cause arteries to narrow, increasing blood pressure.

Secondhand smoke also can increase blood pressure(32).

Salty diet: Too much sodium in diet can cause body to retain fluid, which increases blood pressure(33).

Alcohol use: Over time, heavy drinking can damage heart. Having more than two drinks a day for men and more than one drink a day for women may affect blood pressure(34).

Stress: High levels of stress can lead to a temporary increase in blood pressure(35).

From the review above, there are several risk factors related to hypertension. We focus on elderly who was diagnosed as hypertension which some of risk factors are related to their behavior to control of blood pressure. This study aimed to develop program to help hypertension patients to control their blood pressure by adhering to the antihypertension medication. However, the behavior change approach and providing information on how to control blood pressure by controlling these risks factor is also the approach including in the intervention being develop in this study.

3. Signs and Symptom of hypertension

High blood pressure is often referred to as the “silent killer.” The reason for this is that in normal circumstances, hypertension really has no signs or symptoms. However, during times of elevated blood pressure, there are signs and symptoms that may appear.

According to the Center for Disease Control and Prevention, symptoms that may be possible with elevated high blood pressure include:

- Severe headache

- Fatigue, which could include general confusion
- Problems with your vision
- Pains in the chest
- Problems with breathing under normal daily tasks
- Irregular heartbeat
- May experience blood in the urine
- High blood pressure in the veins could lead to pounding sensation in the chest, neck or ears(24).

4. Diagnosis of Hypertension

Hypertension is diagnosis by the level of blood pressure (systolic blood pressure, SBP \geq 140 mm.Hg. and/or blood pressure (diastolic blood pressure, DBP \geq 90 mm.Hg.

Isolated systolic hypertension (ISH) mean the level of blood pressure \geq 140 mm.Hg. but level of DBP $<$ 90 mm.Hg. Isolated hypertension or white coat hypertension (WCH) refers to the blood pressure being measure in the clinic, hospital or other health facilities and found SBP \geq 140 mm.Hg. and/or CBP \geq 90 mm.Hg. but when measure blood pressure from the automatic blood pressure measurement tools at home, the level of blood pressure not high (SBP $<$ 135 mm.Hg. and DBP $<$ 85 mm.Hg.

Masked Hypertension mean the level of blood pressure being measure at the clinic, hospital or health facility found SBP $<$ 140 mm.Hg. and DBP $<$ 90 mm.Hg. but when measure at home SBP \geq 135 mm.Hg. and /or DBP \geq 85 mm.Hg(36).

Table 2- 1 Definitions and classification of office blood pressure levels (mmHg) in adults aged > 18 years.

Categories	SBP (mmHg)	And/or	DBP (mmHg)
Optimal	<120	And	<80
Normal	120-129	And/or	80-84
High normal	130-139	And/or	85-89
Grade 1 hypertension (mild)	140-159	And/or	90-99
Grade 2 hypertension (moderate)	160-179	And/or	100-109
Grade 3 hypertension (severe)	≥180	And/or	≥110
Isolated systolic hypertension	≥140	And	<90

SBP – systolic blood pressure, DBP – diastolic blood pressure. The higher levels of SBP or DBP should be applied(36).

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5. Measuring blood pressure

Health care provider should be trained and practice how to measure blood pressure. The measuring of blood pressure process includes;

1. Prepare patients: before measure blood pressure, patient should not drink coffee or tea as well as alcohol or smoke any cigarette prior measure blood pressure at least 30 minutes. Patients should urinate before measuring blood pressure. Give patients 5 minutes in the quiet and peace room. Sit in the relax

position on the chair, two feet are on the floor, do not speak or talk while measuring blood pressure. Left or right arm which is measure put on the table.

2. Blood Pressure measurement tool. To measure blood pressure, there are two types of tools: mercury sphygmomanometer and automatic blood pressure monitoring device. These tools should be checked regularly. When measure blood pressure should consider using the arm cuff that fit for patient. And the bladder should be long enough to put around the arm. 80% of patients using bladder size 12 x 22 cms.
3. Measure blood pressure. Measure at the arm that is not used regularly (non-dominant arm). Use the arm cuff and the arm cuff bladder should be at least equal to 80% of the circumference of the upper arm. Warp the cuff around the upper arm with the cuff's lower edge one inch above the antecubital fossa. Lightly press the stethoscope's bell over the brachial artery just below the cuff edge. The rapidly inflate the cuff to 180 mmHg. Release air from the cuff at a moderate rate at 3 mm/sec. Listen with the stethoscope and simultaneously observe the dial or mercury gauge. The first knocking sound (Korotkoff) is the subject's systolic pressure. When the knocking sound disappears, that is the diastolic pressure (such as 120/80). Record the pressure(36).

6. Complications of Hypertension

Heart attack or stroke: High blood pressure can cause hardening and thickening of the arteries (atherosclerosis), which can lead to a heart attack, stroke or other complications(37).

Aneurysm: Increased blood pressure can cause your blood vessels to weaken and bulge, forming an aneurysm. If an aneurysm ruptures, it can be life-threatening(38).

Heart failure: To pump blood against the higher pressure in blood vessels, the heart muscle thickens. Eventually, the thickened muscle may have a hard time pumping enough blood to enough for body's needs, which can lead to heart failure(39).

Trouble with memory or understanding: Uncontrolled high blood pressure may also affect patient ability to think, remember and learn. Trouble with memory or understanding concepts is more common in people with high blood pressure(40, 41).

Uncontrolled hypertension: when considering uncontrolled hypertension that mean the blood pressure level of patients higher that level of controlling which difference from each guideline. For this study we focus on the guideline from the Thai Hypertension Society which mean BP < 140/90 mmHg for non-diabetic patient. For diabetic patients BP control at 130-139/80-85 mmHg. Bp < 130/80 mmHg. For patient high risk for CVD or have CVD (36).

Resistance hypertension: there are two definitions to define the resistant hypertension.

1. Uncontrolled blood pressure in patients who are treated with three or more on diuretic drug.
2. Hypertension patients who can control blood pressure but being treated by more than 4 groups of medication(36).

This study aims to enable patients to adhere to their drug regimen that is prescribed by their doctor to control hypertension. Serious complications can occur from continued high blood pressure and in elderly patients, could be fatal.

Improving adherence to the drug prescription to control hypertension is intended to lessen the risk of complications.

7. Treatment of hypertension

The most common drug treatments for hypertension fall into the following categories as articulated;

Thiazide diuretics: Diuretics are medications that act on kidneys to help body eliminate sodium and water, reducing blood volume. Thiazide diuretics are often the first, but not the only, choice in high blood pressure medications. Thiazide diuretics include hydrochlorothiazide (Microzide), chlorthalidone and others. If taking a diuretic and the patient's blood pressure remains high, the doctor may add an additional medication or replace it. Diuretics or calcium channel blockers may work better for black and older people than do angiotensin-converting enzyme (ACE) inhibitors alone. A common side effect of diuretics is increased urination(42).

Beta blockers: These medications reduce the workload on heart and open blood vessels, causing heart to beat slower and with less force. Beta blockers include acebutolol (Sectral), atenolol (Tenormin) and others. When prescribed alone, beta blockers don't work as well, especially in black and older people, but may be effective when combined with other blood pressure medications(43).

Angiotensin-converting enzyme (ACE) inhibitors: These medications such as lisinopril (Zestril), benazepril (Lotensin), captopril (Capoten) and others help relax blood vessels by blocking the formation of a natural chemical that narrows blood

vessels. People with chronic kidney disease may benefit from having an ACE inhibitor as one of their medications(44).

Angiotensin II receptor blockers (ARBs): These medications help relax blood vessels by blocking the action, not the formation, of a natural chemical that narrows blood vessels. ARBs include candesartan (Atacand), losartan (Cozaar) and others. People with chronic kidney disease may benefit from having an ARB as one of their medications(45).

Calcium channel blockers. These medications — including amlodipine (Norvasc), diltiazem (Cardizem, Tiazac, others) and others — help relax the muscles of blood vessels. Some slow the heart rate. Calcium channel blockers may work better for black and older people than do ACE inhibitors alone(46).

Renin inhibitors: Aliskiren (Tekturna) slows down the production of renin, an enzyme produced by your kidneys that starts a chain of chemical steps that increases blood pressure(47). Tekturna works by reducing the ability of renin to begin this process. Due to a risk of serious complications, including stroke, the patient shouldn't take aliskiren with ACE inhibitors or ARBs(47).

The initial focus of treatment for all hypertension will be a review of the patient's lifestyle and factors that may be attributing to the hypertension. Changes to the patient's lifestyle can have significant impact to treating hypertension without medication. A healthy lifestyle and diet are at the foundation of lifestyle changes. This could include a lower sodium diet, the inclusion of an exercise program, stop smoking, moderate drinking of alcohol and techniques for handling stress, such as meditation at the Temple. However, the target patients of this study may be less

able or willing to make lifestyle changes due to their age and environment. Compliance to the patient's drug treatment is critical to successful treatment of hypertension.

Treatment of hypertension in Elderly patients:

Be aware of BP variability, WCH, white coat effect, orthostatic and post-prandial hypotension. Therefore, proper home BP measurement should be endorsed if available. CCBs and diuretics are drugs of choice, either alone or in combination. ACEIs/ARBs, α blockers and direct vasodilators can be added sequentially if needed(36).

2.2 Elderly

1. Definition of elderly

World health organization provide the explanation of elderly as the human body change according to biological, ageing results from the impact of the accumulation of a wide variety of molecular and cellular damage over time. Aging define at 65 years old of age. The wear and tear overtime lead to a gradual decrease in physical and mental capacity, a growing risk of disease, and ultimately, death. However, the change is not happening in every case some elderly at 70-year-olds enjoy still good health and functioning, other 70-year-olds are who require help from others. Beyond biological changes, ageing is also associated with other life transitions such as retirement, relocation to more appropriate housing, and the death of friends and partners(48)

European Working Group on Sarcopenia in Older People (EWGSOP) define elderly as a grave change associated with human age which is progressive decline in muscle

mass, skeletal and a downward spiral that may lead to decreased strength and functionality and system in the body. When the person age some older person has negative outcomes such as physical disability, poor quality of life and death(49).

For this study, elderly refer to person who 60 years of age who have physical and mental change due to age.

2. Common health conditions in elderly

The most common health condition in elderly such as hearing loss, difficulty of seeing, cataracts and refractive errors, loss memory, back and neck pain and osteoarthritis, chronic obstructive pulmonary disease, diabetes, depression, and dementia. Moreover, when people age, they are more likely to experience several conditions at the same time(50). Aged is one of characterized leading of many health condition that cause the major of diseases later in life. These are commonly called geriatric syndromes. They are often the consequence of multiple underlying factors and include frailty, urinary incontinence, falls, delirium and pressure ulcers(50, 51)

3. Factors influencing Healthy Ageing

Although some of the variations in older people's health are genetic, much is due to people's physical and social environments – including their homes, neighborhoods, and communities, as well as their personal characteristics – such as their sex, ethnicity, or socioeconomic status(52). There are some environmental factors around elderly people that cause problem in older people. Studies proved that the environment factor is cause ageing process at every stage of life. The environments merge with personal characteristic that effect on health in the long

term. Environments are an important influence on the development and maintenance of healthy behaviors. Maintaining healthy behaviors in every stage of life such as eating a healthy food, practice regular physical activity, and away from tobacco use all contribute to reducing the risk of non-communicable diseases and improving physical and mental capacity(53).

Supportive environments can help people do what is have positive effect to them but sometimes it is difficult to create environment that can enhance positive impact on health for elderly. In Australia there was study conducted to examine the association of environment and physical activities of older people. The result from this study suggested finding and create suitable environment is the way to help elderly to maintain their health as they have facilities that they can take care of their health. (54, 55).

2.3 Medical Adherence

1. Definition of medical adherence

Since the year 1976, David Sackett and Brain Haynes propose the words compliance on their first book about compliance(56). Then in the year 1979 the following book with titled “compliance in health care” which include many researches on compliance. In this book’ compliance define as the extent to which a person’s behavior in terms of taking medications coincides with medical or health advice. According to Haynes, the terms compliance and adherence are the same meaning(57). For this study, we will use the word adherence which use to explain in the area where patients have right to determine to follow his or her treatment.

World Health Organization defined adherence as “the extent to which the patient follows medical instructions” was a helpful starting point. However, the term “medical” was felt to be insufficient in describing the range of interventions used to treat chronic diseases. Furthermore, the term “instructions” implies that the patient is a passive, acquiescent recipient of expert advice as opposed to an active collaborator in the treatment process(58).

Joyce A .et.al gave definition of Medical Adherence as: Adherence has been defined as the “active, voluntary, and collaborative involvement of the patient in a mutually acceptable course of behavior to produce a therapeutic result.” This definition implies that the patient has a choice and that both patients and providers mutually establish treatment goals and the medical regimen.

Medication adherence usually refers to whether patients take their medications as prescribed (e.g., twice daily), as well as whether they continue to take a prescribed medication(59).

P. Michael Ho et.al. refers medical adherence is whether patients take their medications as prescribed as well as whether they continue to take a prescribed medication(60).

Bernard Vrijens et.al. provides a new terminology of Adherence. They defined adherence is the process by which patients take their medication as prescribed, further divided into three quantifiable phases: ‘Initiation’, ‘Implementation’ and ‘Discontinuation’. The result from their study gave in a new conceptual foundation for a transparent taxonomy(61).

In this study, medical adherence is the level which a person volunteer, collaborative to follows the recommendation from the health care provider in this study is refer degree of follow the hypertension prescription.

2. Factors effect on medical adherence

Adherence is simultaneously influenced by several factors. The ability of patients to follow treatment plans in an optimal manner is frequently compromised by more than one barrier, usually related to different aspects of the problem. These include: the social and economic factors, the health care team/system, the characteristics of the disease, disease therapies and patient-related factors. Solving the problems related to each of these factors is necessary if patients' adherence to therapies is to be improved.

The qualitative show result from interview over 400 patients , result from this qualitative suggested that patient become poor adherence to their antihypertension medication because they feel well and not sick(62).

Age: study claim that when compare between older and younger age, older age alone is not related to poorer medication adherence. Study suggested that should focus in younger new patients diagnose with chronic diseases. Morris B.A report on his study that increase age is associated with systolic and diastolic when measure the drug adherence. (27, 63).

Gender: result from studies suggested that gender is significant in drug adherence. There are disparities between women and men in their intensity of medication use, their adherence to medications, and their likelihood of receiving guideline-based drug therapy(64, 65).

Education: study in medical adherence in patient, evidence suggested that education patients are more likely to adherence to medication prescription. Study suggested that provide more information to patients may improve their adherence to the medication(66).

Occupation: study show that the occupation is related to medical adherence.

Some jobs have schedules that could lead to poor adherence than another job.

When person had to work in the schedule that they cannot leave to take their medicine follow the prescription. Example of this group such as factories employee (67).

Marital status: evidence from study that tests the relationship between psychosocial factors and hypertension-related behaviors. Being married was associated with higher probability of medication adherence(68).

Number of antihypertension drug taking: Study show the result that number of medication taking can improve patient adhering to the medication. The study suggested that increasing number of pills prescribed significantly improved adherence Significant associations, upon multivariate analyses, included number of drugs that a patient was taking(69).

Duration of taking antihypertensive drugs: study was conducted to examine of the relationship of shorter duration of antihypertensive agents used and drug adherence, the result found out that the shorter duration of taking drug show negatively associated with drug adherence(70).

Living Arrangement: The meta-analysis from 122 studies found that the function of social support such as family cohesiveness and conflict, emotional and social support. It proves that living arrangements by being married or living with someone shows the highest correlation with medical adherence. It found that patients become adhering to their medication 1.74 times higher than patient from cohesive family and live alone. Result for studies show that living with another person help in increase adherence(71).

Relationship with caretaker: Studies in the U.S. test the effect of the caregiver intervention and the medical adherence in dementia people who are care at home. Study found that modifiable caregiver and the treatment implementation factors, including active care giver engagement was associated with adherence. It show result that caregiver with poor health could be risk for not being helpful in improve health of patients(72). Few studies explain that family member is primary caregiver for elderly at home. Therefore, result from these study show that family that have close relationship among them may effect in result of health outcome among elderly patients who are care by family caregiver(73, 74).

Alcohol use: evidence from study that analyze from secondary data in the U.S. found there is relationship of alcohol misuse and nonadherence. The researcher hypothesis that alcohol misuse may be a risk factors for poor medical adherence or nonadherence. The study using patients Alcohol Use Disorder Identification Test (AUDIT) score and using the logistic regression to estimate the predicted of adherence in patients from each AUDIT group. Result from study reported alcohol misuse was associated with increased risk for medical non-adherence(75).

Type of health care insurance: From review, there are limited studies on the relationship between types of health care insurance. However, for this study, the researcher refers the cost of treatment to patients have ability to pay for their medical care as the way of the health care insurance would pay for this cost. The systematic review shows that cost is one of the risk factors for nonadherence. The study finds the relationship between medical cost and non-medication adherence. Result from 19 studies found that some patients not adhering to their treatment due to the costs and financial burden. The review

suggested that reduce cost related to medical adherence which less cost would benefit for patients to continue compliant to the treatment(76).

Self-perceived health status: the evidence show the relationship between the perceived health status and drug adherence(77).

1. Abilities of Daily living: in elderly, there are several risk factors that influence of cognitive, medical, behavioral and social risk factor on medical nonadherence. Evidence from study result that conceptualization can predicted nonadherence(76).Some study using the abilities of daily living instrumental and production of a behavioral record that could be subjected to analysis. There was a cross-sectional study of the ability of living in healthy elder to follow their medication regimen. The ability of daily living has important implication for medication adherence which cognitive impairment in elderly has negative impact on medication adherence(78). Activity of Daily Livings are a basic activity performed by individuals on their daily basis. It is necessary for independents living at home or in the community. There are several ways to definite of the activities of daily living, but most identify in 5 categories include;
 - a) Personal hygiene such as ability to bathing, grooming and care oral.
 - b) Dressing such as ability to choose appropriate clothes and dress yourself.
 - c) Eating such as ability to feed oneself though but not necessary to prepare foods.
 - d) Maintaining continence which includes both mental and physical ability to use restroom.
 - e) Transferring refer to moving oneself from seated to standing and get in and out of bed.

This assessment is assessed whether an individual can perform those activities on their own if they rely on a family or caregiver. The ability to perform the ADLs is a compare time measurement of individual independence(79).

Factors for non-adherence vary among age groups, demographics and lifestyles. For this study, there are a few common factors in the elderly for non-adherence. Forgetfulness is common. This could be age related how active the patient may be with work or family; distractions from a daily routine. The lack of a daily routine is also a common factor. In some cases, ease of access to medical treatment and prescription drugs is a cause of non-adherence. If it's difficult to have a prescription refilled this may cause delays in taking the medications or result is discontinuation of taking the medication. In some families, the lack of family support for the patient to remind them to take medication could be a contributing factor. This may be the result of family members not fully understanding the risks of non-adherence to the drug regimen.

3. Intervention to improve medical adherence

1. Behavioral interventions : From systematic review of intervention to enhance medical adherence suggested that the effect from the behavior intervention did not show the positive impact and most of the studies not significant improve medication adherence or clinical outcome(80). However, some studies show the positive result in behavior intervention that focus on the feedback, reinforcement, and rewards(81).
2. Combination interventions: Several studies show the positive effect of combination of intervention in hypertension drug adherence among elderly patients. The combination of intervention consists of information and behavioral intervention(80-82).

3. Pillboxes are also recommended from systematic review that have strong evidence in the effectiveness to enhance medical adherence. The finding from the systematic review, result that pillbox can serve as the work to influence medication adherence(83).

For the purpose of this study, increased education and training of both the patients and caregivers will be used alongside the introduction of a low-cost, innovative pill reminder box, targeted to the elderly living in rural areas.

Multimodal interventions have shown better results than unimodal interventions. Intervention to improve adherence includes increased monitoring by family, friends, care givers. Using motivational techniques through increased knowledge of the disease and medication or small rewards for adherence can produce increased adherence. In addition, the introduction of intelligent pill dispensers or similar devices can be used to further increase adherence.

4. Medical adherence assessments.

Measurement of medication adherence is challenging because adherence is an individual patient behavior. The following are some of the approaches that have been used:

The assessment of adherence should have the following characteristics: It should avoid dividing the phenomenon into two separate groups, it should give reliable and objective estimates, it should give continuous information about the history of adherence, it should avoid affecting behavior of patients and it should be easy to use when come to analysis of the data. However, there is still lack of method being developed. There are several numbers of methods for assessing the adherence but none of them can be regarded as method of choice. Each method has its strengths and weakness. And it is recommendable to use several methods. The methods for

assessing the adherence can be classified into direct and indirect methods. Direct methods can provide the evidence that the patients have been taking the medication but may give false results if patients take the medicine immediately before checking. For the indirect methods, they are used more often but they cannot provide the direct evidence of medical intake. The use of different measurement methods makes the adherence studies complicated and the use of different definitions of adherence makes comparison practically impossible. The methods as described above can be explained as the following methods,

1. Direct methods: this direct method of measuring adherence includes direct observation of the patient's medication taking or determinations of the concentration of the drug, the drug's metabolite or some biological marker from blood, urine or saliva. When using drugs, metabolites and biological markers, one issue is according to the individual differences in kinetics for instance the serum concentration of a substance may be similar, even though the medications are different. And another issue is that for those chronic medications related to long-term behavior, the daily patterns of taking medication regularly also remain obscure. An ideal biological marker should be safe, tasteless, colorless, pharmacologically inert in human, chemically non-reactive, small in volume and detectable from urine with a simple, sensitive and specific method. The observation of a patient's medication taking may also involve problems because the patient can pretend taking the drug and the method is impractical in an outpatient setting.
2. Indirect methods: these methods are included physician's estimates, patient's self-reports (interview, diary, questionnaire), pill counts, medication taking files and electronic medication devices. The assessment of adherence is easiest based on patient's report, but the method is unreliable for those who report being compliant.

It has some study report that self-report of medical compliance is associated with less doctor visits. Interviews have been found to be less reliable than questionnaires or diaries compared to non-self-report measure.

The measurement of compliance is easiest based on patients' own reporting, but the method is unreliable for those who report being compliant (84). It has been found that self-reported compliance (telephone survey) and filled prescriptions are in very poor agreement, and that overstating compliance is associated with fewer visits to health care providers(85). Interviews have been found to be less reliable than questionnaires or diaries compared to non-self-report(86). However, to indicate poor compliance. The reliability of the results can be further influenced by the skills of the interviewer, the structure of the questions and a blaming tone(84).

Pill counts, which were extensively used in the 1970's and 1980's, are problematic because patients can modify the number of remaining pill before the count.

Furthermore, when the pill count is done in the clinic, it is difficult to get the patient to bring all the medications with him/her(87). It is also impossible to get information about the days on which the patient took too many, too few or the correct number of medicine(87).

The development of different electronic medication devices changed compliance research in the 1990's. These devices record such information as the time and date when the patient opens the drug container and thereby give continuous information of medication-taking(84). There is, however, the problem that although the device has been used, there is no way of knowing whether or not the patient has actually taken the dose of medication(84).

The measurement of adherence by asking the patient or by tablet count is likely to lead to overestimation of compliance compared to electronic medication devices (88).

For this study as we aim to developed and examine the effect of intelligent pill box on medical adherence. This intelligent pill box can also be applied as electronic medication devices that have ability to measure adherence by pill count. Therefore, the pill counts will be the measurement method to assess the hypertension medication adherence in this study. The calculation of pill count is explained as the following;

Pill count

Patients are generally considered adherent to their medication if their medication adherence percentage, defined as the number of pills absent in a given time period (“X”) divided by the number of pills prescribed by the physician in that same time period, is greater than 80%(89, 90),

$$\text{No. of Pills Absent in Time X} / \text{No. of Pills Prescribed for Time X} \times 100 \geq 80\%$$

For this study, the percentage of medical adherence will be collect by using only pill count to calculating percentage of medical adherence using this method is that it assumes that the number of pills absent were taken by the patients. To compare and examine the cooperation among variables and medical outcomes, the ADLs is used to assess the independent of elderly whether he/she can perform those activities or not which one of those is ability to take medication and follow prescription.

2.4 Medication Dispenser and reminder pill box

There are many medical dispensers being developed and examined its effect around the world. Those medical divided had been built for the same purpose which to

manage medical, help people to organize their medicine, improve adherence and control of medical outcome.

Existing medication dispenser device include;

1. Automatic pill dispenser

First developed in the U.S.A in 1983, the dispenser that can dispensing medical pills that which prescribed administration schedules include capable that can contain more than one pill, and automatic released mechanism for dispensing pills at the time intervals with their administration schedule. There is a pill receptor coupled to pill detector such that a pill dispensed from the pill dispenser and received by used then the pill dispenser generates a signal to alert the patient to take the dispensed by a patient. The patients will take pill during 24 hours period of time (91).

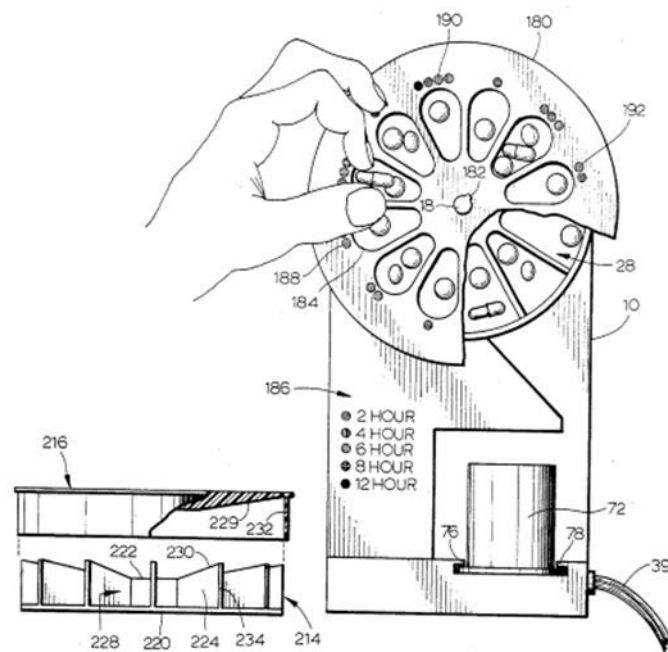


Figure 2- 1 1983 Automated Pill Dispenser

also can dispense liquid medicine. It is an electrical motor connected to a battery(93).

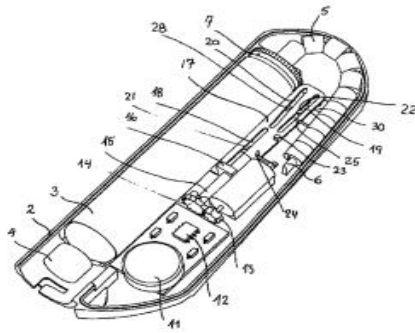


Figure 2- 3 Wearable Medicine Dispensing Device

3. Designing a portable medicine dispenser for persons suffering from Alzheimer's disease.

This is name as automatic wall dispenser comprise of who separate components that interact to each other. The two-component design that can be used inside and outside. This feature can help that the medicine schedule will not be interrupted. The storage ability is from 8-10 tablets which will sufficient for one patient. And the part of the portable medical memory which patient can press the bottle that they are not at home. This will help them control their medication when they are not at home and it will last for 48 hours(94).

4. Home medical station

A medicine dispenser for storing medicine pill that built in 2005. It is for indicating day, segment of day and time for 7 days with 4 segments day medicine dispensers. It is sorting medicine and weekly communication sheets which store as medical records. All the features are show as in the elements are embodies within one housing that can be put in the convenient area. This

device is design for dementia as well as patients who may losing dexterity in their hands. It is built from plastic which make it lightweight and inexpensive(95).

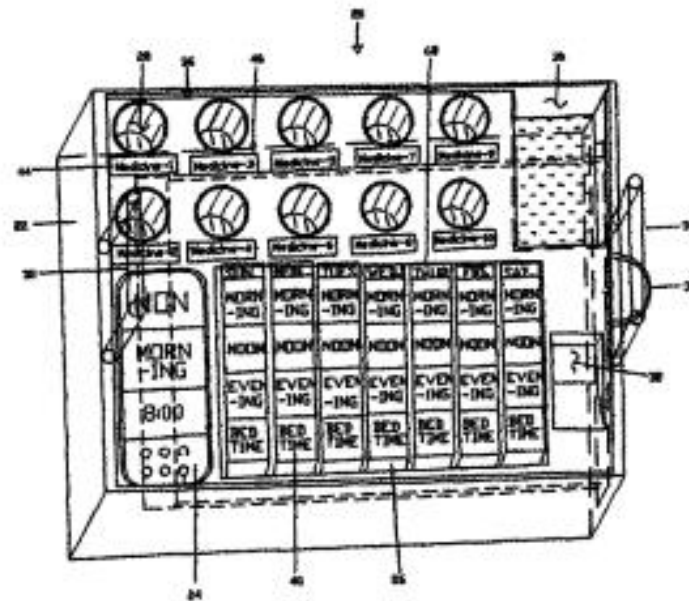


Figure 2- 4 Home Medical Station

5. Low cost robotic medicine dispenser.

In 2012, Mohammad Auzi Ahadani et.al. design and create a low cost scalable prototype of robotic medicine dispenser for the use of pharmacists. In this robot has automatic count ability of medicine then dispense into a vial. The main objective of their study was to build robot in with low cost material and component that can be distribute to the users. The design is custom based design on cell and have more than different types of tables/ capsules of different sizes and shape(96).

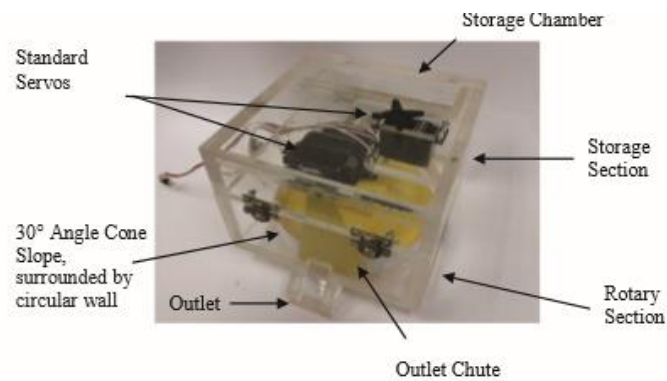


Figure 2- 5 Low cost robotic medicine dispenser

6. Personal medication dispenser

An automated personal pill dispenser examined the effect in 2007, it has one or more chambers for holding a supply of pills. A refill mechanism is link with each chamber and it is selectively operable to dispense a right number of pill from each chamber. The control program is controlled and operates the refill mechanism. The timer controllers, memory and input means and the program operate by the user and from remote input from smart care. The networks, such as one having access to data from the pharmacist. Once the pill released from the chamber the program will present at least one time. The controller operates an alarm to alert the user and control the refill system preset at time and number. It is also has the feature that detecting the user's access to obtain the device to dispensed the pill(97).

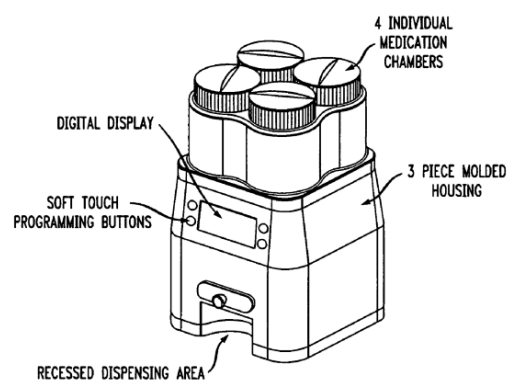


Figure 2- 6 Personal medication dispenser

7. Medication dispenser with automatic refill

A medication dispenser with automatic refill was distributed in 2009. It is aimed to help people stay in their medication compliance. It also has a cap design and a button operation. The operation that connected to the circuitry, for triggering signal to an external dispenser then the request system will request for refill of medication when need by pressed(98).

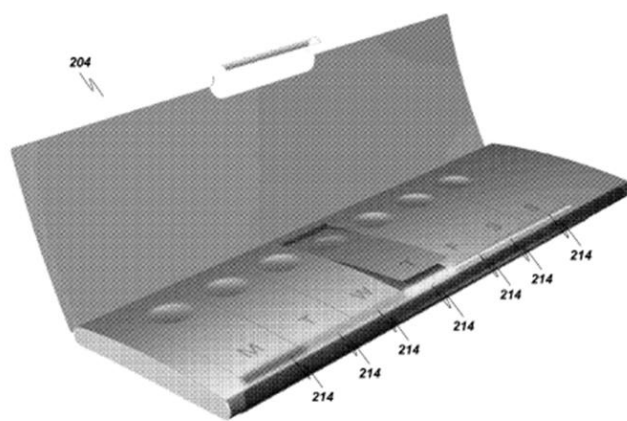


Figure 2- 7 Medication dispenser with auto-refill

8. Intelligent pill box

The intelligent pill box is the invention build in 2011 it is an effective solution to help people to stay adherence with their prescription. The solution from this medical device is a dispensing scheme to help patients keep track on their medicine dosage from the light series. There is also alarm indicate from signals and audio alarm. When patients are not following the treatment that was prescribed to them, the control system will send a patient adherence information via the phone to the disease management system. The effect of it has been tested and found this device can help patients reduce their non-adherence(99).

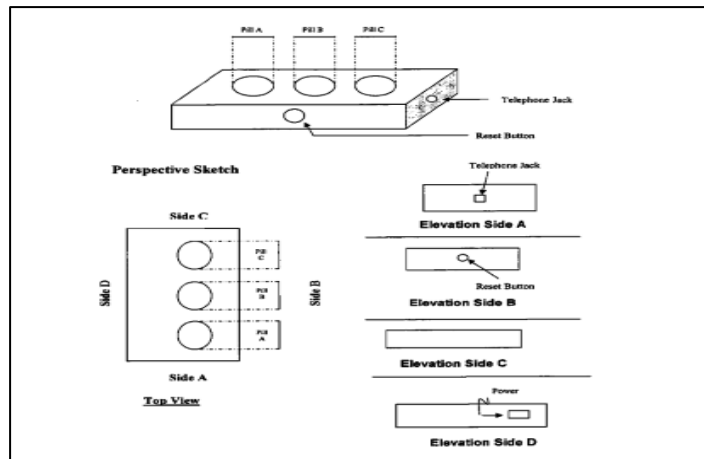


Figure 2- 8 Intelligent Pill Box

9. Smart Pill box

The smart pill box is a device that helps people manage their medication. It was built in India and distributed in 2015. This device is designed and built based on the basic ideology that integrates the alarm clock, light-based slot sensing on a normal pill box. This pillbox is also cost-effective by using slot sensing techniques like capacitance-based slots sensing. The support from GSM technology bridges communication between health care providers and patients (100). Another smart pillbox that was designed and developed in India in 2015, was developed based on an internet of things (IoT) application. The purpose is for health care. This smart pill box contains sensors for reading the heart rate and an intelligent medicine box with a light sensor to indicate the variations in the medicine slots. The slots will count the number of tablets a patient is consuming. Then the alarms are for when the mistake of consuming wrong medicine. This box will also act as medication reminders. This IoT was implemented in home to promote a healthy environment at home by largely using and promoting Home Health IoT (101).

From the increasing of aging, global aging society and prevalence of chronic disease become a common concern in many countries that is described in chapter I. While the

hospital is restructured by reducing number of patients stay in hospital and more focus in increasing the home healthcare. This trend in healthcare is to move routine medical check and other healthcare services from hospital or clinic to home-based care. Checking whether patients are following their prescription, which means if they take their medication as prescribed on time. From the review above, we found that using technology can help in improve in healthcare services to assist patient to meet their goal of treatment. For this study we review the history and generation of pill box and electronic reminder to enhance medical adherence and persistent from the pass until a day. We found that there are several pill boxes that had been developed and tested then distribute in the society.

However, in Thailand there is still lack of evidence that support the idea of using the technology to help patient become good adherence to their medicine. We designed and developed the intelligent pillbox to distribute to elderly patient with hypertension. We review methods on how the pill box works. Several designs of pill box and studies recommended that these pill boxes have a positive effect in helping patient stay compliance to their medication. Also, the recommendation of feature includes; adding the alarm to remind patients to take medication on time, the censer to ensure that patients taking the right medication, and the refill system that should be manage by the health care provider or the care giver to ensure to ensure that medicine are fill in is the right one. We use some of the recommendation from these studies and the limitation from these studies to design and build the intelligent pill box that will suitable for elderly group and more importantly box that cost effective and fit well for Thai context.

2.5 Theories applied in this study

1. Health Belief Model (HBM)

Health belief model is a model developed in 1950 by psychologists Hochbaum and Rosenstock.(102) The model is a psychological model that explains and predicts health behavior. The model focuses on the attitudes and beliefs of individuals.(103) The HBM is explained by the understanding that a person will take a health-related action when;

- A person feels and understands that a negative health condition can be avoided.
- A person has a positive expectation by taking a recommended action, meaning a person will avoid a negative health condition.
- A person believes that he/she can successfully take a desire behavior.

The HBM contains concepts that predict why people will take action to prevent or control illness conditions. These include susceptibility, seriousness, benefits, barriers to a behavior, cues to action and self-efficacy. (104)

2. Constructs of HBM include;

- Perceived susceptibility is a person's opinion of chances of getting a disease or health condition. It can be applicable to the define population at risk, risk levels, personal risk behavior. For instance, a person must believe there is high chance to get liver cancer before he/she will be interested in stop drinking alcohol.
- Perceived severity is a person's opinion of how serious a condition and its consequences are. It can be applicable to specify consequence of the risk and the condition. For instance, in terms of health it can be death, disability and pain and social consequences such as effect of family, work, family life and social relation.

- Perceived benefits are a person's belief in the efficacy of the advised action to reduce risk or seriousness of impact. It can be applicable to a defined action to take, how, where, when, clarify the positive effect to be expected. For instance, financial saving related to quitting smoking.
- Perceived barriers are a person's opinion of the tangible and psychological costs of the advised action. It can be applicable to identify and reduce barriers through reassurance, incentives, and assistance. For instance, a patient that is HIV positive without health insurance may refuse to use antiviral drug because they don't have money to pay for the drug.
- Cues to action are a strategy to activate readiness. It can be applicable to provide how to information, promote awareness and reminders. The concept of cues can be some triggering mechanisms. It is applicable to provide training, guidance in performing action.

Self-Efficacy is a person's confidence on their ability to take action. It can be applicable to provide training, guidance in performing action.

There are other variables that explain in HBM including diverse demographic, sociopsychology and structural variables may influence perception thus, indirectly influences health. In this study social cognitive theory is applied in the developing of the process of developing the website for alcohol use prevention program. In the website, the model developed based on the Health Belief Model and the social cognitive theory. The SCT components applied are the observation learning model, self-regulation and self-efficacy.


The intervention in this study is developed based on the three behavior theories mentioned early theory which is explained as following.

The HBM has been applied to a wide range of health behavior and populations. For this study the intervention is developed by applying the HBM in the intervention as following table.

Table 2- 2 The concept of Health Belief Model in this study.

Concept	Improve antihypertension medication adherence	Applicable
1. Perceived Susceptibility	Elderly hypertension patients believe they can get negative consequence of non-adherence or poor adherences.	<p>The program provide knowledge and build the negative attitude toward non-adherence by showing the short term and long term of negative consequence of non-adherence.</p> <ul style="list-style-type: none"> ● Health: The knowledge of short term negative consequence of non-adherence is showing the picture of; what

Concept	Improve antihypertension medication adherence	Applicable
		happen if they not adhering to medication.
2. Perceived Severity	Elderly hypertension patient believes that the effect of getting negative consequence non-adherence are significant enough to try adhering to medication.	<p>The program provides knowledge and build the negative attitude toward non-adherence by showing and teaching the negative consequence of antihypertension adherence.</p> <p>Video showing the negative consequence of non-adherence.</p> <ul style="list-style-type: none"> ● Health condition ● Financial problem ● Family problem
3. Perceived Benefits	Elderly hypertension patient believes that the	The program provides knowledge and build the

Concept	Improve antihypertension medication adherence	Applicable
	<p>recommended action to adherence to medication and healthy eating and exercise behavior would protect them from of uncontrol blood pressure.</p> 	<p>positive attitude toward medication adherence by showing positive impact of adhering to medication.</p> <p>Picture showing the positive benefit of medical adherence</p> <ul style="list-style-type: none"> ● Health ● Financial ● Family
4. Perceived Barriers	<p>Elderly hypertension patients identify their personal barriers to medication adherence and identify ways to eliminate or reduce these barriers.</p>	<p>On this study, the program will question participants what the barrier for them is to adhere to medication.</p>

Concept	Improve antihypertension medication adherence	Applicable
5. Cues to Action	Elderly hypertension patients receive reminder cues for action in the form of intelligent pill box.	The reminder alarm is one of the features of intelligent pill box. This alarm system will remind patients that there is time for them to take medicine.
6. Self-Efficacy	Elderly hypertension patients confident in their ability to manage their medication and adhering to medication.	In the program the session where showing the intelligent pill box and help them to take their pill regularly. They believe that they will not forget to take medication or taking wrong medication. This will encourage them to be adherence to the prescription.

2. Error Theory: The wear and tear theory

For this study, we considerate apply the wear and tear theory of aging as based for develop of the intervention and the intelligent pill box. This theory is suitable to

apply for the developing process of building service or some divide to help aging simplify of daily life of elder(105). This theory first found by German biologist, Dr. August Weismann in 1882. Dr. Weismann believes that human body as a mechanical system which is going to break down over time after being use. This theory is also the fundamental basis of other theories such as the limitation theory. This theory explains that our human bodies is effect from the environment and with aged it is mote to the continuing damaged in cells and system. This theory is the most population and reasonable to explain human body is damaged over time(106).

The theory explained that Cellular systems that cannot renew or replace themselves throughout life, such as the nerve cells of the brain. As these cells are lost, function eventually will be lost(107). In the human body system, there are systematic change that wear and tear out over time include;

Heart Aging: The muscle become thickens with age. It is response to the thickening of the arteries which effect the pumping rate. The thickness of this muscle will result low pumping rate(108).

Immune System Aging: The immune system (T cell) takes longer to replenish. It cause the slow function of detect any antibody in the body(109).

Arteries and Aging: The blood vessel especially arteries usually to stiffen when age, it cause difficult for blood circulation(110).

Brain Aging: Age brain reduced and less efficient from the problem with the connection between neurons. This may cause loss of memory and function(111).

Sight and Aging: the difficulty of seeing normally start at age of 40 years of age(112).

Hearing and Aging: Age cause of loss of ability to hear(113).

In this study, we apply this in the fundamentals to develop the intelligent box where we use alarm to remind time to take medication, light and color to help in seeing, remembering, and identifying of medication.

3. Diffusion of innovation theory

Working on the health promotion and public health, health care provider must apply resources in services in the most cost-effective way and need to pay attention in on diffuse program to target group. Some public health program is

accepted and recommended to use in helping to enhance good health but some time it has difficult to be sustainable. There are many programs for public health and health promotion that are interesting and proved effective beneficial but those has yet been applied in the general population.

Diffusion mean that the innovation or new ways being distribute to wild population and that will enhance and promote good health in general.

Diffusion of innovations focuses on the concept, guideline and invention that being invented and the community or society accepts it as “new” or “innovative” and distributes it in the community or society. Or, it goes from one society to another. This theory is proposed by Everett Rogers in 1995. He proposed that the diffusion of innovation is the process that the new methods, new invent being distributed to general population through channels in some period of time between community members and society.

Theory of diffusion innovation has been applied in health promotion program and being adopted. The program was adopted was program on condom use, program on stop smoking, or new laboratory test(114).

Table 2- 3 Concept of diffusion of innovation

Concept	Meaning
Innovation	Concept, divide, invent or guideline which is identify as “new” for individual, organization and community.
Communication Chanel	The methods to distribute innovation from one to another.
Society system	Group of individuals that accept and adopt the innovation.
Time	Period innovation being accepted or adopted.

Diffusion is the process which innovation being communicated through one channel in some period of time between the community or social members. There are 5 steps of decision making, for each of the community member to collect and adopt their own innovation.

1. Knowledge: a person knowing, understanding and aware of the innovation and its function.
2. Persuasion: a person builds a positive or negative attitude toward the innovation.
3. Decision: a person decides to engage in action that leads to a choice to adopt or reject the innovation.
4. Implementation: a person applies or uses an innovation.
5. Confirmation: a person evaluates the results of an innovation and made decision.

The decision of most of social member depends on other or if most of members adopt that will make other member want to adopt that innovation. For instant after 10-25% of member adopt an innovation, there is an increase of the percentage of another member rapidly adopt too. In this theory, the theory develops explain that the factors affecting the acceptance and use of innovation is how earlier adopters accepts and found innovation useful that will affect the decision of later adopters.

The cost benefit is also link to the innovation adopted decision. A person will adopt an innovation if he/she believe that it is will enhance their utility. So, they must believe that they will receive benefit from innovation. Also, when people adopt something also related to the cost. People determine whether an innovation would have advantage for this life. There are two things to consider which is the existing habits and values such as is it is difficult or complicated to use, is it cost benefit, how does it work and if he/she use it people will think they are different or not(115).

The diffusion of innovation can be possible only depend on cost it is also depend on individual characteristic and the diversity that what make diffusion possible. The successful innovation is the adopter distribute of the innovation follow a bell-shaped curve and the derivation of the S-shaped diffusion curve. Overtime the bell-shaped curve will be dived to characterize into five categories of system of innovative member which the innovative is defined as the degree to where individual is link to an earlier adopting new approach than other member of the system(116).

The five groups include; 1) innovators, 2) early adopter, 3) early majority, 4) late majority and 5) laggards. This group will affect from one to another like domino effect.

The other approach to adopt innovation is that the innovation's possible benefits. It will trick the eager to try. When people see the value of innovation that confirm the decision to try it(114).

4. Affecting the diffusion of an innovation

The innovation developed and implementation, should provide the data and confirmation of the innovation to make their own adoption decisions. After the leader observe the innovation and see the effectiveness that will lead to another group member to try. Then when a large subsection of the social system follows the trust leaders. This will help to increase in rapid of adoption rate. Then the effect of the domino will continue, eventually affect for those who are slowly innovation adopters which will result in the society the most.

To spread of an innovation, distribute to big group of population the mass media have direct and the most successful in encouraging the spread on innovation because it is immediate and affect the mass audience. However, the diffusion theory has difference idea, as the explanation about opinion of leaders affect the tripping of innovation, this theory suggested that the most powerful way is to make the innovation affect the opinion and attitude of society leaders. The mass media is only rapid affect the mass audience only, it can even make difference in weakly attitude. But for the strong interpersonal are more effective in formation and change of the strongly attitude(117).

Research has shown that firm attitudes are developed through communication exchanges about the innovation with peers and opinion leaders. These channels

are more trusted and have greater effectiveness in dealing with resistance or apathy on the part of the communicatee(118).

The easiest way to form the positive attitude toward innovation is to persuade leader opinion.

Situation is the most characteristics that related to the efforts of successful diffuse an innovation. There are two important channels to diffuses an innovation one is to eliminate a deficit of awareness of an innovation which the mass media channels are most appropriate. And second is to change prevailing attitudes about an innovation, it is best to persuade opinion leaders.

For innovation to diffuse until result in the effective in health promotion and prevent of diseases. The change should be promoting at every level and setting. And it should be multi strategy to promote the change and adopt of an innovation. For the innovation to make some change in an organization, not only target in individual but also include the change in organization rule, regulation, or policy.

Rogers explained several factors that related to an innovative adopted by considerate the value and benefit of the innovation from one community to another. The health care providers can diffuse an innovative by considered these important approach;

1. The relative advantage: compare benefit of an innovation with the existing invent if a new innovation is more value and bring more benefit than the existing one. The new innovation has a better chance to be adopted.
2. Compatibility: the new innovation is suitable to life style and community context. It will be adopted and wild spared use in the community.

3. Complexity: the new innovation is simple to use. If the new innovation is complicate to use that will make slow adopted and only accept in narrow target.
4. Trialability: the target population can try to use an innovation before they make decision about adopt or reject it. After providing the opportunity for the target group to try and they adopt it then it will be simply adopted in wild population.
5. Observability: the innovation showing positive effect and benefit that people can observe. It will be rapid adopted in wild population(117).

Table 2- 4 characteristic of factors effect innovation adopting

Characteristic	Important questions
Compare advantage between new innovation and exiting	Is an innovation better than the existing?
Suitable for target population	Is an innovation suitable to the target population?
Complication	Is the innovation simply to use?
Ability to test effect of innovation	Can the target group try an innovation prior they make decision to adopt?
Observation	Is the effect of innovation can be examined? Is it simply to assessed?

For this study, we apply this theory in to the design and developing of the inelegant pill box which is an innovative way to help elderly with hypertension to keep tract on their antihypertension drug adherence. From the review literature in Thailand on the pill box, medical reminder package, intelligent pill box, medical dispenser.

We found that there is no specific pill box that design for elderly which need to be simple and useable for them because this target group taking multi drug in one day. And from their age and with lack of ability to effectively manage of their own medication. We plan to test the effect of this pill box in target population who can use this box in their normal life. This intelligent pill box will provide simple and valuable prescription for efforts in encouraging diffusion in the wild rang of population in the future.

2.6 Related Studies

From the review, the evidence shows that medical adherence intervention described key aspects of the intervention. There are several systematic reviews and studies examine the effect and result of medical adherence intervention. These studies conducted in type of both true experimental and quasi-experimental study(119). For this study, we aim to test the effect of the program and the intelligent pill box, we searched for at least quasi-prospective study design which design appropriate comparison arm to test the effect of the reminder package and pill dispenses box. At least a non-concurrent comparison arm that was implemented within 3-12 months of the start of the intervention and was similar with respect to population characteristics and setting. At least a 1-month post-intervention follow-up assessment for each study arm (with recall referring to post-intervention period only) for interventions that are clearly discrete or at least a 3-month post-initiation follow-up assessment for each study arm for all other types of interventions(60). For these we use this knowledge as fundamental to design this study to test the effect of our program and the intelligent pill box that we design and develop to meet the outcome of improving the medical adherence in hypertension patients(81).

Currently, several studies conducted in the developing countries such as the U.S., Australia and some of the European countries examine the effect of the electronic pill boxes. Most of the feature of the electronic box addresses the magnitude and impact of nonadherence by pill management and pill count. Some study reports the positive result in both medical adherence and the reduction of blood pressure over some period 3 to 6 months Study conducted in the UK, to test the effect of electronic pill box. The outcome of the measure was the timing of adherence as measured through the program and systolic blood pressure as well as diastolic blood pressure. The study found there is no relationship between adherence and blood pressure(120).

Systematic review from difference countries reported that there are several studies being conducted to test the effect of reminder packaging such as audio reminder package sending text message. Study conducted in the U.S.A. to test the effect of intelligent pill box or smart pill box. The design of the pill box using the several technology sources such as interactive voice response, wireless communication, mobile communication, medical sciences as the way to address and try to overcome non-medication adherence in chronic disease patients especially diabetic and hypertension. These diseases can affect for serious diseases like diabetes and hypertension it can affect the health of the patient in a severely negative if the patient is not adhering to the treatment. The pill box developed from this study can improve patient adhering to the prescription treatment. The intervention can increase prescription adherence by assist patient to better manage of their health outcome. Also, the system to communicate between the health care provider and the patients about their health. This coordination could help in early detect of the problem and it can be solved before it lead to negative consequence(99).

From the review literature, we found that most of the literature review suggested that the combination of behavior change based on theoretical program and apply with the reminder package prove with the positive impact in improve medical adherence among elderly people but slightly significant show the effect in control of blood pressure. To control of blood pressure there are several factors both personal and environment factor that effect the level of blood pressure. However, studies suggested that for patients to meet goal of control blood pressure. Patients should follow their prescription.

However, when the positive effects of intervention from many studies is defined as a statistically significant greater improvement in, or better level of, medication adherence behavioral or biologic outcome in the intervention arm relative to the comparison arm. A relevant behavioral outcome measure may include electronic data monitoring (e.g., MEMs caps), pill count, pharmacy refill, or self-reported adherence. Effect at the follow-up and based on the analyses that meet study design, implementation and analysis criteria.

CHAPTER III

RESEARCH METHODOLOGY

This study aims to examine the effectiveness of the utilization of an innovative easy to use, reminding pillbox to improve adherence to consumption of prescription drugs related to patients with hypertension and poor medication adherence. This study will be focused on the elderly in the rural area.

This chapter describes the details of the process of gathering information for designing the pillbox and development of the pillbox. Patient's acceptance and satisfaction of using the pillbox investigation was also describes in this chapter. And main investigation methods to examine the effect of the pillbox on antihypertension medical adherence and the process of the program in intervention group and how to measure the outcome of the study. Description of the method is divided into several points.

3.1 Research Design

This study consists of three study phases. Phase I: Thai- intelligent pill box design, develop. Phase II: Thai-intelligent pill box development and implementation and phase III, effect of using Thai-intelligent pill box to improve medical adherence, 2 arms randomized controlled trial. The unblinded parallel groups trial with participants randomly assigned to either the control and intervention groups in a 1:1 ratio. The study designed to compare before and after intervention and compare between intervention and control group. The intervention was continued for 3 months period.

Phase I	Phase II	Phase III Baseline	Phase III 1 st month	Phase III 2 nd month	Phase III 3 rd month
June- August 2017	October 2017	November 2017	December 2017	January 2018	February- early March 2018

Note : the development of pillbox scale up to 100 boxes was started to October and continue until early December 2017.

Phases I : Thai-Intelligent pill box design.

Research design

This phase is a qualitative study to gather the requisite information. The researcher gathered information from an in-depth interview. The in-depth interview was conducted to understand the user perceptions of an intelligent pill box, and what an appropriate design would be which promoted better usage patterns and simplify their daily routine.

The design of the intelligent pill box was based on a review of applicable literature, and the results of the qualitative study on user perceptions and appropriate design of intelligent pill box among elderly patients with hypertension. The qualitative study was conducted in an informal manner, but using in-depth interviews of 22 elderly patients, aged 60 to 79. Additionally, the study also included 8 healthcare providers at provincial hospital and health promoting hospitals who work regularly in the hypertension clinic, with experience dealing with patients who have a history of poor adherence to hypertension drug treatment at least one year. The focus was on patients from the previous 3 months, who had experienced uncontrolled blood

pressure, $\geq 140/90$ mmHg, and who reported forgetting to take their hypertension medicine at least one time in the past week.

Study area

This qualitative study, phase II of the study was conducted in Buengkan province. We selected Buengkan district to conduct because hypertension patients in this district are receive the health care from Buengkan hospital.

Sampling

Convenience sampling was applied to select interviewees who meet the inclusion criteria for a group of hypertension patients, and a group of healthcare personnel. The healthcare personnel include: a pharmacist, and nurses who are responsible for the chronic disease clinic, especially in the chronic disease department that included hypertension clinic.

Sample size calculation

From the literature review, it has been determined that the number of participants appropriate to this study is 20 people as in the interview from participant in the same group and there is nothing new come out from the interview(121, 122).For this study we need information from elderly with hypertension who has poor adherence to their hypertension medication and uncontrol of blood pressure as well as manage their own medication. For the health personnel group, we interviewed pharmacists and nurses who working in the chronic diseases department.

Inclusion criteria for patients group include:

1. Hypertension patients who was diagnosed at least 1 year.
2. Patients between 60 to 79 years of age.
3. Patients who take at least one prescription drug for treatment of hypertension.

4. Patients with a history of non-adherence in the 3 months prior to this study.
5. Patients with systolic blood pressure systolic ≥ 140 mmHg and diastolic ≥ 90 mmHg.
6. Patients who manage their own medication.

Exclusion criteria

1. patients who cannot read and write.
2. patients who were not willing to participate in the study.
3. patients who have health complications.
4. Patients who cannot provide informed consent.

Inclusion criteria for health care provider group include;

1. Medical doctor, pharmacist, nurse, and public health officer who has experience working in the chronic disease department at least 1 year.
2. Medical doctor, pharmacist, nurse, and public health officer who are working in the chronic disease clinic at Buengkan hospital and connecting unit of Buengkan health office during the study period.

Exclusion criteria

1. Medical doctor, pharmacist, nurse, and public health officer who not willing to participate in the study.

Recruiting participants

The researcher conducted the meeting to invite elderly with hypertension patients to participate in this study at the chronic diseases clinic of Buengkan Hospital on Thursday, which is the day that patients who have problems controlling their blood pressure (Blood Pressure $> 140/90$ m.m.Hg.) have an appointment for their follow-up. The researcher provided information on the objective of the interview and invited patients who met the inclusion criteria to participate in the study.

The healthcare personnel working at the chronic disease clinic where are all invited to participate in this study.

Note: Patients with uncontrol of blood pressure is scheduled to meet with doctor at the hyperextension clinic.

Research tools

In-depth interviews were performed following guidelines which cover:

- 1.) consumption patterns, and reasons for non-adherence
- 2.) their perceptions of using an innovative pill box
- 3) their input regarding an appropriate design (box size, light and reminder sound)

the guideline questions developed by the researcher, which have been reviewed and revised, based on the recommendations of three experts on elderly health and hypertension.

- 4) Recording audio: one PHILIPS voice tracer and two Philips GoGear

In-depth interview process

Participants who volunteer to participate in this study was invite to a private room individually. The interview process last approximal 10 to 15 minutes.

During the interview, a picture of the preliminary model of the intelligent pill box was shown to participants. During the interview audio record were performed.

The qualitative data: Perceive on intelligent pill box and appropriate design of intelligent pill box among elderly with hypertension

The interview followed the interview guidelines are available in appendix II.)

Field Management

Phase I: Thai-intelligent pill box design

For this first phase of the program, the researcher conducted in dept interview among 22 elderly hypertension patients and 8 health care providers.

1. Researcher and research assistants generate list of patient's names who had uncontrolled blood pressure at the outpatients of the chronic disease clinic of Buengkan hospital and conducted a meeting to invite elderly patients to participant into the in depth interview. For the health personnel group, researcher sending an invitation letter and made appointment to meet with health with which include six nurses, one pharmacist and one public health personnel. The interviews were conducted at the private room in the outpatient chronic disease clinic of the Buengkan hospital.
2. Incorporate information from the in dept interviews and review literature into the design Thai-intelligent pill box.
3. Meeting with the prototype builder company and electronic builder companies to discuss possible feature of the intelligent pill box.
4. Developed the first prototype by using the cupboard.
5. Developed the first prototype by using 3D printer.
6. Functional testing of the intelligent pill box that developed from 3D printer, the recommendations from the phase I was applied to make some change for appropriate functional intelligent pill box which ready to use in the sample group.
7. Developed 30 Thai intelligent pill box from 3D printer cover the area that contact with medicine with plastic food grad for the next phase.

Ethical consideration

Phase I was approved by Buengkan hospital ethical committee.

The participants were given the information and invited to participate in the study. The participants signed an informed consent form before participating in this phase of

study. The interview process was conducted in a private room. An audio record of the interview kept on file. After the interviews, a content analysis was performed.

Phase II: Intelligent pill box development and implementation.

This phase is a pilot study to examine the feasibility and efficacy of the Thai- intelligent pill box. Patients perception and satisfaction were also investigating in this phase.

This pilot project to examine the functionality of the Thai- intelligent pill box, and the patient's ability to use it in the proper manner. The test of feasibility in function of pillbox in assisting patients to follow their blood pressure prescription. Based on the qualitative study results, the information gathered was incorporated into modification of the final design of the Thai intelligent pill box. At this phase the researcher modified design of the pillbox and function on the alarm setting to ensure that Thai-intelligent pill box is friendly for elderly. The design was created by a 3D printer, and the electronic mechanism was inserted. The electronic part used in this study was from the existing simple electronic board from the Alibaba website and from the existing electronic part from normal electronic market in Bangkok (Ban Moh). To assemble the first prototype of the intelligent pill box. The researcher tested the functionality of the prototype by testing the mechanisms that include:

1. The manual dispensing of medicine from a storage compartment in the box, to a separate section where the patient gets the pill.
2. The timer that control alarms system.
3. The reminder (alarm) to take medicine.
4. The function to work properly when participant continue using an intelligent pill box at home. (to ensure that the whole works as designed.)
5. The area that contacted with medicine was cover by the food grad plastic which we use polypropylene: PP which is the same quality as the plastic that produce zipper bag for medicine in hospital.

After the prototype tested by researcher and had result that working properly. Researcher developed first thirty Thai-intelligent pillboxes.

Research design

Experimental study: comparison of adherence statistics before and after intervention. This is a pilot phase, and the main objective is to test the feasibility of Thai- intelligent pill box and its function of its and ensure that it will work properly when applied in the true experiment study of the next phase. It is one group study, with no control group, to determine the outcome measure before and after use of intervention.

Study area

Buengkan district, Buengkan province, Thailand. Study was conducted in Buengkan district where Buengkan hospital is located.

Sampling

Convenience sampling is applied to selected participants in the next phase of the study. Participants are eligible to participate in phase two of this study. Patients who took part in the in dept interview are also invited to participate in this phase of study.

Sample size calculation

To meet the purpose of this phase, in which the main goal is to test the functionality of the intelligent pill box prototype, of the innovation sample size calculation uses the following formula:

$$\underline{n = 1.96^2 \times 4SD^2 / d^2} \quad (123)$$

To estimate the mean systolic blood pressure in a patient group with a 10 mmHg wide 95 % confidence interval (5 mmHg. either side of the mean) previous studies suggested using a standard deviation of 11.8 (124)

The standard deviation (SD) of the measure being estimated = 11.8 (124)

The desired width of the confidence interval (d) = 10

The confidence level = 95 %

$$n = 1.96^2 \times 4SD^2 / d^2$$

$$n = 15.37^2 \times 11.8^2 / 10^2$$

$$n = 20$$

The sample size for this phase is 20 persons. Add additional 10 persons for dropout during intervention total participants were 30 persons.

The Thai-intelligent pill box prototype was tested for its functionality before expanding to 30 pill boxes. The 30 pill boxes were tested in 30 elderly patients for a 2-week period. The results from this test was used to modify and finalize the Thai intelligent pill box design, prior to develop 100 Thai-intelligent pill boxes for the randomized controlled trial of the next phase.

The outcome measurement

1. Blood pressure
2. Medical adherence using pill count

Pill count for medical adherence: Patients are generally considered adherent to their medication if their medication adherence percentage, defined as the number of pills absent in a given time period (“X”) divided by the number of pills prescribed by the physician in that same time period(125)

$$(\text{No. of Pills Absent in Time X} / \text{No. of Pills Prescribed for Time X}) \times 100$$

The percentages will be classified into a 5-level of medication adherence, as show in Table 3-1

Table 3- 1 Level of Medical Adherence

Level	Meaning	Percentage of medical adherence
5	Very good	80.0-100
4	Good	70.0-79.9
3	Acceptable	60.0-69.9
2	Poor	50.0-59.9
1	Non-adherence	0-49.9

After the prototype testing has been completed and any needed improvements have been implemented, the feasibility testing on its implementation was began.

Field Management

Phase II: Thai-intelligent pill box development and implementation

Patients who were participant in phase I were asked to participant in phase II. After development of the first prototype and test function by researcher. 30 Thai-intelligent pill boxes were developed and trial in the 30 patients.

1. Researcher explained to the study protocol to participants at their home.
2. Researcher and research assistants went to patient's home and fill in all antihypertension medication into the Thai intelligent pill box and provide manual and explain how to use the pill box to participants.

3. Initial 30 of the intelligent pill boxes trial in 30 elderly hypertension patients. This trial to test functional and efficacy of pill box as well as test the feasibility of the pill boxes. This function testing period was continued for 14 days.

4. Participants were provided with 24 hrs. telephone number that participants can contact anytime if there is any problem regarding using the Thai-intelligent pillbox.

5. The questionnaire use to collected baseline before intervention was used to collect sociodemographic characteristic, clinical characteristic and medication characteristic.

6. After 14 days of using Thai-intelligent pillbox, researcher went each of patient's home to collected data after intervention.

7. The same questionnaire as in the baseline data collecting were use and additional questionnaire on perception and satisfaction were used to collect patient's perception and satisfaction on using Thai intelligent pillbox.

8. Researcher and research assistant conducted pill count and measure blood pressure with the mercury sphygmomanometer 2 time 2 minutes apart two times from the same arms by 2 nurses who trained as research assistants.

9. Result from interview patient's recommendations and result of the testing with in patients were incorporate to final design of the Thai intelligent pill box.

Data collection

Phase II: at baseline, data was collected using face to face questionnaire. Data gathering from the questionnaire include sociodemographic characteristic, medication (s) taken for hypertension, medication adherence and blood pressure. Level of medical adherence identify by pill count conducted by register nurses. Blood pressure measurement using manual mercury sphygmomanometer. The assessment of blood pressure was assessed two times, two minutes apart from the

same arm in sitting position. The assessment was conducted by registration nurses. After intervention was implemented for 2 weeks, the same questionnaire was used to gathering data after intervention. Pill count and blood pressure assessment were performed by registration nurses. Medication adherence was determined using a percentage of adherence from pill count, meaning counting pills that have been taken relative to the number of pills that should have been taken follow the formula for calculate pill count showed in page 79

Data analysis

To compare the effect of intelligent pill box before and after. Mean, median and SD will be used to measure medical adherence. Changing in medical adherence compare using paired t-test. Percentage of adherence was calculated in Excel prior refer to SPSS version 17.

Ethical consideration

Phase II was approved by Buengkan hospital ethical committee.

The participants were given the information and invited to participate in the study. The participants signed an informed consent form before participating in this phase of study.

Cost to develop Thai intelligent pillbox

The pill box developed in this study is still a model and use 3 D printer to build. The first design of the pill box that included the inventory for store medication cost approximately 3,280 Baht. In this cost, it is including the plastic parts, electronic parts and building cost. During phase II, we use 30 models which cost 98,400 Baht. In phase III, we take out the inventory for storage of medicine based on recommendation from phase II. We developed the medicine tray which cost 1,450 Baht total cost for 120 boxes cost 174,000 Baht. However, this study is a pilot project to test effect of the pill box that design for elderly. It is not cost effective; the better idea is to invest in plastic mole and produce in the big scale.

3 D printer is good for prototype or model development, not suitable to build plastic goods in big amount.

Phase III: Intelligent pill box to improve medical adherence among elderly patients which hypertension in rural area, Thailand: A Randomize controlled trial

This phase of study is the main objective of this study which to examine the effect of the new innovative Thai-intelligent pillbox, appropriate technology for elders who live in the rural area of Thailand.

In this phase: The proposal and protocol of this study submitted to the ethical committee of BuengKan Hospital. One of the main suggested of the ethical committee was to ensure that the process of study not disturb process of work in the hospital. The recommended was to conduct study in one of health promoting hospitals which located in BuengKan District include Muang Health Promoting Hospital, Wisit Health Promoting Hospital, Nasawan Health Promoting Hospital and Non Somboon Health Promoting Hospital. This 4, health promoting hospitals work closely with Buengkan hospital in refer case and same physicians provide treatment to patients. The protocol being implemented in this health promoting hospitals are the same as implementing in Buengkan hospital.

The researcher and three research assistants made a list of hypertension patients from data base of Buengkan Hospital and 4 health promoting hospitals in Buengkan District. For those patients with uncontrol blood pressure in the last 3 months. Non Somboon Health promoting hospital has the highest number of elderly with uncontrolled blood pressure from the last three months visiting at the health facility. Researcher screen the first step before selected patients to participant in the baseline data collection process. Elderly with hypertension who were selected were face to face invited to participant in the study. Patients who willing to participate in this study passed the second screening which follow the inclusion and exclusion criteria.

All list of participants after screened by inclusion and exclusion criteria were allocated into intervention and control group.

Note: Buengkan hospital and health promoting hospital of Buengkan health office follow the Thai guideline on the treatment of hypertension 2015. Patients who are over 60 years old and have uncontrol of blood pressure were appointed to visit doctor or health personnel every month until the person blood pressure under controlled.

Each patient who participate in this study was scheduled to come back to health facility once a month (every 30 days). According to the outpatient data-based program of Buengkan hospital and 4 health promoting hospitals, patients were scheduled to visit health facility for follow up, patients who recruited in this study were scheduled to come to health promoting hospital once a month continue for three months. We propulsive selected **Non Somboon Health Promoting hospital** to conduct the study due to the number of elderly hypertension patients with uncontrolled blood pressure. This health promoting hospital approximately 11 kilometers far from Buengkan hospital (where phase I and II being conducted).

From our original study plan, we recruited at least 50 to 100 patients per week. For 2 weeks 200 patients were recruited in to this study. Each of the patients was allocated to intervention and control as explained in the randomization method.

Initial visit: data was collected included baseline demographics and self-perceived health status, medication list, baseline of antihypertension medication adherence and baseline of blood pressure. In this phase, there is no specific education or adherence intervention was performed. Patients who were selected into baseline data collection were given medication for 1 months and were asking to stop taking medication that had left at home. Medicine provides to the patients who participate in this study was counted. Patients were asked to bring back the whole package that were given to them to health facility after 30 days.

Baseline of antihypertension adherence is defined as the mean value of 30 days adherence assessment. Adherence level identify by pill count.

Baseline of blood pressure was measured by calibrated manual sphygmomanometer. Blood pressure was measured 2 times each 2 minute apart. The measurement was done from same arm in the seated position.

During phase III, following successful completion of phase II. The antihypertension medical adherence improving education program with the intelligent pill box will be given in the intervention group and in the control group only antihypertension medical adherence education improving program (standard program) was given to the control group. The participants in both group were appointed to come back for regular appointment at 30 days. The intervention group and control group were appointed in different day. The demographic, medical adherence was assessed by using pill count and the blood pressure were measured. The usual antihypertension medical adherence program was given to both intervention and control group both in group and individually before patients collected their medication. For the intervention group, they were asked to bring the Thai-intelligent pill box along with them to refill the antihypertension medication by research assistants. The process will be continuing for three months after baseline. Home visits were conducted in the first month of intervention after patients receive Thai-intelligent pillbox.

The flow of hypertension patients through the trial is shown in figure 3. The intent of the flow is for all participants to participate in phases III of the study.

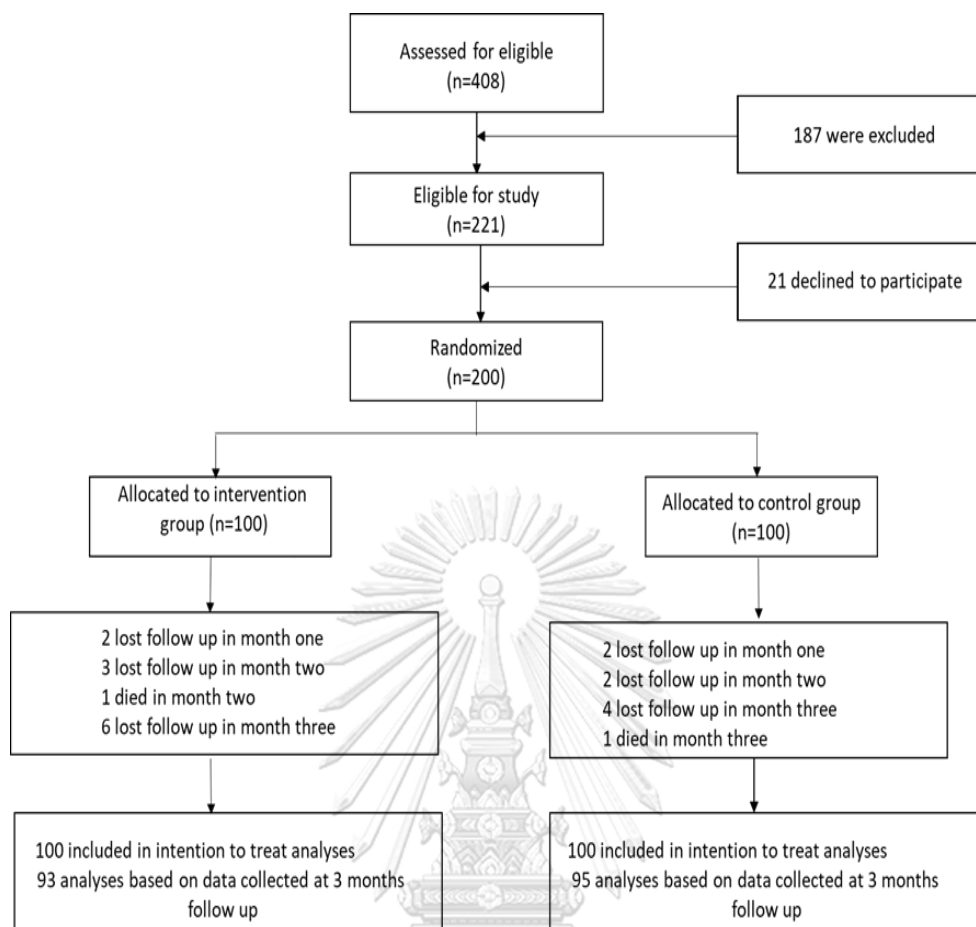


Figure 3- 1 Eligible of patients through the study protocol.

3.2 Randomization

After the baseline questionnaire had been administered, the participants were randomized into an intervention or control group. The participants selected using a simple random number generator without replacements assigned to either the usual program with intelligent pill box (intervention) and only the usual antihypertension medical adherence education program (control group) in a 1:1 ratio. Allocation to study arm was concealed in sealed individual small opaque envelopes, opened consecutively after a patient met study criteria. The random number sequence and envelopes were generated off-site. The envelopes were

opened by research assistants, who had no knowledge to the allocation. Participants both groups are unblinded because of the nature of the intervention. It is not possible to hide the assignment of the group to either the participants or the health care providers. For this study neither the patients nor the researcher were blinded to the intervention. From the total of 408 elderly with uncontrolled blood pressure hypertension patients registered at the five Health Promoting Hospitals, of those 187 were excluded out due to location of the health promoting hospitals and due to exclusion criteria before they were contacted. Of the 221 eligible participants, 21 were refused to participate, 200 were randomized into intervention or control group. The study protocol followed the Consolidate Standards of Reporting Trials (CONSORT) guidelines to report the results from clinical trials (126)

3.3 Treatment groups

Control group

Elderly hypertension patients will receive standard antihypertension medical adherence from the health care providers from Non Somboon health promoting hospital which include; 1) knowledge about hypertension 2) knowledge on short term and long term of non-adherence of antihypertension medication 3) benefits of adhering to antihypertension medication 4) what are the barriers of adherence 5) encourage patients to take medication regularly and help them believe that they can follow prescript to achieve the goal of controlling blood pressure.

Intervention group

Elderly hypertension patients who were randomized to the standard antihypertension medical adherence 1) knowledge about hypertension 2) knowledge on short term and long term of non-adherence of antihypertension

medication 3) benefits of adhering to antihypertension medication 4) what are the barriers of adherence 5) encourage patients to take medication regularly and help them believe that they can follow prescript to achieve the goal of controlling blood pressure with Thai- intelligent pill box. The education program provided by researcher and three trained research assistants.

3.4 Study area

The trial follows the specifications of the revised consort criteria.

The study area is in Buengkan district, Buengkan Province, Thailand. Buengkan is newest province and one of the northeast provinces of Thailand. Neighboring provinces are Nongkhai, Nakorn Panom, Sakon Nakron and Laos People's Democratic Republic (PDR). According to the 2014 census, the population of this province was 418,516 persons. Buengkan health office networking which has an estimated 92,039 residents. The study was conducted in the outpatient chronic disease clinic of Non Somboon Health promoting Hospital. The number and percentage of hypertension patients who can meet the goal of control blood pressure as show in table 3-1

Table 3-1 Number of elderly with hypertension and percent of patients who can control blood pressure \leq 140/90 mmHg in this study area.

Location	Hospital and Health Promotion Hospital	Number of elderly with hypertension	Percent of patient can control blood pressure \leq 140/90 mmHg
Nasawan sub-district	Nasawan health promoting hospital	962	210 (21.82%)
Wisit sub-district	Wisit health promoting hospital	690	162 (23.47%)
Non Somboon sub-district	Non Somboon Hospital Promoting Hospital	852	255 (30%)
Mueang sub - district	Buengkan hospital	20,510	6,564 (32%)



Figure 3- 2 Map of Buengkan Province include Mueang district. Original source from http://patricklepetit.jalbum.net/BUENG%20KAN/MAPROOM/bungkan_1.jpg

3.4 Study Population

The study participants were elderly persons, 60 to 79 year of age who had uncontrolled blood pressure and history of poor antihypertension medical adherence in Non Somboon health promoting hospital, located in Buengkan district, Buengkan Province, Thailand. Patients approached for written consent to participate in this research study. Non SomBoon, Health Promoting Hospitals was used to identify potential patient candidates based on diagnosis of hypertension that listed in the databased. Buengkan hospital and Buengkan District Health office reports a high number of elderly patients with hypertension. Data from the chronic disease clinic collecting in 2015, 20,510 elderly patients who were diagnosed

hypertension and 68 % of these elderly hypertension patients have blood pressure $\geq 140/90$ mmHg. (127).

3.5 Inclusion and Exclusion criteria

Inclusion criteria

1. Hypertension patients who was diagnosed at least 1 year.
2. Hypertension patients who 60 to 79 years of age.
3. Hypertension patients who take at least one prescription drug for the treatment of hypertension.
4. Hypertension patients with a history of non-adherence to take their hypertension medication as prescribed by their physician in the last 3-month prior conduct this study.
5. Hypertension patient who have systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg.
6. Hypertension patients who manage their own medication.

3.6 Exclusion criteria

1. Hypertension patients who (do not exercise) has exercise less than 15-30 minutes 3 time a week or house work less than 60 minutes 5 days a week.
2. Hypertension patients who has BMI over 29.9
3. Hypertension patients who has experience of alcohol drinking 4 drinks in woman and 5 drinks in man in the past month before study.
4. Hypertension patients who has smoked more than 100 cigarettes in their life time and has smoked in the last 30 days before study(128).
5. Hypertension patients who has experience of using any kind of addicted drug in the last 3 months and during study period.

6. Hypertension patients who are unwilling to participate and be monitored for adherence.
7. Hypertension patients that are hearing impaired.
8. Hypertension patients that lack basic reading skills.
9. Hypertension patients who planned to move out of the study area during the research timeline.
10. Hypertension patients who have serious medical conditions, which may, inadvertently, interfere with conducting the study.

3.7 Sample and Sample size calculation

Participants are 200 elderly hypertension patients who registered to receive hypertension treatment at Non Somboon health promoting hospital which in connecting with Buengkan hospital and receive medication and follow up services from Non Somboon health promoting hospital which in the Buengkan Health office connecting of Buengkan Hospital. The number of sample size from the calculation below;

Compare mean difference between two groups independently

Effective size base on existing study : Effect of a pharmacy care program (program and pillbox) on medication adherence and persistence blood pressure(129, 130).

Effect size = 0.5

Assuming Significant level 0.05, power 0.95

Using the G power version 3.1.9.2 for sample size calculation

Total sample size is 181, 91 from each group.

Add additional 10 % to account for drops out. Total sample size is 200, 100 from each group.

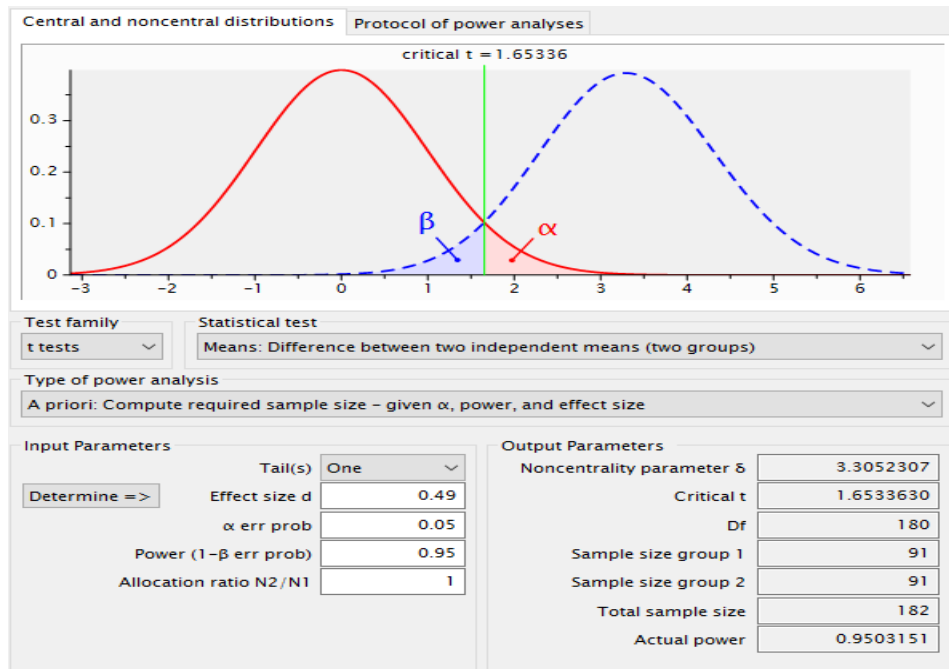


Figure 3- 3 Sample size calculation

3.8 Sampling Technique and Approaching Participants.

Participants in this study are hypertension patients who identify as poor medical adherence on hypertension medication.

Sampling technique are included following steps;

Step 1: Purposively select Buengkan province for sampling because this province has high prevalence of hypertension patients. And high percentage of uncontrolled blood pressure in hypertension patients.

Step 2: Multistage sampling selecting Non Somboon sub district as reported highest prevalence of uncontrol blood pressure in elderly hypertension in Buengkan District(127).

Step 3: Use the district health office databased program to generate list of patients who meet the inclusion criteria, 60-79 year of age, have history of

non-medical adherence and un control of blood pressure ($BP \geq 140/90$ mmHg.)

The researcher contacted the hypertension patients from the contact list in the databased if no contact detail, patients were contacted via village health volunteers who responsible for the village that patient lives. Patients were approached either the day that they come for their regular checkup or researcher go to villages with community health volunteers to invite them to participate in the study. Eligible patients approached for consent.

Step 4: Exclude patients who meet the exclusion criteria and refused to participate in this study.

Step 5: Enrolled patients in to phase III of study.

Step 6: Randomization assign 100 patients to intervention group and 100 patients to control group.

3.9 Field Management

Phase III: A randomized control trial and program implementation.

Baseline Data Collecting

1. Researcher generated the list of hypertension patients from computer databased of Buengkan hospital and Non Somboon health promoting hospital then print out the list of patients who are 60-79 years of age and above with history of uncontrolled blood pressure and antihypertension non-adherence in the last three months.
2. Researcher checked appointment date of patients who will come to hospital and health promotion hospital during September 2017. The appointment date of patients merge with the inclusion criteria will be print out. This process is to plan to approach patient for volunteer and consent to participate in this study for those patients with no contacted show in the data based. Researcher met with village

health volunteer at community to identify if patients are in the community and visit them at their home to invite to participate in the study. For those patients who willing to participate, the new appointment was made for them to come to hospital for baseline data collecting.

3. At baseline, on the date that patients come to health facility due for their doctor appointment. The researcher explains the program and invites hypertension patients from the list of uncontrolled patients, after the participants confirmed eligible in this study. The data collected were included demographic characteristic, review the blood pressure record in the hospital data based, medication list. The blood pressure was assessed at baseline and recorded.

4. From all patients that meet the exclusion criteria were exclude out from the eligible process.

5. Participant who eligible to study were randomized in to intervention and control group.

6. At this step patients were giving medicine and advice to start taking medicines which were given from the day that they sign consent form to participate in the study.

7. All patients were appointed to come back to health promoting hospital after 30 days. They were asked to bring their hypertension medicine packages with them. The research assistants collected medicine and conducted pill count for antihypertension medicines that had left in the package. The baseline of the medical adherence was collected at this step. First day of baseline data collecting was from the day that medicine was given to patients which was on October 23-27, 2017. And pill count of baseline data collecting was on November 21-25,2018.

The participants are allocated to intervention and control group on the date that medicine was given when start of baseline data collecting. On the complete of the simple randomization to allocate participants in to intervention (100 participants) and control group (100 participants) Each of the group was received the antihypertension treatment as usual.

In this phase, it is the implementation phase of the study. The researcher gave the introduction of study for participants in both intervention and control group.

The information provide to participant during this introduction are;

- 1) Program introduction
 - Objective of the study
 - Intervention which included education to improve adherence program and Thai intelligent pill box.
 - Study duration.
- 2) The researcher and research assistant provide information on hypertension and medication adherence for 30 – 45 minutes. This process is being done while patients waiting to meet health personnel for their routine follow up at the waiting room.
- 3) After patient meet with the health personnel, the medication prescription was record in the patient's logbook and computer system of Non Somboon health promoting hospital. After patients receive their medicine, they assigned to come to the medication refill table. At this table, nurses managed and filled medicines into the Thai intelligent pill box.
- 4) For the intervention group, each of patient eligible in this study was given Thai intelligent pill box that already fill with their supply and explanation on how to use the pill box. This process will take about 20-30 minutes.

- 5) After participants bringing the intelligent box home and start to use this pill box. The researcher and research assistants conducted home visit after 5 days after patients receive the pill box. This home visit is a onetime home visit. The phone call is for recheck if participant have any problem using the pill box. The telephone number of researcher and two research assistants were posted on the back of the pill box. Participants can call research team anytime when they have any difficulty or problem using the pill box.
- 6) The process had been continued for three months. Patients were appointed to come back to Non Somboon health promoting hospital every 30 days continue for 3 times (months) After first month receive Thai intelligent pill box in November 2017, the first appointment was in December 2017, second appointment was in January 2018 and third appointment was in February 2018.
- 7) As this is the pilot project to test effect of the Thai-intelligent pill box on improve medical adherence however the Thai-intelligent pill box were developed using the 3D printer but not manufacturing with quality control. All patients who receive the Thai-intelligent pill box were asked to return the Thai-intelligent pill box to researcher and for those pillbox that had been broken were recorded.

3.9 Data Collecting

After implement intervention one month, the patients returned to the hospital for their doctor appointment. Researcher and research assistants counted the pill and calculated the percentage of medical adherences. Blood pressure was assessed two time and 2 minutes break between in each time. Pill count was used to identify data for medical adherences. The same process continued in month 2 and month

3. The final outcomes of intervention which include medical adherence by pill count and blood pressure measurement were collected at the end of month 3.

At the end of month 3, the same questionnaire as baseline was used to collect sociodemographic characteristic, clinical characteristic and medical characteristic in both intervention and control group.

3.10 Structure of Intervention

Following successful completion of Phase I, patients enter to phase II. In phase II, the feasibility of the Thai-intelligent pillbox was tested. From the successful of phase II, researcher developed the final design of the Thai-intelligent pillbox and tested the effect on improve medical adherence among elderly hypertension patients. In phase III, consist of two groups, each group was with a different approach. The intervention group received health education program on antihypertension medical adherence and Thai-intelligent pill box. The control group receive only education program which with no Thai intelligent pill box. Researcher also conducted home visits at patient home one time after they received Thai- intelligent pill box. However, during home visit researcher did not giving any information on medical adherence. The home visit was only to ensure that the Thai intelligent pill box working properly.

The intervention group was undergoing a comprehensive program and using intelligent pill box. There were three elements introduced into this approach. First, using standardized scripts recommended from Thailand ministry of Public Health(131), the patient was provided education on the medication currently being taken. Secondly, reminding to take medication by used of an innovative Thai-intelligent pill box which was designed for this study and last, one-time follow-up

after first receive Thai-intelligent pill box 5 to 7 days with researcher and health personnel who was trained as research assistant.

The educational intervention was a 15-30 visit that addresses the proper drug name, key attributes of the drug, adverse effects, and usage. This education is arranged with patients with 5 to 10 persons per session by researcher and 2 register nurses who were trained as researcher assistants.

Research assistant

Research assistants are register nurses who were trained by researcher. The training is focus on how to use the intelligent pill box and adherence to antihypertension treatment.

The research assistant training is a participatory training which trainer to assess their knowledge and skill during the training. At the end of training, research assistants practiced how to teach elderly to use intelligent pill box follow the intelligent pill box manual for elderly with hypertension and the teaching plan, developed by researcher and the researcher evaluated their teaching skill and their understanding the use of intelligent pill box.

Research assistant role include;

1. Assist researcher in identify patients with hypertension who has poor adherence from the hospital record.
2. Assist researcher in provide education program to participants.
3. Assist researcher in filling hypertension medicine into intelligent pill box and cross check each other after filling in the pill in the pill containers.
4. Asist researcher in home visit during phase II and III of study.

At the start of this phase, Thai- intelligent pill box were distributed to patients in intervention group. Thereafter, medication was dispensed by a pharmacy technician in the designated pill box used for the study. Medication will be provided for a period to cover one month of the prescription.

During the subsequent follow-up visits for adherence, pill counts was performed to determine level of adherence. Researcher did not make any adjustments to medications or their doses. In addition, the patient's blood pressure was taken by using the same method as the initial BP measurement.

In case, the Thai intelligent pill box is damaged or has any problems regard its function while participants using in at home. There was a technical support from the research team which the phone number is placed on the back of the box for 24 hrs. Phone number which link directly to the technical support team in the field. This technical support team was trained on how to identify problem and fix the intelligent pill box.



Figure 3- 4 Front view of Intelligent Pill Box



Figure 3- 5 Front view of Intelligent Pill Box with label of medication name and dose on the glass door lid.



Figure 3- 6 Top View of Intelligent Pill Box



Figure 3- 7 Pill Box Containers for inventory and medication supply

The 10 innovative functions that innovative design suitable for elderly patients with hypertension and other chronic diseases. This design is not duplicate with any existing pill box. The functions in this Thai-intelligent pill box include;

1. Nine compartments for medications.
2. Compartments difference sizes that suitable for different kind of pills, size of compartment start from 0.5 mm. to 13 mm.
3. Each compartment can contain medicine supply that take one tablet per day from 7 to 30 tablets.
4. Each of compartment can identify time to take medicine by reflective color tape that help patient identify which medicine to take at and when to take medicine. Orange for morning, dark blue for lunch, pink for evening and light green for before bed time.
5. The alarm could be set for 4 groups as a reminder in accordance with four time include morning, lunch, evening and before bed.
6. The alarm system has snooze function.
7. Slide murky glass door that can protect medicine from light.
8. On the slide glass door place sticker which label name of medication, how many tablets to take, and when to take this for patients or care taker can recheck whether patient taking the right medicine, right dose and the right time.
9. In the body of the box have place to put name of patient.
10. Using simple and long lasting affordable battery (3V CR2025 or CR2032)

Initiative detail of specification of intelligent pill box.

The intelligent pill box consists of two parts

1. The inventory of medication supply
2. The pill box size height 17 cm. x width 10 cm x length 12 cm., weight 280 grams.

Safety and precaution

1. Should avoid placing the intelligent pill box near heat and wet area.
2. Keep it away from children.
3. Place it near where the user can hear alarm (not over 10 to 12 meters).

After Phase II was conducted the result from phase II was used to finalize the design of the Thai-intelligent pill box. One of the main modify of the pillbox was to remove the inventory part and add information on medication inventory and check expire date of the medicines in the usual care program. And one other out-standing gap of the pill box was that the original design has expose to air and impact of the moisture from the air could have effect on the medications. We addressed this issue by put the medicine tray in the seal plastic box to protect medicine from moisture and air. The final design as was using in Phase III shown in figure3-6.

3.11 Research instruments

Qualitative data

Instrument for collecting qualitative data is the guideline for in-depth interview. The in-depth interview used to collect information on recommendation from health care personnel and elderly patients on appropriate design of the pill box.

Quantitative data

Research instrument to collect qualitative data for this study is the interview questionnaire consist of

Part 1: personal data include; age, gender, marital status, education, occupation, living arrangement, type care taker, co-morbidity, number kind of medicine taking per day, weight, height, and type of insurance.

Part 2: Blood pressure measurement by sphygmomanometer

Blood pressure was measured using a sphygmomanometer and measured two times in the sitting position, spaced two minutes apart on the same arm. Blood pressure record was blood pressure that calculated the average blood pressure from the two times measurement.



Figure 3- 8 Mercury sphygmomanometer using in this study.

Part 3: Medical adherence level

Pill count for medical adherence: Patients are generally considered adherent to their medication if their medication adherence percentage, defined as the number of pills absent in a given time period (“X”) divided by the number of pills prescribed by the physician in that same time period(125)

No. of Pills Absent in Time X/ No. of Pills Prescribed for Time X_x 100,

if it is greater than $\geq 70\%$ mean the adherence is good adherence

once calculate the percentage of medical adherence on antihypertension drug. The percentage was classified into 5 level of medication adherence as show in the table3-2

Table 3- 2 Level of medical adherence

Level of medical adherence	Meaning	Percentage of medical adherence from calculation formula
5	Very good	80.0-100.0
4	Good	70.0-79.9
3	Moderate	60.0-69.9
2	Poor	50.0-59.9
1	Non-adherence	<50.0

Part 4: Perception and satisfaction of using intelligent pill box

The perception and satisfaction of using intelligent pill box developed by researcher consist of 10 questions included 5 questions asking about perception toward intelligent pill box and another 5 questions asking about the satisfaction of using intelligent pill box.

1. Perception toward intelligent pill box among elderly with hypertension.

Questions asking about perception toward intelligent pill box using 5 levels of Likert Scale.

2. Satisfaction of using intelligent pill box. Questions asking about satisfaction of using intelligent pill box using 5 levels of Linkert Scale. Questions in four

areas included; reminding time to take medicine, work function, size and design, sound and light, store of medicine and benefit to daily life.

3.12 Validation and Reliability

The questionnaire was reviewed by 3 experts in the field of chronic disease especially hypertension to validate the content of the questionnaires.

This study used the internal consistency reliability testing. This is conducted by trying out the instrument once, and the results of the analysis were used to predict the reliability of the instrument. Instruments testing, both validity and reliability were not tested on all respondents when the data collection process had been completed, but the preliminary sample of at least 30 respondents in the similar group in a different area or province was conducted. The scores are used in this instrument to produce dichotomy scores (1 and 0). The data was calculated by using manual calculation (132). Reliability of perception and satisfaction questionnaire Cronbach's $\alpha = 0.94$

3.13 Data Collection

Baseline data was collected. This data includes: sociodemographic characteristic, medication(s) taken for hypertension, medication adherence and blood pressure. Data collection method using interview. No counseling, education or any type of intervention is performed during the data gathering. Patients receive medicines which were counted for 30 days' supply. Researcher and researcher assistants explain to patients that they only take medicine from the package were given to them this time for 30 days without taking any antihypertension that had left at their home. In this phase, patients were appointed to come to the health facility every 30 days for checkup and data gathering every 30 days continue for 3 times (3 months). In this phase during intervention at month 1, 2 and month 3 pill count and blood

pressure assessment were collected and record in same the record sheet (appendix I) from the baseline data collecting. This process was conducted by researcher and three research assistants. The process of pill count in this phase was conducted as same as in phase II which medication adherence was determined by using a percentage of adherence from pill count, meaning counting pills that have been taken relative to the number of pills that should have been taken.

Blood pressure was taken using calibrate manual mercury sphygmomanometer and was measured two times 2 minutes apart in the sitting position. Measured BP was calculated as the mean of the second BP values.

3.13 Outcome Measurement

The outcome of Phase II and Phase III is percentage of medical adherence and blood pressure, along with the mean medication adherence between the control and intervention groups.

3.14 Data Analysis

The study analyzed and used the statistical package for Social Sciences. SPSS version 17 for Windows was applied in this study. The statistical analysis is comprised of the two follow parts;

Part 1: Descriptive Statistics: Frequency and percentage was used to measure Socio-demographics analysis include; age, gender, education, occupation, number of year was hypertension diagnosed and number of medication taking.

Baseline characteristics between control and education to improve adherence program and Thai-intelligent pillbox group were compared using Chi square test.

Part 2: Compare the effects of intervention and control group.

- Mean, median and SD were used to measure medical adherence and blood pressure.

- Chi-square (test for categorical variables) and independent t-test (for continuous variables) to compare the baseline characteristics between the groups.
- Changes in medication adherence, BP, for phase II is compared using paired *t* tests.
- Changes in medication adherence, BP for phase III is compared between 2 group using student independent t-test.
- Repeated measures ANOVA was used to compare the effect of intervention over time.
- The dependent variable for this analysis is the change in medication adherence between the end of baseline and the conclusion of month 3 after intervention.

For the end point of phase III, analysis is performed according to the intention to treat principle. Patients who not complete the randomized trial because of death or withdrawal were analyzed by the imputation method of last data carried forward, using the medical adherence level at the conclusion of month 3 in phase III of this study.

3.15 Ethical Consideration

The study protocol was reviewed and approved by the Ethics Review committee of research involving human research subjects, Health Science Group, Chulalongkorn University and Ethics review committee of Buengkan Hospital.

Phase I and phase II: qualitative study and design and development of the Thai-intelligent pill box was approved by;

Buengkan Hospital Ethical approval Number: BKHEC2017-05

Phase III: A randomized controlled trial was approved by;

Chulalongkorn University Ethical approval Number: COA No.184/2560

Buengkan Hospital Ethical approval Number: BKHEC2018-01

Under the guidance of humans, the participants received a full explanation about the study including; the study purpose, process, benefits of the study and signed consent form participants prior participate in the program and answer the questionnaire. As for the control group, was provided education and participate in the education to improve adherence to antihypertension and hypertension control program. Participants were provided clearly explanation on the process of participate in the study which also provided clearly that they could rest or stop participate in the study whenever they want. And have right to ask any questions as well as fully receive explanation.

CHAPTER IV

4. RESULT

This study aimed to examine the effect of Thai-intelligent pill box, the utilization of a low-cost elderly friendly and simple electronic pill box to improve medication adherence in elderly with hypertension patients in the rural area northeast of Thailand.

This chapter showing result from the finding from 3 phases. The outcome from each phase is described in detail in this chapter. The three phases included;

1. Phase I: Thai-intelligent pill box design. We used the qualitative method by conduct in- dept interview in 22 elderly hypertension patients and 8 healthcare providers include 6 nurses, 1 pharmacist and 1 public health officer then incorporate their perception and recommendation into the design of the pill box. The sub sequence home visit to observed how patient manage their medication as well as store their medication at home was also performed.

2. Phase II: Thai-intelligent pill box development and implementation. This phase was a pilot project to test the efficacy and feasibility of the pill box. We also examine the satisfaction from using the pill box of 30 elderlies.

3. Phase III: A two arms unblinded randomized controlled trial. The unblinded parallel groups trial with participants randomly assigned to either the control group (receive only the education to improve medical adherence program) and the intervention group that receive the same education program and Thai-intelligent pill box. The assigned to each group in a 1:1 ratio. The study designed to compare before and after intervention between intervention and control group. The following period was 3

months after baseline. The outcome measure at 1 month, 2 months and 3 months after baseline.

4.1 Phases I

Thai-Intelligent pill box design.

These was 30 participants comprised of 22 elderly patients included 14 females and 8 males. And 8 health providers included 6 female nurses and 1 male pharmacist 1 public health officer. Elderly patients age between 60 to 71 years of age.

Summary of qualitative findings from interview patients.

The themes from the interviews and observation include:

1) Perception toward hypertension.

Many of the patients reported they understand that hypertension is a chronic lifelong disease. However, many of them reported that they don't believe that taking medicine will help and they have been taking medicine for a long period of time but still their blood pressure still high.

“Hypertension cannot be cure. Medicine that we are taking sometime not really help as I took it for a long time but still my blood pressure is high”

Most of participants are aware that the doctor's appointment is important. they think that coming to the hospital and following the appointment schedule is important because they need a chance to meet with doctor and check their blood pressure and other health related.

“I come to hospital and follow my appointment schedule every time at least to check my health condition”. (Male age 70 years)

2) Knowledge of hypertension and its treatment.

Most of participants do not know what causes hypertension. Most of them believe that older person tends to have hypertension.

“I do not know the cause of it but people who get older are more likely to have hypertension than young person.” (female age 65 years)

When asked about how to control hypertension, all of them knows that common treatments of high blood pressure is to avoid salty and oily food as well as taking antihypertension medication.

“Avoid salty and oily food and take medicine. I had heard people die from kidney failure from taking too much medicine, so I think maybe taking medicine is ok, but not as many as we are given.” (Female age 68 years)

When asked about the name of their medication, none of participants knew the name of the medication but they can identify what each medicine does (basically). All of them remember the colors and shape of the package and pills and based on this, they know which medicine to take. This is method used for all their medications.

“I don’t know the medicine’s name, but I know what it’s for and I can remember color, shape and package of medicine which that tells me if that medicine is for hypertension or not.” (Male age 69 years)

When asked how they receive information regarding hypertension and other chronic diseases, all of them commented they receive information from the hospital and health promoting hospital.

“While waiting to see doctor in hospital or health promoting hospital there were nurses who give information about hypertension and diabetes to us.” (Female age 74 years)

3) Reason of poor adherence to hypertension medication.

More than half of participants reported that they are taking medication according to their prescription but from the pill count results, it shows that they are in poor adherence to their treatment. Reason for poor adherence as following;

A. Patients use their routines of taking the same dose of medicine for a long period of time.

“I remember all my medicine, what and when to take because I took this medicine for more 5 years when doctor change, I still took the same”. (Female age 70 years)

B. For some patients who needed to take half or a quarter of the dosage, often took the wrong dosage due to misunderstanding the dosage instructions.

“I cut that white big hypertension medicine into four pieces and I took one piece the rest that left I throw them away. Some months I finish all the medicine in 10 days. (Female age 62 years)

C. New package of medicine from different company sometime caused confusion and patients will not take that medicine as they don't understand that medicine is the same.

“Doctor gave me new medicine. I don't see reason to take more medicine because I still have many left at home. (Male age 69 years).

D. Forgetfulness. All of patients reported that they sometimes forget to take hypertension medicine.

“I admit that many times I forget to take medicine due to my daily life activity”.

(Male age 62 years)

“When I go to the farm or go to the temple in the morning, I take breakfast there, but my medicine was at home and that make me miss taking that dose of medicine” (Male age 64 years)

E. Wanting to avoid potential side effects of medicine.

“When I take medicine, I feel tired, cough a lot and cannot sleep at night so I stop taking medicine.” (Female age 68 years)

F. No signs and symptoms. Many of participants mentioned, there are no signs and symptoms which leads them to believe there is no reason to continue taking medicine.

“I don’t feel like I need to take medicine because I don’t have any signs or symptoms. I don’t have headache or anything. I don’t see reason why I need to take medicine.” (Male age 66 years)

G. Belief that taking many medications would cause other serious health problems.

“We think that taking hypertension medicine for a long time will damage kidney and liver which is the reason why people have diabetes after hypertension so for me that’s why I don’t take medicine every day”. (Female age 67 years)

4) Self-care management at home of hypertension patients.

Most participants take care of themselves at home. They understand that to control their blood pressure just medicine is not enough. They need to control diet and exercise as well as control their stress.

“The doctor told us to take medicine and don’t eat salty and oily foods. I tried to follow the advice, but still every time I check my blood pressure it is still high”.

(Female age 67 years)

Most of patients expressed they do not consume salty or oily foods, however the researcher discovered that while the patients avoid salt, the seasonings they use are high in monosodium glutamate.

“My daughter is concerned that I have hypertension, so she does not put much salt in the food. She mostly uses fish sauce and roddee.” (Female age 69 years)

“We eat vegetables and nam prikplara (fermented fishes and salt) with fishes as it is easier to find than pork or other meat product”. (Male age 60 years)

All participants mentioned that even though they do not exercise regularly.

“I don’t have exercise regularly at least 3 time per week but I walk to temple every morning from my house to temple it takes about 15 minutes or more.”

(Female age 64 years)

5) Patients manage and store their hypertension medication at home.

All of participants managed their own medication. All participants store their medication in bags that contain many other prescription drugs. Expired medication was

commonly found being stored by the patients. New medication and old medicine were stored together in one place.

“I manage my own medicine and take it based on my routine as I have taken medicine for so long. I know better than anyone what to take.” (Female age 60 years)

In addition, most all the patients used a simple clear plastic bag for storage of their medicines and some stored their medicine in hot areas. None of the participants organized their medications in any way. Expired medicine was commonly found in their inventory of medications. None of the patients were aware of checking the expiry dates. In many cases, did not know how to check the expiration date.

“I do not know how to check and never checked expire date before. After I received medicine from hospital I put them all in the same place”. (male age 61 years)

When asked about how they do to help taking medication follow the prescription. Most of them report they do not do anything. They took medicine when they can remember.

“I do not do anything to help, I just take medication when I remember”. (male age 62 year)

6) Preferred pill box design

Researcher showing picture of existing pill box and asking if they will use the pill box to help them manage and remind them when to take medicine. Most of the participants reported they would use the box as they do not have to buy it.

“It will be good, but it must be expensive. If I can get the pill box for free I will use it. It will help remind me to take medicine”. (female age 68 years)

When asking participants what they preferred design of the pill box include the color, screen, size and ring sound of the box. Most of common answer were the white color is frequency reported from participants. Screen with light also common answers. The square shape and small size that not too big to carry around was recommended.

“White and simple to use. Square not too big that would be easy to carry around if I need to bring it with me”. (male age 70 years)

When researcher asking about experience using any pillbox, pill dispenser or pill reminder to help in manage their medication. Most of patients report that they do not use any of those only store medicine in the plastic package that health facility gave them. Only few reported that they use simple pillbox to store their medication especially when medicine need to be divide into half pill or one fourth of pill.

“I never used any of those pill box. (Male 64 years)

“I use small plastic pill box to help organized my medicine when I need to cut medicine to half” (female 71 years)

Some patients show their current pill box that they were using and provide opinion on problem and difficulty of using it. Some patient provide recommendation on the design base on the difficulty of using the existing pillbox.

“I use this pillbox for a long time I bought it from the store, the lid cover is very difficult to open when I open the lid sometimes the medicine falls out from the compartment. It would be better if a new can easily open”



Figure 4- 1 Existing pill box available in the study area

When researcher showed the initial Thai-intelligent pillbox picture and asked patients what function that they prefer in the Thai intelligent pill box. Most of participants prefer to have pillbox that simple to use as they manage medication themselves without any supervision.

“Pillbox that simple to use and set up will help me because something too high technology I will be afraid to use as I have no one help me when I take medicine”

(female 72 years)

Summary of qualitative findings from interview health care providers.

1) Target to achieve hypertension treatment and strategy to achieve target of hypertension treatment.

When researcher asking about the main objective to achieve hypertension treatment and what the strategy to achieve hypertension treatment. The most common answer was hypertension patient's blood pressure should be under control. Strategy to control blood pressure include diet, exercise, control stress and taking antihypertension medication.

“Patient's blood pressure should be under control and to achieve that we need patient participation. They need to control their diet, stress, exercise and taking medication follow the prescription”. (female nurse age 38 years and work in the chronic disease clinic for 3 years)

When asking about how to assess patient's selfcare. The common answer was check their blood pressure and asking patients if they take medication follow the prescription.

2) Hypertension medication management at home among elderly patients.

When asking about the patient's behavior from the health care provider perception and experience. The common answer was most of patients manage their own medication and only few who need family to help in manage medication. And one common answer about medication storage was patient mix old and new medicine in the same place.

“Most of the patients manage their own medicine and they remember medicine and what to take by the color and shape of medicine when we change company and give the same medication they do not take medicine then when they bring medicine home they mix new with old medicines”. (female nurse age 42 years and experience working in the chronic disease clinic for 5 years)

3) Antihypertension adherence among elderly patients.

When ask about patient medication adherence, most of common answer was patients are poor adherence to their medication.

“Patients do not take medicines that we gave. When we went for home visit we found so many medicines are left at their home”. (female nurse age 29 years, experience in the chronic disease clinic for 2 years)

4) Perception of introduce electronic pill box to patients.

Most of health care providers perception was positive when researcher gave the picture of existing pill box and asking their perception on introduce pill box to elderly patients.

“I think the pill box might help remind patient to take medicine”. (male pharmacist age 35 years, experience in the chronic disease clinic for 5 years)

“Try to make it simple to use our patients are older person they have to manage their own medicine” (female nurse age 38, experience in chronic disease clinic for 3 and a half years)

5) Recommend for pill box design

There are few keys idea that health care providers recommend in the feature of the pill box. 1)pill box should have chamber that separate each of medicine from each other 2) pill box should protect from light and humidity 3) the ring sound reminder should be loud. 4) The pill box should add name of patient, name of medication, dose of medication and time to take medication.

“The pill box should have chambers that can separate medicine and it should be simple to use”. (male pharmacist age 35 years, experience in the chronic disease clinic for 5 years)

“The pill box should protect medicine from sun light and humidity”. (female nurse age 38 years, experience working in the chronic disease clinic for 3 years)

“The pill box should be design that we can tell medicine, dosage, time and who is the box belong to (right drug, right dose and right patient)”. (female nurse age 49 years, experience working in the chronic disease clinic for 10 years)

Research incorporate information gathering from patients and health care providers into the design of the Thai intelligent pill box.

Key requirements of that the intelligent should have;

We had several keys requirements that generate the design of the intelligent pill box.

First, we require that the device should be multi-compartment pill box which number of the compartment should be at least 3-9 compartment according the minimum of medicine that patients taking per day.

Second, we require that the pill box should be simple and apply appropriate technology not too high as elders who live in the rural area are mostly low education and not familiar with high technology. The figuration that require a high technology but not appropriate for this study population.

Third, the intelligent pill box should be portable and can move around and carry when need to go work in the field or out for their daily life. Which mean the pill box should run by battery that small and easy to find in the community with affordable cost.

Fourth, the pill box should have reminding system and ability of identify time to take medication. We wish to create a pillbox that have reminding system that using reminding clock system not differ in use from the familiar product that elderly familiar to such as an alarm clock. This alarm system can be set and remind when to take medicine. Using color to separate and identify time to take medicine include; morning, Non, evening and before bed. We wish to create a pill box that help elderly who has a little bit of memory lost by using color to help them identify when to take medicine and which medicine to take at which time.

Fifth, the pill box should have the way to identify which pill box belong to whom by adding patient's name on the pill box. For health care provide or care taker to recheck of which medicine that elders are taking, Following the 5 R, right drug, right dose, right time, right method and right patients. All this information should be visible on the pillbox.

Sixth, we need pillbox that can help elders organized their medicine as well as inventory supply to help prevent taking medicine that expire.

From the key requirements above, we draw a design of the pill box and develop the prototype using 3D printer.

The first initial 30 prototype of the Thai -intelligent pill box were developed and test feasibility and function in Phase II



Figure 4- 2 Part of Thai-intelligent pill box.



Figure 4- 3 Initiate design the Thai-intelligent pill box.

4.2 Phase II

Thai-intelligent pill box development and implementation.

In this phase we examine the feasible and function of the Thai-intelligent pill box. We developed 30 a brand-new innovation Thai-intelligent pill box from 3 D printer. Prior testing the elderly with hypertension patients, we test the function to ensure it work properly and friendly for elderly to use.

The function we test before trial in patients included electronic part install properly, part that contact with medicine we ensure that it cover with plastic food grade, the LED light and sound of alarm. We found that the alarm sound can approximate hear

up to 12 meters for normal hearing person. The LED light work properly and alarm system work according to time setting.

In this phase we reported the result from our trial in 30 elderlies with hypertension patients. Patients perception and satisfaction of using the Thai-intelligent pill box also reported in this phase. This phase of study was conducted in BuengKan Sub-district which is about 15 kilometers distance from Non Somboon Sub-district where the Randomized Controlled Trail in phase III was conducted.

1. Baseline characteristic

There were 30 participants enroll in this phase of study. More than half of participants were female (60%). Most of participant were married (76.66%). Ninety perception of participants had education lower than high school and all of them still working in the agriculture. All of them has diabetes mellitus as co morbidity. The mean BMI of patients was 23.54. All of them had uncontrol blood pressure, systolic blood pressure mean was 154.07 mmHg and diastolic blood pressure mean was 86.56 mmHg All of participant taking more than 2 medicines per day. And most of them had been diagnosed hypertension for less than 10 years (96.67). Most of them poor adherence to their antihypertension medication (93%) from the pill count.

Table 4- 1 Baseline characteristics of the participants (n=30)

Sociodemographic characteristics	All participants (n=30)
Demographic characteristic	
Age, mean, (SD)	65.53(4.09)
Gender	
Female n, (%)	18(60)
Male	12(40)
Marital status, n, (%)	
No partner	7(23.33)
With married partner	23(76.66)
Education level n, (%)	
Lower than high school	27(90)
High school and higher	3(10)
Occupation, n, (%)	
Agriculture	30(100)
Type of care taker (%)	
Children	8(26.66)
Partner	22(73.34)
Other	
Type of insurance	
Universal Health Coverage Service for elderly	30(100)
Clinical characteristic	
Co-Morbidity (%)	

Sociodemographic characteristics	All participants (n=30)
HT and DM	30(100)
BMI mean, (SD)	23.53(1.41)
Systolic blood pressure means, (SD) mmHg	154.07(8.52)
Diastolic blood pressure means, (SD) mmHg	86.57(5.21)
Medication characteristic	
Type of medication taking /day (%)	
1-2 /day	0(0)
>2 /day	30(100)
Number of years being diagnosed (%)	
1-10 years	29(96.67)
>10 years	1(3.33)
Medical adherence rate means, (SD)	
Good adherence n, (%)	2(6.7)
Poor adherence	28(93)

SD, Standard deviation, HT, Hypertension, DM, Diabetes Mellitus

2. Antihypertension medication adherence before and after 2 weeks intervention.

There was statistical significant difference of antihypertension medication adherence before and after intervention mean different -22.96 (-28.57 to 17.36 CI) p value <0.001 (Table4-2)

Table 4- 2 Medical adherence for antihypertension before and after intervention

Outcome	Medical adherence baseline, mean, (SD)	Medical adherence after 2 weeks means, (SD)	Mean difference	95% (CI)*	P-Value
Thai-pill box (n=30)	56.53(15.23)	79.50(14.05)	-22.96	-28.57 to 17.36	<0.001

Significant at p-value <0.05

3. Blood pressure compare at baseline and 2 weeks after intervention.

There was no statistic significant different in both systolic and diastolic blood pressure in participants when compare before and after 2 weeks intervention.

Table 4- 3 Blood pressure at 2 weeks intervention compare before and after intervention.

Outcome (n=30)	Before intervention mean, (SD)	After one week mean, (SD)	Mean difference	95% (CI)*	P-Value
Systolic BP (mmHg)	154.07(8.52)	154.63(5.90)	-0.56	-3.22 to 2.08	0.66
Diastolic BP (mmHg)	86.57(5.21)	86.80(4.64)	-0.23	-2.53 to 2.06	0.83

Significant at P-value <0.05

4. Patient perception on using Thai-intelligent pill box.

The overall patient perception mean score for the Thai-intelligent pill box was 4.31 out of 5. Patients has mean score 4.53 out of 5 for helping simplify medication taking. The score for reminding to take medication was 4.30 out of 5, help in taking correct dose and time was 4.26 out of 5, help simplify daily life was 4.23 out of 5 and help gain confident when manage medication was 4.23 out of 5 (Table 4-4)

Table 4- 4 Patient's perception of using the Thai- intelligent pill box.

Perception	Mean (SD)/total
1. Pill box help in simplify medicine taking	4.53(0.68)/5
2. Pill box remind to take medication	4.30(0.65)/5
3. Pill box help in correct dose and time to take medicine	4.26(0.63)/5
4. Pill box help simplify daily life	4.23(0.62)/5

Perception	Mean (SD)/total
5. Pill box help in gain confident in manage medication	4.23(0.62)/5
Overall	4.31(0.52)/5

5. Patients satisfaction of using the Thai-intelligent pill box.

The overall patient satisfaction mean score for working function of the Thai-intelligent pill box was 4.04 out of 5. The satisfaction mean score on reminder function was 4.13 out of 5, medicine container was 3.96 out of 5, durable to use was 4.16 out of 5, simple to use was 4.16 out of 5 and size and chambers enough to contain all medicine was 3.86 out of 5 (Table 4- 5)

The overall patient satisfaction mean score for body and feature of the Thai-intelligent pill box was 3.90 out of 5. The satisfaction mean score on beautifully design and appropriate was 4.26 out of 5, size of the pill box was 4.23 out of 5, reminder sound was 4.20 out of 5, light of screen was 3.40 out of 5 and color was 3.40 out of 5 (Table 4-5)

Table 4- 5 Patient's satisfaction of using Thai-intelligent pill box.

Satisfaction	Mean (SD)/total
1. Thai-intelligent pill box work function (overall)	4.04(0.46)/5
- Reminder function	4.13(0.68)/5
- Medicine container	3.96(0.66)/5
- Durable to use	4.10(0.60)/5
- Simple to use	4.16(0.64)/5

Satisfaction	Mean (SD)/total
- Size and chambers enough to contain medicine	3.86(0.62)/5
2. Thai-intelligent pill box body and feature (overall)	3.90(0.58)/5
- Design beautiful and appropriate	4.26(0.63)/5
- Size of the pill box	4.23(0.62)/5
- Reminder sound	4.20(0.61)/5
- Screen light	3.40(0.81)/5
- Color	3.40(0.81)/5

The key finding from the trial to incorporate in the design of the Thai-intelligent pill box from patients included;

1. The glass door lid that protect medicine from weather should be more closed up to protect medicine from weather.
2. Manual function in Thai should be placed over the press buttons.
3. We uses this phase for find reliability of perception and satisfaction on using intelligent pill box questionnaire. Cronbach's alpha was 0.94, reliability was reported in chapter III.
4. Compartment in the pill box also was design for patients who need to take medicine half of the pill or a quarter of the pill. In the small compartment, the size is fit for those big pills that were cut into half or quarter.

4.3 Phase III

Intelligent pill box to improve medical adherence in elderly with hypertension.

A randomized controlled trial

This phase is the main part of study. To meet objectives of the study, we conducted a randomized controlled trial to examine the effect of the Thai-intelligent pill box on improve medical adherence among elderly with hypertension patients. We used result from phase II to finalize design and the Thai-intelligent pill box. The final design of the pill box which we add a close plastic box that found in the market to pill the pill box that we developed in to protect the pill box and medicine from weather. We add function manual over the manual buttons and highlight the stop alarm manual with the reflexional red color for elders to see it clearly. We use color to assist elders to identify time to take medicine. The orange color is for morning, dark blue for Non, pink for evening and yellow for before bed time. We remove the inventory design out of the final design. We add addition knowledge on how to invent of medication supply at home in the proper way with the materials that available in the community in the education program to improve medical adherence which provide to both intervention and control group. The final design of the pill box as shown in the figure 4-3



Figure 4- 4 Final design of the Thai-intelligent pill box.

This phase we report the result from the randomized controlled trial conducted in Non Sombon Health Promoting Hospital in Buengkan District. The finding of Phase III is reported as following;

Of the 200 elderly hypertension patients, 145 (72.5%) female and 55 (27.5%) male were randomized into this study. Patients in both groups were compared at baseline with

respect to demographic and clinical characteristics. Statistics found baseline characteristic were not significantly different between the intervention and control groups (p-value >0.05). The mean and standard deviation (SD) age of the elderly hypertension patients was 67.18(5.92) years. Most of patients were female (72.5%). Most of them are married (76%) and all the patients are literate, most of them had primary school education (84%). Most work in the agriculture field (66%). Almost half of them have married partners as care takers when sick (49%). All of them has universal Health Coverage Service for elderly (100%). Diabetes Mellitus (60.5%) was found to be most common co-morbidity among elderly patients. The mean baseline BP was 155/90 mmHg Patients have BMI ranging from 15.62 to 29.78. The baseline of medication characteristics was also similar between two groups, many of them (79%) were diagnosed hypertension from 1-10 years and take one or two medications per day (94.55%). Most of them poor adherence (90%) to their antihypertension medication (table 4-6).

Table 4- 6 Baseline comparison on characteristics of the participants (n=200)

Sociodemographic characteristics	All participants (n=200)	Intervention group (n=100)	Control group (n=100)	P-value
Demographic characteristic				
Age, mean, (SD)	67.28(5.92)	67.49(6.15)	66.88(5.70)	0.468
Gender				

Sociodemographic characteristics	All participants (n=200)	Intervention group (n=100)	Control group (n=100)	P-value
Female n, (%)	145(72.5)	74	71	0.752
Male	55(27.5)	26	29	
Marital status, n, (%)	48(24)	23	25	0.869
No partner	152(76)	77	75	
With married partner				
Education level n, (%)	168(84)	81	87	0.335
Lower than high school	32(16)	19	13	
High school and higher				
Occupation, n, (%)	132(66)	62	70	0.296
Agriculture	68(34)	38	30	
Another field include not working				
Type of care taker (%)	65(32.50)	18	19	0.979
Children	98(49)	50	48	
Partner	37(18.50)	32	33	
Other				
Clinical characteristic				
Co-Morbidity (%)				
HT and DM	121(60.50)	58	63	0.563

Sociodemographic characteristics	All participants (n=200)	Intervention group (n=100)	Control group (n=100)	P-value
HT and other	79(39.50)	42	37	
BMI mean, (SD)	24.06(3.04)	23.88(3.06)	24.23(3.02)	0.420
Systolic blood pressure means, (SD)	155.28(10.49)	154.51(11.15)	156.05(9.77)	0.300
Diastolic blood pressure means, (SD)	90.78(5.85)	90.47(6.13)	91.09(5.57)	0.455
Medication characteristic				
Number of medication/day (%)				
1-2 /day	189(94.55)	96	93	0.537
>2 /day	11(5.50)	4	7	
Number of years being diagnosed (%)				
1-10 years	158(79)	77	81	0.603
>10 years	42(21)	23	19	
Percentage of medical adherence means, (SD)	53.11(17.17)	53.62(17.49)	52.59(16.92)	0.672
Good adherence	16(10)	10	6	0.537
Poor adherence	184(90)	90	94	

SD, Standard deviation, HT, Hypertension, DM, Diabetes Miletus

Medical adherence between intervention and control group.

There was statistic significantly improvement of antihypertension medical adherence rate in both intervention and control groups at 3 months intervention. Both group, medical adherence was improved after 3 months intervention (mean difference 18.24 (95% CI;23.01 to 13.57), p-value <0.001) in intervention group and (mean difference 15.01 (95% CI; 20.33 to 9.68), p-value <0.001) in control group (table 4.7)

Table 4- 7 Medical adherence for all medication before and after 3 months intervention within group.

Group	Before intervention mean,(SD)	After intervention mean,(SD)	Mean difference between	95% (CI)*	P-Value
Intervention group	53.68(17.49)	71.92(16.37)	18.24	23.01 to 13.57	<0.001*
Control group	52.59(16.92)	67.60(18.31)	15.01	20.33 to 9.68	<0.001*

Significant at p-value <0.05

However, the group of patients that were given intelligent pill box had a greater improvement in the medical adherence rate than those in the control group after three months of follow up (mean difference 4.32(95% CI;-9.17to0.53), p-value <0.037)(table 4-8).

Table 4- 8 Medical adherence for all medication between intervention and control group before and after intervention

Outcome	Intervention group (n=100)	Control group (n=100)	Mean difference between group	95% (CI)*	P-Value
Medical adherence baseline, mean, (SD)	53.68(17.49)	52.59(16.92)	-1.09	-5.83 to 3.76	0.648
Medical adherence 3 months follow mean, (SD)	71.92(16.37)	67.60(18.31)	4.72	0.61 to 8.85	0.025*

Significant at p-value <0.05

Blood pressure at 3 months intervention between intervention and control group

There was no major effect was observed on systolic blood pressure after 3 months intervention (mean different 2.28 (95% CI;-1.64 to 6.22), p-value 0.252) while diastolic blood pressure was observed a significantly change difference between two groups after 3 months intervention. The mean diastolic blood pressure was 73.22 in intervention group and 76.69 in control group. The mean difference was 3.78(95% CI;1.06-5.86, p-value 0.005) (table 4-9).

Table 4- 9 Comparison of systolic and diastolic Blood pressure before and at 3rd months after intervention between intervention and control group.

Variables	Time	Intervention group (n=100)	Control group (n=100)	Mean difference	95% (CI)*	P-Value
Systolic BP mean, (SD)	baseline	154.51 (11.15)	156.05(9.77)	1.54	-1.38 to 4.46	0.300
	3 rd month	141.27 (13.58)	143.56(14.59)	2.28	-1.64 to 6.22	0.252
Diastolic BP mean, (SD)	baseline	90.47 (6.13)	91.09(5.57)	0.62	-1.014 to 2.25	0.455
	3 rd month	73.22 (8.22)	76.69(8.97)	3.78	1.06 to 5.86	0.005*

Significant at P-value <0.05

When compare the change over time of medical adherence between intervention and control group, there was no statistical significantly difference between two group at 1st and month, 2nd month. At month 3rd, there was statistical significant between intervention and control group (table 4-10)

Table 4- 10 Change of medical adherence over time from baseline to 3rd month between intervention and control group

Medical adherence	Intervention (n=100) Mean (SD)	Control (n=100) Mean (SD)	P-value
Baseline	53.62 (17.49)	52.59 (16.92)	0.672
1 st month	71.71(18.49)	70.64 (20.34)	0.699

Medical adherence	Intervention (n=100) Mean (SD)	Control (n=100) Mean (SD)	P-value
2 nd month	69.04 (18.12)	65.01(19.73)	0.134
3 rd month	71.92(16.37)	67.60 (18.38)	0.018*
P-value	<0.001	<0.001	
Bonferroni post-hoc analysis	A (p<0.001) B (p<0.001) C (p<0.001)	A (p<0.001) B (p<0.001) C (p<0.001)	

Notes : A : baseline versus 1st month; B : Baseline versus 2nd month; C : baseline versus 3rd month

There was no statistically significant difference in medical adherence between intervention and control group at month 1st and 2nd post intervention. Finally in month 3rd there was statistical significant difference in medical adherence percentage mean score between intervention and control groups (Figure 4- 4)

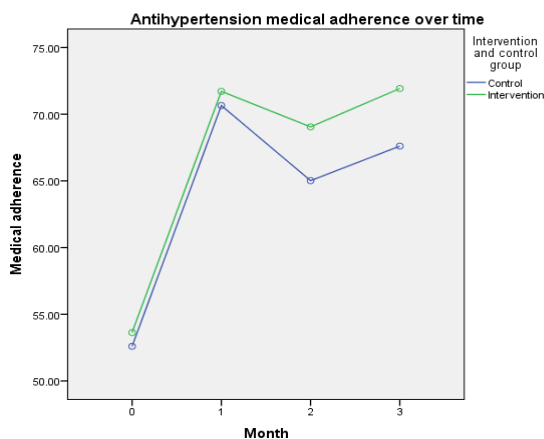


Figure 4- 5 Change of medical adherence baseline, 1st month, 2nd month and 3rd month between intervention and control group.

When compare the change over time of systolic blood pressure between intervention and control group, there was no statistical significantly difference between two group at 1st and month, 2nd month and 3rd month post intervention (table 4-11)

Table 4- 11 Change of systolic blood pressure over time from baseline to 3rd between intervention and control group

Medical adherence	Intervention (n=100) Mean (SD)	Control (n=100) Mean (SD)	P-value
Baseline	154.51 (11.15)	156.05(9.77)	0.300
1 st month	142.57(11.33)	144.70(10.91)	0.177
2 nd month	143.29(12.58)	145.62(12.58)	0.146
3 rd month	141.27(13.58)	143.56(14.59)	0.252
P-value	<0.001	<0.001	

Medical adherence	Intervention (n=100) Mean (SD)	Control (n=100) Mean (SD)	P-value
Bonferroni post-hoc analysis	A (p < 0.001)	A (p < 0.001)	
	B (p < 0.001)	B (p < 0.001)	
	C (p < 0.001)	C (p < 0.001)	

Notes A : baseline versus 1st month; B : Baseline versus 2nd month; C : baseline versus 3rd month

In each of the groups, the systolic blood pressure was no statistically significant different between the two groups at month 1st, 2nd and 3rd (figure 4-5).

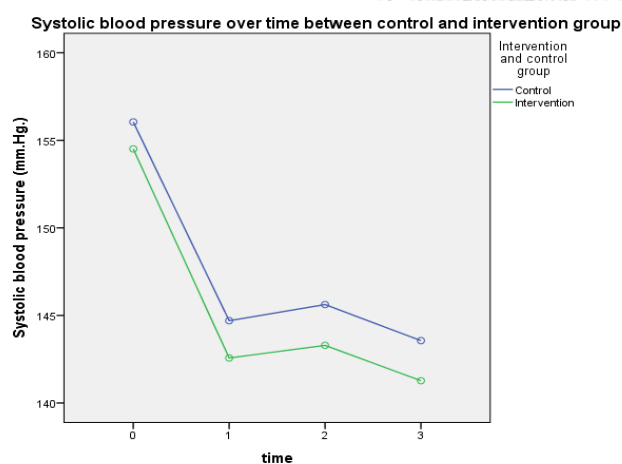


Figure 4- 6 Change of systolic blood pressure at baseline, 1st month, 2nd month and 3rd month

For diastolic blood pressure, there was no statistically significant difference between intervention and control group at 1st month and 2nd month. Finally, at 3rd month there is statistically significant between group intervention and control group in mean score of diastolic blood pressure mean score (p-value =0.005) (table 4-12)

Table 4- 12 Change of diastolic blood pressure over time from baseline to 3rd between intervention and control group

Medical adherence	Intervention (n=100) Mean (SD)	Control (n=100) Mean (SD)	P-value
Baseline	90.47(6.13)	91.09(5.57)	0.455
1 st month	82.59(8.01)	83.77(7.46)	0.283
2 nd month	84.27(11.72)	85.56(8.11)	0.367
3 rd month	73.22(8.22)	76.69(8.97)	0.005*
P-value	<0.001	P<0.001	
Bonferroni post-hoc analysis	A (p<0.001)	A (p<0.001)	
	B (p<0.001)	B (p<0.001)	
	C(p<0.001)	C (p0.001)	

Notes : A : baseline versus 1st month; B : Baseline versus 2nd month; C : baseline versus 3rd month

In each of the groups, the systolic blood pressure was no statistically significant different between the two groups at month 1st and 2nd. Finally in month 3rd there was statistically significant difference between two group (p value 0.005) (figure 4-6).

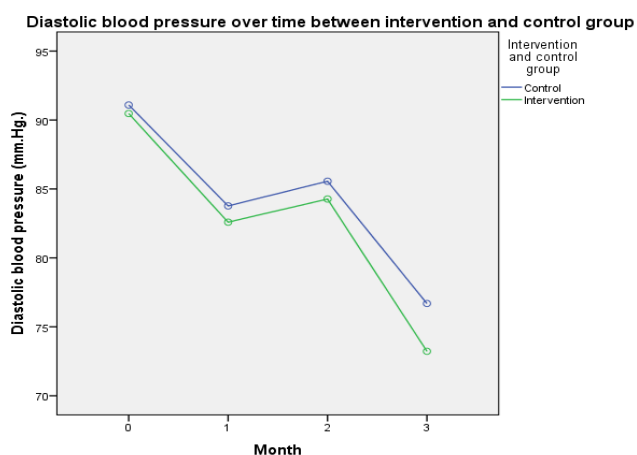


Figure 4- 7 Change of diastolic blood pressure at baseline, 1st month, 2nd month and 3rd month

4. Patient perception on using Thai-intelligent pill box.

The overall patient perception mean score for the Thai-intelligent pill box was 4.32 out of 5. Patients has mean score 4.62 out of 5 for helping simplify medication taking. The score for reminding to take medication was 4.28 out of 5, help in taking correct dose and time was 4.32 out of 5, help simplify daily life was 4.22 out of 5 and help gain confident when manage medication was 4.19 out of 5 (Table 4-13)

Table 4- 13 Patient's perception of using the T- intelligent pill box.

Perception	Mean (SD)/total
1. Pill box help in simplify to take medication	4.62(0.63)/5
2. Pill box remind to take medication	4.28(0.60)/5
3. Pill box help in correct dose and time to take medicine	4.32(0.61)/5
4. Pill box help simplify daily life	4.22(0.57)/5
5. Pill box help in gain confident in manage medication	4.19(0.56)/5

Perception	Mean (SD)/total
Overall	4.32(0.51)/5

5. Patients satisfaction of using the Thai-intelligent pill box.

The overall patient satisfaction mean score for work function of the Thai-intelligent pill box was 4.06 out of 5. The satisfaction mean score on reminder function was 4.28 out of 5, medicine container was 3.88 out of 5, durable to use was 4.13 out of 5, simple to use was 4.17 out of 5 and size and chambers enough to contain all medicine was 3.88 out of 5 (Table 4-14)

The overall patient satisfaction mean score for body and feature of the Thai-intelligent pill box was 3.90 out of 5. The satisfaction mean score on beautifully design and appropriate was 4.27 out of 5, size of the pill box was 4.20 out of 5, reminder sound was 4.17 out of 5, light of screen was 3.38 out of 5 and color was 3.51 out of 5 (Table 4-14)

Table 4- 14 Patient's satisfaction of using Thai-intelligent pill box.

Satisfaction	Mean (SD)/total
1. Thai-intelligent pill box work function	4.06(0.49)/5
- Reminder function	4.28(0.63)/5
- Medicine container	3.88(0.70)/5
- Durable to use	4.13(0.52)/5
- Simple to use	4.17(0.56)/5
- Size and chambers enough to contain medicine	3.88(0.68)/5
2. Thai-intelligent pill box body and feature	3.90(0.54)/5

- Design beautiful and appropriate	4.27(0.61)/5
- Size of the pill box	4.20(0.56)/5
- Reminder sound	4.17(0.56)/5
- Screen light	3.38(0.73)/5
- Color	3.51(0.82)/5

Patients recommendations

At the end of the study, we also asking recommendation and how they fell after using the Thai-intelligent pill box. The most common recommendation from patients included;

1. The visible of the Thai-intelligent pill box reminded patients that they need to take medicine and when the alarm ring it provide an accurate time to take medicine.
2. Color to identify time help in not have to find which medicine to take as patients only have to remember color of which time of the day to take which medicine.
3. Smaller size of the plastic box that help protect the pill tray from weather should be fit the medicine tray better.

CHAPTER V

5. DISCUSSION AND CONCLUSION

5.1 Phase I

Regarding elderly patient's perception on hypertension, participants understand that it is a chronic long-life disease, but they have little knowledge about hypertension and treatment. This phase was in line with study conducted in rural China, awareness about hypertension, treatment and control of hypertension, were low. There is an urgent need to provide knowledge about hypertension and improve the awareness among the population in the rural areas (16).

The results showed patients take wrong doses or wrong medicine. A few reasons given for this were relying on their memory to take the right dosage because they have taken medicine for a long period of time; also, for patients who are required to take partial doses, a misunderstanding of cutting the tablets and only taking a portion of what was cut. Additionally, prescription changes confuse some patients that are used to taking a medicine of a size and shape when a new prescription is given that is different from their previous prescription (16,17). Other common reasons among patients for poor adherence were forgetfulness. When no signs or symptoms, some patients believe their medicine is no longer required. By not taking their medicine, they believe they will avoid the potential side effects of the medicine. Our findings are like previous a qualitative study conducted in Southern Sweden, reason for non-adherence based on

patients misunderstanding of the condition and general disapproval of medication but mostly taken to facilitate daily life or minimize adverse side effect of medicine (17). The interview results are in line with study regarding hypertension treatment where adherence was found to be better among those patients who are only taking one medication per day, who never changed their medication regimen and those who continue visit the same doctor over time (18).

Other studies published similar key risk factors associated with poor adherence including: lack of a medication administration routine, therapeutic duplication, hoarding, confusion between generic and trade names, multiple prescribers, discontinued medication repeats retained and multiple storage locations(18,19). Forgetfulness, lack of effectiveness, adverse side effects and patient's general dissatisfaction with the medicine have also shown to be contributors to adherence levels (19,20). These studies also align with our proposition that there are several barriers for good adherence among elderly that need to be addressed (20). In addition, improved methods to provide accurate education to patients and the community for their education on the nature of hypertension and its treatment may be helpful to improving adherence among this group of patients (21,22,23).

There are several published works regarding the management of hypertension at home among elderly patients. This literature supports the idea that a controlled diet, exercise and adherence to medication will assist in control of blood pressure. Dietary habits among elderly in the rural areas in northeast of Thailand found that salty food is a

common diet habit among people living in these areas (24,25,26). The interview showed that there is still a lack of information provided to this group of patients as most of them misunderstand what constitutes a salty diet where they only focus on salt but no other salt products such as seasoning ingredients that contain high levels of monosodium glutamate.

From the interviews, many patients indicated that they were influenced by friends or others in the community to stop taking their medications because the perception is that taking this medicine over a long period of time could potentially lead to additional health problems. Therefore, the comprehensive education program for the community should be implemented. Providing education can't be the only solution to increase awareness of hypertension. Continued dialogue at the outpatient clinic for each visit, home visits by healthcare workers and family-based discussions will contribute to higher rates of adherence from the patients (25,26).

There are several of studies published regarding the management of medications, but not how the elderly store their hypertension and other medications at home. From our findings, results show that the elderly manage their own medication with little support or without any support from family members. Our findings showed that management of medication at home by elderly patients need supervision from health personnel and family to be able to adhere to their medication (27). Similar results but different in terms of storage. One study reported that one reason of poor adherence was that patients store their medication in multiple places which causes difficulty to

find medication which leads to poor adherence. Patients stored their medications in a single place but with no organization. This lack of organization was a contributor to taking the wrong medicine or medicine that was past its expiration date. Therefore, storage and organizing medicine is an urgent need to be addressed as patients continue taking expired medicine which may cause negative health outcomes. Providing education to the patients alone is not enough. It needs to be innovative and combined strategies for monitoring to determine whether the patient is taking their medication as per the prescription (28).

Regarding design of the intelligent pill box body and feature, both patients and health care providers recommends include, the small easy to carry around and simple to use in square shape, white color, simple ring tone with flashing light and loud was also common recommend. The name of the owner of the box, medication name, dose and time of medicine taking should be clearly write on the box were the strong recommend by health care providers. One of the most important key element recommend by health care providers was the pill box should have feature that can help protect medicines from weather such as heat, light and humidity.

We conducted qualitative study in a small sample size which may not be generalized to the wider population. This study conducted among elderly who live in the rural area with limited education. The results may not be generalized to elderly what live in the urban areas or patients who are well educated. To generalize to wider

population, a broader study should be conducted as some issues may be different in other segments of elderly population and culture.

Conclusion

This information could be used to propose design of the intelligent pill box. The pill box should be elderly friendly and simple to use. The finding from this phase will be incorporated in the development of the intelligent pill box to improve adherence among elderly living in the rural areas. Key factors from the finding that should be addressed when developing the pill box include; forgetfulness, misunderstanding of the prescription, configuration that other people can recheck and identify which medicine and pill box owner, prescription changes and lack of organization of stored medicines. The pill box should help protect medicines from damage from the weather.

5.2 Phase II

This pilot study was to examine the efficacy of the initial Thai-intelligent pill box in helping elderly improve their medical adherence to antihypertension medication. The proposed intelligent pill box called Thai-intelligent pill box is designed for long-term (storage) and short-term medication storage. The detection of time when to take medicine was controlled in the electronic board. The time to take the medicine, designed to work with the ring tone which will alarm follow the clock that can be set up. The clock can be set for 4 times reminder ring sound that will ring and repeat if patients do not take medicine or turn the ring off. When the scheduled time for medicine is up, the system will give the alarm to remind patient to take their medicine. At the same

time the light on the display screen will flashed. There are 9 compartments in medicine tray that can contain 9 types of medication. Each of the compartment can contain medicine from 15 to 30 tablets depend on the table size. Our reminder pillbox can be called smart or intelligent as it is more functional than existing reminder pillbox that available which provided alarm system on then the right time to take medication. It is smart design that design to be elderly friendly as its feature design to suitable for the need of elderly who have chronic disease and need to take multi medication to maintain their health status. However, there is still limitation of this pillbox design on its ability to protect from weather. This limitation should be considered and re design to finalize the final design of the pillbox.

Experimental result

We measure antihypertension medical adherence before and after two-weeks implementation and asking patients perception regards the use of the Thai-intelligent pill box and the satisfaction of patents after use the Thai-intelligent pill box. Result from our finding show the positive result. There was statistical significant different between before and after intervention in antihypertension medical adherence. Our finding consistent with previous study. That person who use pillbox is more likely to adhere to their medication more than those non user(133). Some previous study applied the reminder pill box as intervention that also provided positive outcome on improve adherence among patients this may be due to the reminder pillbox or devices help in improve medical adherence by remind patient to take medicine and ensure of

the right dose and schedule. Our pillbox design has an clear glass lid which label dose and time to take medicine clearly also help patient understand better on which medicine to take and what dose to take. Our pillbox also has ability and make simplify when the care taker or health care provider need to recheck if patients taking medication follow schedule by pill count. The health care provider or care taker can count pills in each compartment and re check whether patient follow drug prescription regiment.

However, there was no different change of blood pressure found between before and intervention. Previous studies recommended that hypertension patients who adhere to their antihypertension will help in control their blood pressure and lower blood pressure. A 25 % increase in medical adherence associated with a 1.0 mmHg and 1.2 mmHg reduction in systolic and diastolic blood pressure(12, 134). In our finding there was no reduction of blood pressure this may be because the main reason is that all patients participate in the phase of study have diabetes and hypertension; previous study explained that hypertension patients who has diabetes as comorbidity has difficulty to control blood pressure and control blood sugar. And for those who has high blood sugar tend to have difficulty to their uncontrol blood pressure(135).

We found patients perception was positive, overall perception regards experience after using the Thai-intelligent pill box was positive with mean score 4.53 out of 5. For the patient's satisfaction of the Thai-intelligent pill box function was positive with mean score 4.04 out of 5. And patient's satisfaction of the body and feature of the pill box

was 3.90 out of 5. This maybe as the Thai pillbox is new for participants and help in reminder for them to take medicine which consistent with previously study that using the reminder pillbox as intervention result show the positive perception and satisfaction among user as most of the user who use pillbox and select to use based on the need of the person and demands of personal habits and medical regiments (133). We design the Thai-intelligent pill box based on patients and health care providers perception and recommendation which is may be because our pill box design suitable for their need and their medication regiments which lead to a positive result in perception and satisfaction.

Conclusion

From the key finding suggested that the design of the Thai-intelligent pill box is appropriate and friendly use among elderly with hypertension patients. The result show that using the Thai-intelligent pill box help elderly improve their medical adherence. This design should be expanded for a bigger scale and examine the effect of the Thai-intelligent pill box in a bigger sample size with a respective research design.

5.3 Phase III

The main objective of this phase was to examine the effects of the Thai- intelligent pill box to improve medication adherence and help in the control of blood pressure among elderly persons with hypertension in rural area of Thailand. The primary outcome results from our finding showed that the Thai- intelligent pill box improves medical adherence rate by approximately 4.32 % at 3 months post intervention. For

the secondary outcome, we found no statistical significant difference of systolic blood pressure between two groups. We found diastolic blood pressure was significantly different in intervention and control group. In intervention group diastolic blood pressure was reduced 3.78 mmHg which lower than in the control group. However, while statistical significance was not achieved in the systolic blood pressure in the Thai-intelligent pill box trial, the data showed a trend of reducing and controlling blood pressure levels. This result suggests using Thai-intelligent pill box when medical adherence was improved there is no reduction in systolic blood pressure after three months post intervention. For diastolic blood pressure, it is more likely to be controlled when patients adhere to their antihypertension medication. Using Thai-intelligent pill box to manage elderly antihypertension medication and reminding to take medication at the right time maybe the reason on lower of diastolic blood pressure.

Our study results are in line with several previous studies that had used a pill box as a reminder and organizing medication. Results from using the pill box showed a positive outcome on medical adherence(136, 137). There were several previous studies that have focused on improving antihypertension medication adherence among elderly group by using pill box as intervention. However, the design of the pill box from each study are different but have similar features and functions (138, 139). The pill boxes were used to support medication management, used as memory aids, used as reminder calendar which may help in cognitive effort and support memory.

Previous studies have shown that patients with hypertension who have good adherence to their antihypertension medications maintain appropriate blood pressure levels. Our study is in line with previous studies, where the results showed that patients who are adherent to antihypertensive medications are 45% more likely to achieve blood pressure control(140). A 25% increase in medication adherence has also been associated with a 1.0 millimeter of mercury and a 1.2 millimeter of mercury reduction in systolic and diastolic blood pressures(37, 141). In our study, systolic blood pressure was not significantly reduced when compared between intervention and control group, but diastolic blood pressure was reduced, and the trend showed a decrease of blood pressure among two groups. There are few studies testing effects of using the reminder pill box show positive outcomes on improved medical adherence among patients. However, results show no significant change in blood pressure control. In this our study when consider the percentage of medical adherence among elderly, the mean of medical adherence is approximately 70 % when study and world health organization recommended that for hypertension patients to successful of treatment medical adherence should reach 80 %. This may also the reason of systolic blood pressure still remind uncontrol in both intervention and control group. Moreover, attribution of multiple risk fastors related to high blood pressure. And, adherence to medication treatment is not the only method for controlling blood pressure. Studies suggest adherence to hypertension treatment, modification of life style by eating healthy foods

with low sodium and fat, sufficient fruits and vegetables, regularly physical activity, and exercise as well as controlling stress will help in controlling blood pressure(142).

Results from our study supported that the Thai- intelligent pill box could improve medical adherence and use of the Thai-intelligent pill box should be applied to assist elderly to monitoring and manage other their adherence to other chronic disease medications. Another point that should be considered is with the growth of the Internet of Things, this should be added as a feature of the pill box and test its feasibility with elderly who live in urban areas where internet connectivity is available. This may be a good opportunity to improve medical adherence among elderly when using the pill box that can be used as a time reminder, dosages and rechecked when elderly take wrong medication or wrong dosage. In addition, the ability to send a message on adherence information to care taker or health care provider can help elderly to be in good adhere to their medication. While the clinical efficiency of the pill box is positive, cost analysis is necessary for a greater group of users when implementing the pill box. The health care provider could apply the intelligent pill box to the usual program in improve medication adherence among elderly.

In our study, the medication adherence improved in both group when compare before and after 3 months intervention. This maybe happened because during the implementation of the study, there was a new strategy and method to provide usual care to chronic patients in the health promoting hospital and the effect of the education program to improve medical adherence that we provided in both group of

study. Before we conducted the study, the usual care of the education program was provided by the village health volunteer at their home after patients receive medication from their checked up. During our intervention, the usual care education on pharmacy and medication was provided to patients by register nurses at the health facility. This might be the main reason on the improve of medical adherence in the control group.

Patient perception and satisfaction of using the Thai-intelligent pill box were positive. The mean score of the perception on using the pill box was 4.62 out of 5. And the mean score of patient's satisfaction on the working function was 4.06 out of 5. For the patient's satisfactions on the Thai-intelligent pill box body and feature was 3.90 after using the Thai-intelligent pill box for 3 months. Our finding consistent with other studies that using pillbox in the intervention to improve medical adherence among chronic diseases patients. The study evaluated if participants were satisfied with the pillbox. In our study we assessed elderly patient's experiences of using the pillbox. Result from previous study showed that patients who used pillbox found as pillbox is being helpful(143). However, study recommended that some patients did not use the pillbox all the intervention period which required the multicomponent intervention consisting of pharmacist delivered education, and pillbox reminder(144).

Strengths, limitation, and recommendation for further study.

The strength of our study was we identified the rate of medical adherence using pill count which is recommended for the most accurate way to identify medical

adherence((145, 146). Another strength was that after 3 months intervention, we provided high (96%) completed rate of participant complete 3 months period of study. We had developed the intelligent pill box that was suitable for the needs for elderly according to their recommendations on the important features of the pill box. This study has few limitations. The research assistants were not blinded when conducted pill count. However, the pill count was conducted by three research assistants who had no relationship with participants and cross checked of the number of pill that were counted to ensure the number of pills is accurate. We focused only on antihypertension medication; thus, we did not include medications for other diseases or other nonprescription in the analyses. Research assistants were unblinded during data collection at baseline even though they did not have contact with participants during randomization and after 3 months data collection, they were not blinded to study arm assignment to data collection which could lead to unconscious bias to data collection at 3 months. This study was conducted in the rural area with a population with low education levels. The results may not be generalization to all elderly persons with hypertension.

Recommendation

This recommendation in this phase of study, we incorporated the finding from phase I to phase II and draw the recommendation from all three phases from our finding. Medication adherence is a complex behavior and multifactor related to non-adherence. There are two components of non-adherence to medication which include

intentional non-adherence and unintentional non-adherence. Non-adherence behavior could be influenced by factors from patients and health care system which include health care providers and the method on delivery of health education or message to patients. Patients related factors include unintentional factors, which often found worsen in those patients who has complex medication regimens which come from forgetting to take medicine or obtain refills and lack of understanding of dose and schedules. And intentional factors which come from patient's decision, beliefs and perception about their health problem and its treatment. To improve medication adherence, the comprehensive strategies that address both unintentional and internal factors related to non-adherence. From our study, we not only develop the Thai-intelligent pill box to help elderly patients to improve their adherence to antihypertension, we also develop an education program to improve medical adherence. The Thai-intelligent pill box only assist in the unintentional non-adherence however for those intentional non-adherences more work should be focus in the patient related barriers include lack of engagement in treatment decision. And provided related factors which include communication between health care providers, care givers on complex dosage of medication regimens. The more important related barrier that should be focus was the coordination between the multiple health care providers in the prescription, refills, clear medication labelling and clear instructions of how to take medication that provide to patients.

Our Thai-intelligent pillbox that developed in this study provide a positive effect on medical adherence improvement and elderly find it useful to help them with their forgetfulness of when to take medicine. For future study, to evaluate the effect of the pill box should focus in patients who are non-intentional adherence to medication regimen. For the further study, to strengthen the function of the pillbox, internet of things should be added in feature of the pillbox and conduct trial in the urban residents that internet access will not be barrier to delivery intervention.

Conclusion

This study demonstrated that the Thai-intelligent pill box improves antihypertension adherence when compared to usual education program among elderly with uncontrolled blood pressure in rural area. To improve the reduction of blood pressure the comprehensive program that include good health behavior among hypertension patients should be implement and incorporate in the program to improve medical adherence and control of blood pressure among elderly with hypertension patients.



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Appendix I

Questionnaire



แบบสัมภาษณ์

ลำดับที่.....

แบบสัมภาษณ์นี้เป็นส่วนหนึ่งของการวิจัย เรื่อง **กล่องยาอัจฉริยะส่งเสริมความร่วมมือในการรับประทานยาความดันโลหิตสูง สำหรับผู้สูงอายุที่มีภาวะความดันโลหิตสูง : การวิจัยเชิงทดลองแบบสุ่มและมีกลุ่มควบคุม** โดยการศึกษาในครั้งนี้เป็นส่วนหนึ่งของการศึกษาระดับปริญญา ดุษฎีบัณฑิต วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย

วัตถุประสงค์ของการวิจัยในครั้งนี้เพื่อพัฒนากล่องจ่ายยาอัตโนมัติที่เหมาะสมกับผู้สูงอายุและช่วยเพิ่มความร่วมมือในการรับประทานยาในผู้สูงอายุที่มีภาวะความดันโลหิตสูง ซึ่งจะเป็นประโยชน์ในการรักษาระดับความดันโลหิตและป้องกันภาวะแทรกซ้อนของการรับประทานยาความดันโลหิตสูงไม่ต่อเนื่องหรือขาดยาในผู้ป่วยผู้สูงอายุที่มีความดันโลหิตสูง

อนึ่งการตอบแบบสัมภาษณ์ในครั้งนี้เป็นการให้ข้อมูลตามความสมัครใจของผู้ตอบและผู้วิจัย จะไม่เปิดเผยชื่อผู้ให้ข้อมูล และข้อมูลจะถูกเก็บไว้เป็นความลับสำหรับการวิจัยเท่านั้น จะไม่มีผลกระทบใด ๆ ต่อผู้ตอบแบบสัมภาษณ์และครอบครัว

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แบบสัมภาษณ์ผู้ป่วยความดันโลหิตสูง

กล่องยาอัจฉริยะเพิ่มความร่วมมือในการรับประทานยาความดันโลหิตสูง ในผู้สูงอายุที่มีความดันโลหิตสูง : การวิจัยเชิงทดลองแบบสุ่ม

ประกอบไปด้วย 3 ส่วน ดังนี้

ส่วนที่ 1: ข้อมูลทั่วไป จำนวน 12 ข้อ

ส่วนที่ 2: การรับรู้เกี่ยวกับภาวะสุขภาพ 4 ข้อ

คำชี้แจง:โปรดทำเครื่องหมาย ลงในช่อง ตามข้อมูลที่ได้รับจากการสัมภาษณ์

ผู้ป่วย

ผู้บันทึกข้อมูล (ชื่อ-สกุล).....

วันที่บันทึกข้อมูล.....

รหัส(ผู้ให้ข้อมูล).....

กลุ่ม ควบคุม..... กลุ่ม ได้รับกล่องยาอัจฉริยะ.....

ส่วนที่ 1 ข้อมูลทั่วไป		
1. เพศ	<input type="checkbox"/> 1.ชาย <input type="checkbox"/> 2.หญิง	2Gen.....
2. อายุ ปี	3Age.....
3. บุคคลที่ดูแลท่านเป็นประจำ	<input type="checkbox"/> 0. ไม่มีผู้ดูแล ระบุเหตุผล <input type="checkbox"/> 1.สามี/ภรรยา <input type="checkbox"/> 2.บุตรชาย <input type="checkbox"/> 3. บุตรสาว <input type="checkbox"/> 4.บุตรเขย /บุตรสะใภ้ <input type="checkbox"/> 5. หลาน <input type="checkbox"/> 6.ญาติ <input type="checkbox"/> 7.อื่นๆ (ระบุ).....	11LCare.....
4. เมื่อท่านเจ็บป่วย บุคคลใดดูแลท่าน	<input type="checkbox"/> 0. ไม่มีผู้ดูแล ระบุเหตุผล	12Icare.....

	<input type="checkbox"/> 1.สามี/ภรรยา <input type="checkbox"/> 2.บุตรชาย <input type="checkbox"/> 3. บุตรสาว <input type="checkbox"/> 4.บุตรเขย /บุตรสะใภ้ <input type="checkbox"/> 5. หลาน <input type="checkbox"/> 6.ญาติ <input type="checkbox"/> 7. อื่นๆ (ระบุ).....	
5. การใช้อุปกรณ์ช่วย ท่านใช้อุปกรณ์ช่วยเหลือใดบ้างในการใช้ชีวิตประจำวัน	<input type="checkbox"/> (0) ไม่ได้ใช้ <input type="checkbox"/> (1) ใช้ (ตอบได้มากกว่า 1 ข้อ) <input type="checkbox"/> (1.1) แวนตา <input type="checkbox"/> (1.2) ไม้เท้า <input type="checkbox"/> (1.3) ไม้เท้าสามขา <input type="checkbox"/> (1.4) คอกช่วยเดิน <input type="checkbox"/> (1.5) เครื่องช่วยฟัง <input type="checkbox"/> (1.6) รถเข็น <input type="checkbox"/> (1.7) อื่นๆ ระบุ.....	14.equipuse
6. ท่านเดินทางไปรับการรักษาด้วยวิธีใด	<input type="checkbox"/> 1.ไปเอง <input type="checkbox"/> 2.มีคนพาไป ส่วนใหญ่ผู้ที่พาไปรับการรักษาพยาบาล คือ <input type="checkbox"/> 1.ลูก/หลาน <input type="checkbox"/> 2.คู่สมรส <input type="checkbox"/> 3.เพื่อนบ้าน <input type="checkbox"/> 4. อื่นๆ (ระบุ).....	16Trav.....
7. ท่านมีสวัสดิการการรักษาพยาบาลหรือไม่	<input type="checkbox"/> 0.ไม่มี เนื่องจาก..... <input type="checkbox"/> 1.มี ท่านใช้สิทธิการรักษาใด <input type="checkbox"/> 1.สิทธิประกันสุขภาพประเภทผู้สูงอายุ <input type="checkbox"/> 2.สิทธิข้าราชการ <input type="checkbox"/> 3. สิทธิประกันสังคม <input type="checkbox"/> 4.สิทธิประกันชีวิต <input type="checkbox"/> 5. อื่นๆ (ระบุ)	18insur..... 18right... .. 18Used...

	ท่านใช้สิทธิการรักษา ^{ขั้น} หรือไม่ว <input type="checkbox"/> 1.ใช้สิทธิรักษา <input type="checkbox"/> 0.ไม่ใช้สิทธิรักษาเนื่องจาก	
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แบบสัมภาษณ์ทัศนคติและความพึงพอใจ ต่อการใช้กล่องยาอัจฉริยะในผู้ป่วยความดันโลหิตสูง
 ส่วนที่ 1 : ทัศนคติต่อการใช้กล่องยาอัจฉริยะ

ข้อ ที่	ทัศนคติที่มีต่อการใช้ กล่องยาอัจฉริยะ	ระดับความคิดเห็น				
		เห็นด้วย อย่างยิ่ง	เห็นด้วย	เฉย ๆ	ไม่เห็น ด้วย	ไม่เห็น ด้วย อย่างยิ่ง
1.	กล่องยาอัจฉริยะทำให้ การรับประทานยาความ ดันโลหิตสูงของท่านง่าย ขึ้น	5	4	3	2	1
2.	กล่องยาอัจฉริยะช่วยให้ ท่านไม่ลืมรับประทานยา	5	4	3	2	1
3.	กล่องยาอัจฉริยะช่วยให้ ท่านรับประทานยาได้ ถูกต้องในแต่ละมื้อ	5	4	3	2	1
4.	ท่านรู้สึกสะดวกสบายใน การปฏิบัติกิจวัตร ประจำวันเมื่อใช้กล่องยา อัจฉริยะ	5	4	3	2	1

ข้อ ที่	ทัศนคติที่มีต่อการใช้ กล่องยาอัจฉริยะ	ระดับความคิดเห็น				
		เห็นด้วย อย่างยิ่ง	เห็นด้วย	เฉย ๆ	ไม่เห็น ด้วย	ไม่เห็น ด้วย อย่าง ยิ่ง
5.	ท่านรู้สึกมั่นใจในการ รับประทานยาเมื่อใช้ กล่องยาอัจฉริยะในการ บริหารยาความดันโลหิต สูง	5	4	3	2	1

ส่วนที่ 2 :แบบสอบถามความพึงพอใจต่อการใช้กล่องยาอัจฉริยะในผู้ป่วยความดันโลหิตสูง

ข้อ ที่	ความพึงพอใจที่มีต่อการ ใช้กล่องยาอัจฉริยะ	ระดับความคิดเห็น				
		เห็นด้วย อย่างยิ่ง	เห็นด้วย	เฉย ๆ	ไม่เห็น ด้วย	ไม่เห็น ด้วย อย่าง ยิ่ง
1.	การเตือนเวลาการ รับประทานยา	5	4	3	2	1
2.	การบรรจุและนำยา ออกไปรับประทาน	5	4	3	2	1
3.	ความคงทนในการใช้งาน	5	4	3	2	1
4.	ความง่ายและสะดวกใน การใช้งาน	5	4	3	2	1

ข้อ ที่	ความพึงพอใจที่มีต่อการ ใช้กล่องยาอัจฉริยะ	ระดับความคิดเห็น				
		เห็นด้วย อย่างยิ่ง	เห็นด้วย	เฉย ๆ	ไม่เห็น ด้วย	ไม่เห็น ด้วย อย่าง ยิ่ง
5.	กล่องสามารถบรรจุขนาด ของยาได้ตามที่ท่าน ต้องการและเพียงพอ	5	4	3	2	1
ด้านการตัวกล่อง						
1.	การออกแบบที่สวยงาม และเหมาะสมกับผู้สูงอายุ	5	4	3	2	1
2.	ขนาดของกล่องเหมาะสม	5	4	3	2	1
3.	เสียงเตือนที่ใช้เหมาะสม	5	4	3	2	1
4.	แสงที่ใช้เตือนเหมาะสม	5	4	3	2	1
5.	สีของตัวกล่องเหมาะสม	5	4	3	2	1

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ข้อเสนอแนะ

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ตารางบันทึกผลการรักษาความดันโลหิตสูงและการรับประทานยาอย่างสม่ำเสมอจากการนับยา

รหัสอายุ.....ปี

ปีที่เริ่มวินิจฉัยความดันโลหิตสูงครั้งแรก.....วินิจฉัยโรคอื่น ๆ.....

วันที่	น้ำหนัก/ ส่วนสูง	รอบ เอว (cm.)	ความดัน โลหิต (mmHg)	การรักษา/ ชื่อยาและ ขนาด	อาการ ผิดปกติ	ความร่วมมือ ในการ รับประทานยา โดยนับเม็ด ยา***	วัน นัด/ผู้ บันทึก

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หมายเหตุ : การชั่งน้ำหนัก ประเมินโดยผู้วิจัยและผู้ช่วยนักวิจัย โดยเครื่องชั่งน้ำหนักที่ผ่านการ
ตรวจสอบมาตรฐาน ทุกเดือนและเป็นเครื่องเดียวตลอดการวิจัย การวัดส่วนสูง โดยผู้วิจัยและผู้ช่วย
วิจัย โดยวัดโดยเครื่องมือเดียวกันตลอดการวิจัย การวัดความดันโลหิตโดยพยาบาลวิชาชีพ

Appendix II

In-depth Interview Guide



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แนวทางการสัมภาษณ์ผู้ป่วยความดันโลหิตสูง

ตามแนวคิดการอธิบายโรค การปฏิบัติตน การดูแลรักษาโรคความดันโลหิตสูง และการ
รับประทานยาและการจัดยาความดันโลหิตสูง

1. ท่านคิดและเข้าใจอย่างไรเกี่ยวกับ “ความดันโลหิตสูง” ที่ท่านเป็นอยู่?
2. ท่านคิดว่าอะไรเป็นสาเหตุของการป่วยเป็นความดันโลหิตสูง เพราะอะไร?
3. ท่านคิดว่าใครที่สามารถเป็นโรคความดันโลหิตสูงได้บ้าง เพราะอะไร?
4. โรคความดันโลหิตสูงมีผลกระทบต่อชีวิตของท่านอย่างไรบ้าง?
5. ท่านคิดว่า ณ เวลานี้การเจ็บป่วยด้วยโรคความดันโลหิตสูงของท่านรุนแรง หรือไม่ เพราะเหตุใด?
6. ท่านมีวิธีการในการดำเนินชีวิตเพื่อควบคุมโรคความดันโลหิตสูงอย่างไรบ้าง?
7. ท่านรู้สึกกลัวหรือกังวลกับโรคความดันโลหิตสูงที่ท่านเป็นอยู่หรือไม่ เพราะเหตุใด?
8. มีวิธีใดที่จะลดความกลัว หรือกังวลที่ท่านมีต่อการเป็นโรคความดันโลหิตสูงของท่าน?
9. ท่านคิดว่าการรักษาที่ได้รับอยู่ในปัจจุบันดี เหมาะสมหรือไม่ เพราะเหตุใด?
10. ท่านคิดว่ามีวิธีการรักษาที่สามารถทำให้ท่านหายขาดจากการเป็นโรคความดันโลหิตสูงได้หรือไม่ เพราะเหตุใด?
11. การรักษาโรคความดันโลหิตสูงแบบใดที่ท่านปรารถนา เพราะอะไร?
12. การรักษาโรคความดันโลหิตสูงที่ท่านได้รับอยู่ในปัจจุบันทำให้ท่านหวาดกลัว หรือวิตกกังวลหรือไม่ เพราะเหตุใด?
13. ท่านคิดว่าท่านรับประทานยารักษาความดันโลหิตสูงเป็นประจำหรือไม่?
14. ท่านจัดยาความดันโลหิตสูงด้วยตัวเองหรือไม่ ถ้าไม่ใครเป็นคนจัดยาให้ท่าน?
15. ท่านมีวิธีในการจัดยาความดันโลหิตสูงอย่างไร?
16. ท่านมีวิธีในการช่วยให้ท่านรับประทานยาความดันโลหิตสูงได้ถูกต้องตามแผนการรักษาของแพทย์อย่างไร?
17. ท่านมีข้อเสนอแนะในการช่วยให้ท่านรับประทานยารักษาโรคความดันโลหิตสูงได้ถูกต้องอย่างไร?
18. ท่านคิดอย่างไรหากมีกล่องยาที่สามารถช่วยในการเตือนการรับประทานยารักษาโรคความดันโลหิตสูงของท่าน?
19. การออกแบบและขนาดของตัวกล่องยาที่ท่านปรารถนาเป็นอย่างไร?
20. สีของกล่องยาที่ท่านชื่นชอบและเหมาะสมกับท่านควรเป็นอย่างไร?

21. หน้าจอและแสงเตือนเมื่อถึงเวลารับประทานยาที่เหมาะสมกับท่านควรเป็นอย่างไร?
22. เสียงเตือนเมื่อถึงเวลารับประทานยาที่ท่านปรารถนาควรเป็นอย่างไร?

แนวทางการสัมภาษณ์เชิงลึกบุคลากรสาธารณสุข
คลินิกโรคเรื้อรัง โรงพยาบาลบึงกาฬ จังหวัดบึงกาฬ

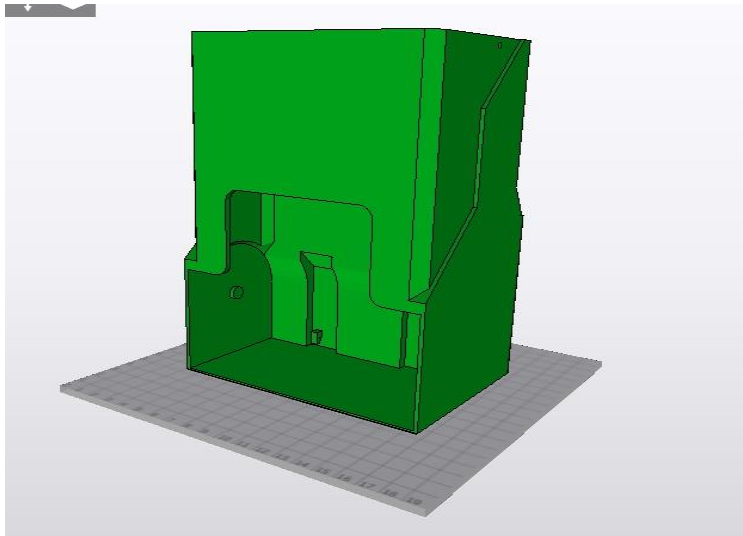
1. อะไรที่ท่านคิดว่าเป็นเป้าหมายในการดูแลรักษาผู้ป่วยความดันโลหิตสูงในสถานบริการของท่าน?
2. ท่านมีวิธีการ หรือ กลวิธี การดูแลรักษาผู้ป่วยความดันโลหิตสูงอย่างไร เพื่อให้บรรลุเป้าหมายที่ท่านตั้งไว้ตามข้อ (1)
3. ท่านประเมินผลการดูแลรักษาผู้ป่วยอย่างไร เพื่อบ่งชี้ว่าท่านบรรลุเป้าหมายที่ท่านตั้งไว้?
4. หลังจากประเมินผลการดูแลรักษาผู้ป่วยความดันโลหิตสูงของท่าน พบว่า บรรลุ/ไม่บรรลุเป้าหมายที่ตั้งไว้ ท่านว่าเพราะอะไร และจะแก้ไข/พัฒนาอย่างไร?
5. จากประสบการณ์ของท่านผู้ป่วยความดันโลหิตสูงมีการจัดยาอย่างไร
6. จากประสบการณ์การทำงานของท่านผู้ป่วยความดันโลหิตสูงมีความร่วมมือในการรับประทานยาเป็นอย่างไร
7. ท่านมีแนวทางในการส่งเสริมความร่วมมือในการรับประทานยาของผู้ป่วยความดันโลหิตสูงอย่างไร
8. ท่านมีความคิดเห็นอย่างไรหากมีการใช้กล่องยาที่สามารถเตือนผู้ป่วยในการรับประทานยา และช่วยในการบริหารยา
9. ท่านมีข้อเสนอแนะในการออกแบบกล่องยาที่ช่วยส่งเสริมความร่วมมือในการรับประทานยาของผู้ป่วยความดันโลหิตสูงอย่างไร

Appendix III

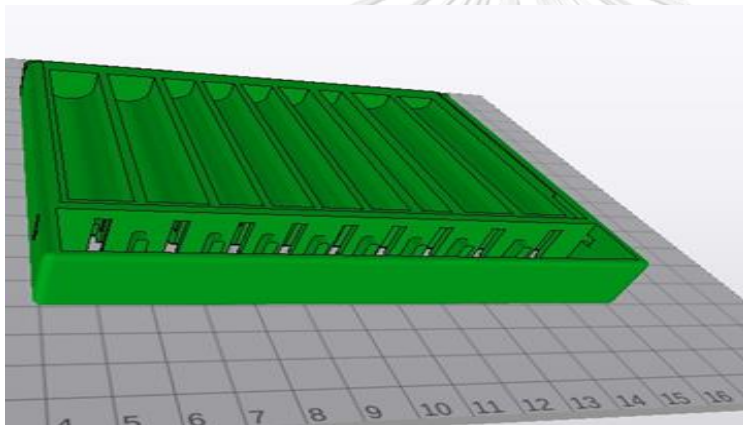
Intelligent Pill Box Design Diagrams



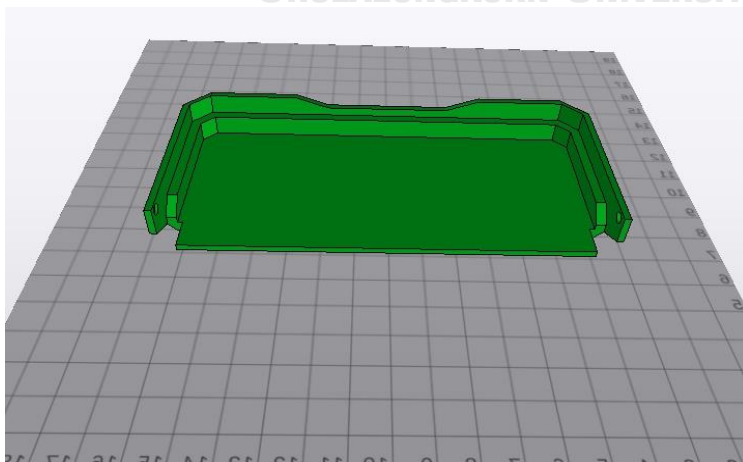
จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

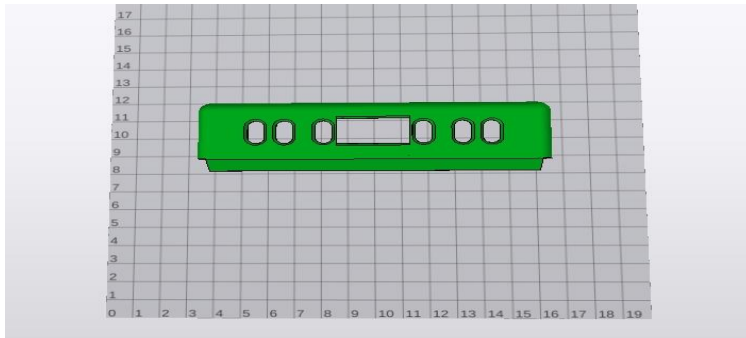


3 D diagram of intelligent pillbox



3 D diagram of medicine compartment





3D diagram of the front of electronic part



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Part of Thai-intelligent pill box.

Appendix IV

Program to improve medical adherence teaching plan





จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

วิทยาลัยวิทยาศาสตร์วิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย

แผนการสอน การรับประทานยาความดันโลหิตสูงอย่างต่อเนื่องและการใช้กล่องยาอัจฉริยะ

หัวข้อเรื่อง การรับประทานยาความดันโลหิตสูงอย่างต่อเนื่องและการใช้กล่องยาอัจฉริยะ

ระยะเวลาสอน 10-15 นาที

สำหรับ ผู้สูงอายุโรคความดันโลหิตสูงที่

สถานที่ คลินิกความดันโลหิตสูง โรงพยาบาลบึงกาฬและโรงพยาบาลส่งเสริม

สุขภาพตำบล

โนนสมบูรณ์ อ.บึงกาฬ จ. บึงกาฬ

แผนการสอนฉบับนี้เป็นส่วนหนึ่งของวิทยานิพนธ์ระดับปริญญาเอกเรื่อง

กล่องยาอัจฉริยะเพิ่มความร่วมมือในการรับประทานยาความดันโลหิตสูง :

การวิจัยแบบสุ่มที่มีกลุ่มควบคุม

ผู้สอน นันทกาญจน์ สูงสุมาลย์ วุฒแฮม นิสิตปริญญาเอก สาขาสาธารณสุข

ศาสตร์

วัตถุประสงค์ เมื่อสิ้นสุดการเรียนการสอนผู้เข้าร่วมการวิจัยสามารถ

1. บอกความหมาย สาเหตุของโรคความดันโลหิตสูง และแนวทางในการปฏิบัติตัวเมื่อเป็นความดันโลหิตสูงได้
2. บอกข้อดีของการรับประทานยาความดันโลหิตสูงอย่างต่อเนื่อง และบอกข้อเสียของการรับประทานความดันโลหิตไม่ต่อเนื่องได้
3. บอกวิธีการใช้กล่องยาอัจฉริยะได้

การประเมินผลการสอน

1. การตอบคำถามระหว่างและหลังการสอน
3. การมีส่วนร่วมในการทำกิจกรรมระหว่างการสอน

วัตถุประสงค์เชิงพฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการสอน	การประเมินผล
			ผู้สอน	ผู้ร่วมวิจัย		
	<p>ชั้นนำ</p> <p>ผู้สอนกล่าวทักทายและแนะนำตัวเอง</p>	3-5 นาที	<p>ชั้นนำ</p> <p>1. กล่าวทักทายผู้เรียน</p>	<p>1.</p> <p>แนะนำตัว</p>	<p>1.ผู้ร่วมวิจัย</p>	<p>ความสนใจและมีส่วน</p>

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>สวัสดีค่ะผู้วิจัยชื่อ นันทกาญจน์ สูงสุมาลย์ วุฒแอม เป็น นิสิตปริญญา เอกวิทยาลัย วิทยาศาสตร์ สาธารณสุข วันนี้จะ มาแลกเปลี่ยนความรู้ เกี่ยวกับการ รับประทานยาความ ดันโลหิตสูง และการ ใช้กล่อมยาอัจฉริยะที่ อยู่ที่ได้รับไปจากการ เข้าร่วมในการวิจัยใน ครั้งนี้ โดยในส่วนที่ เราจะได้รับความรู้ไป ในวันนี้นั้นจะ ครอบคลุม ในเรื่อง</p> <ol style="list-style-type: none"> 1. โรคความดันโลหิต สูง 2. การรับประทานยา ความดันโลหิตสูง 3. การใช้กล่อมยา อัจฉริยะ <p>ก่อนอื่นขอให้ทุกท่าน แนะนำตัวและบอก ระยะเวลาที่ป่วยด้วย โรคความดันโลหิตสูง</p>		<p>และ แนะนำ ตนเอง 2.สร้าง สัมพันธ ภาพและทำ ความรู้จัก กับผู้เรียน</p> <ol style="list-style-type: none"> 3. ชี้แจง วัตถุประสงค์การ เรียนรู้ 4.เกริ่นนำ เนื้อหาเข้า สูบทเรียน 	<p>2. ซักถาม ข้อ สงสัย</p> <ol style="list-style-type: none"> 3. ผู้วิจัย 	<p>2.กล่อ งยา อัจฉริ ยะ</p> <ol style="list-style-type: none"> 3. ผู้วิจัย 	<p>ร่วมของผู้ ร่วมวิจัย</p>

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	และประสบการณ์ใน การรับประทานยา ความดันโลหิตสูง ของท่าน ซึ่งในวันนี้เราจะมา ทบทวนการ รับประทานและการ ให้กลัวยาอัจฉริยะ ในการเก็บยาและ ช่วยเตือนเวลาใน การรับประทานยา ของท่าน					
1.บอก ความหมาย และสาเหตุ ของโรค ความดัน โลหิตสูง และ แนวทางใน การปฏิบัติ ตัวเมื่อเป็น ความดัน โลหิตสูงได้	โรคความดันโลหิตสูง เป็นโรคที่พบได้บ่อย ในผู้สูงอายุ แต่ไม่ได้ หมายความว่า ผู้สูงอายุทุกคนต้อง เป็นโรคความดัน โลหิตสูง ผู้สูงอายุที่ เป็นโรคความดัน โลหิตสูงแล้ว จำเป็นต้องได้รับยา ลดความดันโลหิต มิฉะนั้นจะเกิดปัญหา ร้ายแรงตามมา ได้แก่ ภาวะหัวใจวาย โรค กล้ามเนื้อหัวใจขาด	10 นาที	1. ให้ ข้อมูล เบื้องต้น แก่ผู้ร่วม วิจัย 2.กระตุ้น ให้ผู้ร่วม วิจัยมีส่วน ร่วม 3.สรุป ประเด็น สำคัญ หลังการ อภิปราย	1. ตั้งใจ และ สนใจ 2. ซักถาม และ ตอบ คำถาม 3. มี ส่วน ร่วม	1. ตัวอย่าง ยาความ ดัน โลหิตสูง	1. ความ สนใจของผู้ ร่วมวิจัย 2. การมี ส่วนร่วมของ ผู้ร่วมวิจัย

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>เลือด และหลอด เลือดสมองแตกเป็น อัมพาตหรืออัม พฤกษ์ ได้ องค์การอนามัยโรค ได้รายงานถึง สาเหตุ การเสียชีวิตของ ประชากรโรค อันดับ หนึ่งมาจากโรคไม่ ติดต่อ ในปี 2551 โรคความดันโลหิตสูง เป็นสาเหตุการโรค หลอดเลือดสมอง และสาเหตุการ เสียชีวิตถึงร้อยละ 50 ในปัจจุบัน มีผู้ที่ ตรวจพบว่าเป็นความ ดันโลหิตสูงถึงหนึ่งใน สามของประชากร ทั้งหมด เนื่องมาจาก จำนวนประชากรที่ เพิ่มขึ้น และมีอายุที่ ยืนขึ้น รวมทั้งมี ปัจจัยเสี่ยงทางด้าน สุขภาพ เช่น อาหาร ที่มีผลเสียต่อสุขภาพ เครื่องดื่มแอลกอฮอล์ ขาดการออกกำลังกาย</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
2. บอก ข้อดีของ การ รับประทา นยาความ ดันโลหิตสูง อย่าง ต่อเนื่อง และบอก ข้อเสียของ การ รับประทา นความดัน โลหิตไม่ ต่อเนื่องได้	<p>กาย น้ำหนักเกิน และการอยู่ในสภาวะเครียด ซึ่งความดันโลหิตสูงที่เกิดขึ้นจะมีผลเกี่ยวข้องกับความเสี่ยงในการเกิดโรคอื่น ๆ ด้วย เช่น โรคหลอดเลือดสมอง และไตล้มเหลว</p> <p>ดังนั้นการตระหนักถึงปัญหาที่เกิดขึ้นจากความดันเลือดสูง และการแก้ไขปัญหานี้ให้ทัน่วงทีจึงมีความสำคัญอย่างยิ่ง</p> <p>1.1 ความดันโลหิตสูงคือ ความดันเลือดจะวัดในหน่วยมิลลิเมตรปรอท โดยรายงานเป็นสองค่า ค่าแรกคือค่าที่สูงกว่า เป็นค่าความดันเลือดขณะที่หัวใจบีบตัว และค่าที่สองคือค่าที่ต่ำกว่า เป็นค่าความดันเลือดขณะที่หัวใจคลายตัว ค่าปกติใน</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>ผู้ใหญ่มีน้อยกว่า 120/80 มม.ปรอท</p> <p>ผู้ที่มีภาวะความดันโลหิตสูงคือ ผู้ที่มีความดันเลือดขณะหัวใจบีบตัว มากกว่า 140 มม.ปรอท และมีความดันเลือดขณะหัวใจคลายตัว มากกว่า 90 มม.ปรอท</p> <p>1.2 สาเหตุของความดันโลหิตสูง</p> <p>1.2.1 ความดันโลหิตสูงปฐมภูมิ ความดันโลหิตสูงไม่รู้สาเหตุ</p> <p>ความดันโลหิตสูงอาจเกิดจากพันธุกรรม และสิ่งแวดล้อม และจากอายุที่สูงขึ้นซึ่งทำให้หลอดเลือดแข็งซึ่งลักษณะนี้จะเป็นความดันโลหิตสูงแยกคือ มีความดันเลือดขณะหัวใจบีบตัวสูง แต่ความดันขณะหัวใจคลายตัวปกติ</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>ซึ่งพบได้บ่อยใน ผู้สูงอายุ ปัจจัยต่าง ๆ ที่ เกี่ยวข้อง ได้แก่ การรับประทาน อาหารที่มีเกลือและ ไขมันสูง การรับประทานผัก ผลไม้ไม่เพียงพอ ดื่มแอลกอฮอล์ ขาดการออกกำลังกาย การบริหารจัดการ ความเครียดได้ไม่ดี การสูบบุหรี่ ปัจจัยทางพันธุกรรม การตั้งครรภ์ ครรภ์ เป็นพิษ อายุที่เพิ่มขึ้น</p> <p>1.2.2 ความดันโลหิต สูงทุติยภูมิ คือความ ดันโลหิตสูงที่ทราบ สาเหตุที่พบบ่อย ได้แก่ โรคไตเรื้อรัง หลอดเลือดที่ไตตีบ เนื้องอกที่ต่อมหมวก ไต เป็นต้น</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>2. การควบคุมความดันโลหิต</p> <p>หากมีภาวะความดันโลหิตสูงอย่างต่อเนื่องโดยไม่ได้รับการรักษา จะทำให้เกิดความผิดปกติของระบบหัวใจหลอดเลือด ซึ่งเป็นสาเหตุของการเกิดโรคต่าง ๆ เช่น</p> <p>กล้ามเนื้อหัวใจตาย</p> <p>โรคหลอดเลือดสมอง</p> <p>กล้ามเนื้อหัวใจโต</p> <p>หัวใจล้มเหลว ซึ่งอาจเป็นสาเหตุของการเสียชีวิตในที่สุด</p> <p>การควบคุมความดันโลหิตสูง</p> <p>มีเป้าหมายให้ความดันเลือดอยู่ในช่วงที่กำหนด คือ ความดันหัวใจบีบตัวน้อยกว่า 140 มม.ปรอท และความดันโลหิตหัวใจคลายตัวน้อยกว่า 90 มม.ปรอท ดังนั้นเป้าหมายโดยทั่วไป</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>ของการลดความดันโลหิต คือ ลดความดันโลหิตให้มีค่าต่ำกว่า 140/90 มม.ปรอท สิ่งสำคัญอีกประการ คือ ผู้ได้รับการรักษาความดันโลหิตสูงต้องตระหนักว่าเป็นการรักษาแบบตลอดชีวิต ดังนั้นผู้ป่วยควรปรึกษาแพทย์ก่อนหยุดยาการควบคุมความดันโลหิตนอกจากมีวัตถุประสงค์เพื่อลดความดันโลหิตแล้ว ยังต้องลดปัจจัยเสี่ยงอื่น ๆ ที่ทำให้เกิดโรคหัวใจร่วมด้วย ได้แก่ ภาวะไขมันเล็ดสูง ภาวะต้านอินซูลินหรือเบาหวาน โรคอ้วน และการสูบบุหรี่ เป็นต้น</p> <p>แนวทางในการควบคุมความดันโลหิตมีหลักการ</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>ใหญ่ ๆ 2 ประการ คือ</p> <p>2.1 การควบคุม แบบไม่ใช้ยา เป็น การเปลี่ยนแปลง พฤติกรรมและวิธีการ ดำเนินชีวิต จะช่วย ลดความดันโลหิต และอาจป้องกัน อันตรายจากการเกิด โรคหัวใจร่วมหลอดเลือด ได้ ดังนั้นผู้ป่วย ความดันโลหิตสูงทุก ประเภทควรปฏิบัติ โดยเฉพาะอย่างยิ่งใน ผู้ที่มีน้ำหนัก มากกว่าปกติ ถ้า ผู้ป่วยไม่มีโรคอื่น ๆ ร่วมด้วย เช่น เบาหวาน ไขมันใน เลือดสูง เป็นต้น การ ลดน้ำหนัก ออกกำลัง กาย ลดการสูบบุหรี่ และการดื่ม แอลกอฮอล์ จำกัด การรับประทานเกลือ โซเดียมในแต่ละวัน ให้ได้วันละ 1 ช้อนชา</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>ถ้าทำได้ จะช่วยลด อัตราการเสียชีวิต จากการเกิดโรค หลอดเลือดสมองได้ ถึง 14 % นอกจากนั้นควร รับประทานอาหาร พวกผักผลไม้แต่ละ มือให้มีสัดส่วนมาก ขึ้น และบริโภค อาหารประเภทที่มี ไขมันต่ำ สรุปการรับประทาน อาหารตามหลักของ สากล (Dietary Approach to stop hypertension(DAS H))</p> <p>1. เน้นการ รับประทานผัก ผลไม้ และผลิตภัณฑ์นม ไขมันต่ำหรือไร้ไขมัน</p> <p>2. ในมืออาหารควรมี เมล็ดธัญพืช ปลา สัตว์ปีก ถั่ว เมล็ด พันธ์ และน้ำมันพืช</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>3. จำกัดปริมาณ โซเดียม ของหวาน เครื่องดื่มที่มีน้ำตาล และเนื้อสีแดง</p> <p>2.2 การควบคุม ความดันโลหิตโดย การใช้ยา คือ ผู้ที่มีความดันโลหิตสูง ระยะที่ 1 คือ สูงกว่า 140/90 มม.ปรอท ให้ปรับพฤติกรรม การดำเนินชีวิตก่อน ถ้าไม่สามารถลด ความดันโลหิตได้ จึง จะเริ่มใช้ยา ในผู้ป่วย ที่มีความดันโลหิตสูง อยู่ในระยะที่ 2 คือมี ความดันมากกว่า 160/100 มม.ปรอท ให้เริ่มใช้ยาได้ทันที ยาที่ผู้ป่วยความดัน โลหิตได้รับ ได้แก่ ยา ขับปัสสาวะ ยาต้าน ซิมพาเทติก ยาขยาย หลอดเลือด และยา ยับยั้งแองจิโอเทนซิน คอนเวอร์ติงเอนไซม์ และยาปิดกั้น</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>ตัวรับแองจิโอเทนซิน ซึ่งแพทย์จะพิจารณา จากภาวะของโรค ของผู้ป่วยแต่ละ บุคคลซึ่งจะไม่ขอ กล่าวถึงรายละเอียด ในที่นี้</p> <p>แพทย์จะมีการ วางแผนนัดติดตาม ผลการรักษาขึ้นอยู่กับ ความรุนแรงของ โรค ซึ่งในบางครั้งแพทย์ อาจมีการปรับลดยา เพื่อให้ยามมี ประสิทธิภาพ เหมาะสมในการ ควบคุมความดัน โลหิต</p> <p>1. ยาขับปัสสาวะ ยา ขับปัสสาวะ ทำให้มี ปัสสาวะมากขึ้น ยา ชะลอการเต้นของ หัวใจ ทำให้หัวใจเต้น ช้าลง ยาขยายหลอดเลือด เลือดทำให้รูของ หลอดเลือดกว้างขึ้น</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	เลือดจึงไหลได้ดีขึ้น และมีแรงดันน้อยลง จากยาในกลุ่มต่าง ๆ นี้ แพทย์จะเลือกยาที่ เหมาะสมให้แก่ผู้ป่วย แต่ละราย มีข้อที่ควร ทราบ คือ ยาขับ ปัสสาวะ ทำให้ผู้ที่ รับประทานยานั้นเข้า ห้องน้ำบ่อยกว่าปกติ เพราะยาขับปัสสาวะ มีฤทธิ์ขับน้ำออกจาก หลอดเลือด ทำให้ ปริมาตรเลือดใน หลอดเลือดลดลง ความดันโลหิตจึง ลดลง ขนาดยา โดยทั่วไปคือ รับประทานวันละ 1 ครั้ง หลังอาหาร เช้า แต่ผู้ป่วยบางราย ก็จำเป็นต้อง รับประทานวันละ 2 ครั้ง ในกรณีหลังนี้ ให้รับประทานยาหลัง อาหารเช้าและเที่ยง ห้ามรับประทานยา หลังอาหารเย็นหรือ					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>ก่อนนอน เพราะจะทำให้ปวดปัสสาวะ ตอนกลางคืน และต้องลุกมาเข้าห้องน้ำตลอดคืน</p> <p>ยาลดความดันโลหิตอีกกลุ่มหนึ่งที่ใช้กันบ่อย คือ ยาเอซีอีอินฮิบิเตอร์ (ACE inhibitors) ยานี้มีฤทธิ์ยับยั้งเอนไซม์แองจิโอเทนซินคอนเวอร์ติ้ง (angiotensin converting enzymes) เช่น อินาลาพริล (enalapril), ลิสิโนพริล (lisinopril), รามิพริล (ramipril), เพอรินโดพริล (perindopril) อาจทำให้เกิดอาการข้างเคียงที่ก่อความรำคาญแก่ผู้ใช้ยา คือ อาการไอแห้งๆ ได้ ซึ่งไม่เป็นอันตรายแต่</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>อย่างไร และไม่ใช่ออาการแพ้ยา อาการนี้อาจทำให้รู้สึกรำคาญ ซึ่งสามารถบรรเทาได้ด้วยการหมั่นจิบน้ำ หรือรับประทานยาอมชนิดที่ทำให้ชุ่มคอ ร่างกายจะสามารถปรับตัวได้ แต่ในกรณีที่อาการเป็นมากจนรบกวนคุณภาพชีวิต อาจจำเป็นต้องเปลี่ยนยา แต่ผู้ป่วยไม่ควรหยุดยาด้วยตนเอง ควรไปปรึกษาแพทย์เพื่อให้แพทย์พิจารณาเปลี่ยนยาให้</p> <p>ผู้ป่วยบางรายใช้ยา รักษาโรคความดันโลหิตสูงเพียงชนิดเดียว ก็ลดความดันโลหิตได้ดี และสามารถควบคุมให้มีค่าอยู่ในระดับที่น่าพอใจได้ แต่ผู้ป่วย</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>บางรายต้องใช้ยา 2 ชนิด หรือมากกว่า นั้น ความดันโลหิตจึงจะลดลงมาอยู่ในระดับที่น่าพอใจ ในกรณีนี้ผู้ป่วยมักจะได้รับยามื้อละหลายเม็ด อยากรู้สึกเบื่อเสียบ่อย และอย่าหยุดยาเพราะเมื่อที่จจะรับประทานยาทุกวัน หรือ เพราะคิดว่าไม่มีอาการผิดปกติใดๆ การหยุดยาจะเป็นผลเสียเพราะทำให้ความดันโลหิตกลับสูงขึ้นมาอีก และอาจสูงมากจนหลอดเลือดในสมองแตก เกิดอัมพาต อัมพฤกษ์ตามมาได้</p> <p>ข้อสำคัญในการใช้ยารักษาโรคความดันโลหิตสูงให้ได้ผลดี ก็คือ จะต้องรับประทานยาต่อเนื่องกันทุกวัน</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>และรับประทานยา ตรงเวลา หากลืม รับประทานยาและ นึกขึ้นได้เมื่อใกล้จะ รับประทานยามื้อ ต่อไป ให้รับประทาน ยาของมือนั้นก็พอ และห้ามรับประทาน ยาเพิ่มเป็น 2 เท่า มิฉะนั้นความดัน โลหิตจะลดต่ำลง อย่างมาก เกิดอาการ หน้ามืด ล้มลง หมด สติ เป็นอันตรายได้</p> <p>ยารักษาโรคความดัน โลหิตสูงโดยทั่วไป เป็นยาเม็ดที่ ปลดปล่อยตัวยาแบบ ปกติ ซึ่งรับประทาน วันละครั้งเดียว นอกจากนี้ก็เป็นยา เม็ดที่ออกแบบเป็น พิเศษให้ค่อยๆ ปลดปล่อยตัวยา ออกมา เพื่อให้ออก ฤทธิ์ได้ยาวนาน และ ลดจำนวนครั้งของ</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>การรับประทานยาได้ เหลือเพียง รับประทานวันละ 1- 2 ครั้ง ยาเม็ดที่ ออกแบบเป็นพิเศษนี้ มักมีขนาดโต กว่า ปกติ ทำให้กลืนยาได้ ลำบาก แต่แม้ว่ายา จะเม็ดใหญ่ ก็ห้ามบด เคี้ยว หรือหักเม็ด เพราะจะทำให้ รูปแบบยาที่ออกแบบ เป็นพิเศษนั้นเสียไป ที่อันตรายก็คือ หาก เคี้ยวหรือบดยาแล้ว กลืนยาลงไป ก็จะได้ ตัวยาเข้าร่างกายใน ปริมาณสูงมาก ภายในการกลืนยา ครั้งเดียว แทนที่ตัว ยาจะค่อยๆ ออกมาที ละน้อย ฤทธิ์ยาที่จะ สูงมากและความดัน โลหิตจะตกลงอย่าง มาก จนอาจทำให้ หน้ามืด ล้มลงและ หมดสติได้ยิ่งไปกว่า นั้น ผู้ที่เป็นโรคความ</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>ต้นโลหิตสูงจะต้อง ระมัดระวังภาวะ ความดันโลหิตตก เนื่องจากเปลี่ยน อิริยาบถอย่าง ฉับพลัน ดังนั้นเวลา จะลุกจากเก้าอี้หรือ ลุกจากเตียง ก็ต้อง ลุกขึ้นอย่างช้า ๆ มิฉะนั้นจะหน้ามืด เป็นลม ล้มลงได้</p>					
3. บอก วิธีการใช้ กล่องยา อัจฉริยะ	<p>การใช้กล่องยา อัจฉริยะ กล่องยาอัจฉริยะ ถูก ประดิษฐ์ขึ้นเพื่อช่วย ในการรับประทานยา ของท่านเป็นเรื่องที่ ง่ายยิ่งขึ้น โดยกล่อง ยาอัจฉริยะมี คุณสมบัติในการช่วย ในการบริหารยาให้ ตรงเวลา และเตือน เมื่อถึงเวลา รับประทานยา คุณสมบัติของกล่อง ยาอัจฉริยะ</p>	5 นาที	1. อธิบาย การใช้ กล่องยา อัจฉริยะ 2. สาธิต การใช้ กล่องยา อัจฉริยะ	1. รับ ฟังการ อธิบาย การใช้ กล่อง ยา อัจฉริย ะ 2. ฝึก การใช้ กล่อง ยา อัจฉริย ะ	กล่อง ยา อัจฉริย ะ	ความสนใจ และมีส่วน ร่วมในการ ฝึกการใช้ กล่องยา อัจฉริยะ

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>กล่องยาที่สามารถ บรรจุยาได้ 2-9 ชนิด และ 4 มือต่อวัน โดย การแยกมือจากสี ที่ วางถาดยา โดย สีส้ม มือเข้า สี แต่ละมือ บรรจุ ได้ 3-7 เม็ด เป็นระยะเวลา 1 เดือน ทำให้ท่าน สามารถจัดยาเพียง ครั้งเดียวใน 1 เดือน โดยไม่ต้องเสียเวลา จัดยาทุกวันหรือทุก สัปดาห์ การ ออกแบบกล่องยาที่มี ระบบการทำงานที่ เหมาะสมกับผู้สูงอายุ ไม่ว่าจะเป็น รูปลักษณะภายนอก ขนาด ระบบการ ทำงาน เสียงเตือน ระบบหน้า จอมอนิเตอร์ที่มีการ แสดงผล วันที่และ เวลาในการ รับประทานยา ที่ผ่าน ออกแบบและการ ทดลองวิจัยให้</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>เหมาะสมกับผู้สูงอายุ โดยเฉพาะ</p> <p>การใช้งาน</p> <p>1. เมื่อท่านได้รับยา จาก ห้องจ่ายยาของ โรงพยาบาล ให้ท่าน นำยานั้นไปที่จุด “บรรจุนยา” ซึ่งจะมี ทีมผู้วิจัยและ พยาบาลวิชาชีพเป็นผู้ช่วยในการอ่านลาก ยา ตรวจสอบ ความถูกต้องของการ บรรจุนยา และ ช่วยเหลือท่านในการ บรรจุนยาเข้ากล่องยา อัจฉริยะ</p> <p>2. เปิดฝากล่องยา รวมออก ท่านจะพบ ช่องยาแต่ละชนิด 9 ช่องวาง รางที่ 1 จาก ด้านซ้ายมือ คือสาร ป้องกันความชื้น ห้ามรับประทาน ช่องถัดไปจะถูก ออกแบบขนาดรางให้พอดีกับยาที่ท่านต้อง รับประทานในมือ</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>เข้า มือเที่ยง มือเย็น และก่อนนอน ตามลำดับจากซ้ายไป ขวา</p> <p>3. ตรวจสอบขนาด ยาแต่ละชนิดที่ท่าน ได้รับ เช่น ยา ก ขนาดรับประทาน 2 เม็ด วันละ 1 ครั้ง หลังอาหารเช้า</p> <p>4. นำยาที่ท่าน ตรวจสอบชื่อยา ขนาด และเวลา รับประทาน ออกจาก ถุงยา ตามฉลากที่ เขียนไว้ที่ถุงยา ที่ รับมาจากห้องยาของ โรงพยาบาล บรรจุนยา ลงในแต่ละช่องยา บรรจุ ในข้อ 2 ตาม ขนาดและเวลา ที่ ได้รับให้ถูกต้อง</p> <p>5. หลังบรรจุยาชนิด แรกเสร็จเรียบร้อย ก่อนที่จะบรรจุยา ชนิด ถัดไป ให้ส่ง กล่องให้พยาบาล วิชาชีพ ที่จุด บรรจุ</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>ยา ตรวจสอบ ความถูกต้อง</p> <p>6. บรรจุนยาตามลำดับ ในข้อ 3-5 จนกระทั่ง บรรจุนยาที่ท่านได้รับ ให้ครบทุกชนิด</p> <p>7. นำกล่องยาไปตั้ง ระบบการเตือนเวลา กินยา โดยทีมผู้วิจัย เป็นผู้ตั้งเวลาและ ตรวจสอบความ ถูกต้องของการตั้ง เวลา</p> <p>8. ในกรณีที่ท่านต้อง ออกจากบ้านและไม่สามารถนำกล่องยา ไปด้วยได้ ท่าน สามารถถอดกล่อง บรรจุนยาขนาดเล็กที่ บรรจุนยามือที่ท่าน จะต้องรับประทาน นอกบ้านออกมาจาก กล่องยาอัจฉริยะเพื่อ นำไปรับประทานเมื่อ ท่านไม่สามารถนำ กล่องยาอัจฉริยะไป ด้วยได้</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>9. การทำความสะอาด สะอาดกล่องยา ใช้ ผ้าหรือสำลีแห้ง สะอาดเช็ด ไม่ควรใช้ น้ำหรือผ้าเปียกเช็ด ภายในกล่องยา</p> <p>10. เมื่อท่านพบ ปัญหาในการใช้กล่อง ยาอัจฉริยะ เช่น กล่องยาเกิดการ เสียหาย การทำงาน เสียหาย ท่าน สามารถติดต่อผู้วิจัย ได้ตลอด 24 ชั่วโมง ที่ หมายเลขโทรศัพท์ 084 752 8211 ทาง ทีมงานนักวิจัยจะมี การส่งผู้เชี่ยวชาญไป พบท่านที่บ้านและ แก้ไขปัญหาในการใช้ กล่องยาอัจฉริยะ ให้แก่ท่าน โดย หมายเลขโทรศัพท์ ข้างต้นได้ถูกติดไว้ที่ ด้านหลังตัวกล่องยา อัจฉริยะ</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>บทสรุป</p> <p>ผู้ที่เป็นโรคความดันโลหิตสูง ต้องมีพฤติกรรมสุขภาพที่เหมาะสม ร่วมกับรับประทานยาอย่างต่อเนื่องตามแผนการรักษาของแพทย์ ต้องลดการรับประทานอาหารเค็ม นั่นคือปริมาณเกลือต้องไม่เกินวันละ 1ช้อนชา หรือน้ำปลาไม่เกินวันละ 3-4 ช้อนชา หากอ้วนหรือมีค่าดัชนีมวลกายมากกว่า 23 กิโลกรัมต่อตารางเมตร ก็ต้องลดความอ้วนซึ่งหากต้องการใช้วิธีออกกำลังกาย ควรทำแต่พอประมาณให้มีเหงื่อออก ไม่หักโหม ออกกำลังกายประมาณครั้งละ 30 นาที สัปดาห์ละ 3 ครั้ง งดการดื่ม</p>	1-2 นาที	<p>1. สรุปประเด็นสำคัญ</p> <p>2. กระตุ้นให้ผู้ร่วมวิจัยซักถามข้อสงสัย</p> <p>3. ตอบคำถามของผู้ร่วมวิจัย</p>	<p>1. ตั้งใจและสนใจ</p> <p>2. การซักข้อสงสัย</p> <p>3. มีส่วนร่วมในการถามและตอบคำถาม</p>	ผู้ร่วมวิจัยโทรศัพท์ของผู้ร่วมวิจัยหรือญาติ	<p>1. ความสนใจของผู้ร่วมวิจัย</p> <p>2. การมีส่วนร่วม</p>

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		
	<p>เครื่องดื่มน้ำที่มีคาเฟอีน เช่น เครื่องดื่มชูกำลัง น้ำชา กาแฟ หยุดดื่ม เหล้า หยุดสูบบุหรี่ รวมทั้งทำจิตใจให้สบาย ไม่เครียด การปรับเปลี่ยนพฤติกรรมเพียงเท่านี้ จะช่วยให้การรักษาโรคความดันโลหิตสูงมีประสิทธิภาพมากขึ้น</p> <p>การใช้กล่องยาอัจฉริยะในการช่วยในการรับประทานยาให้ถูกต้องและตรงเวลานั้นควรปฏิบัติตามคำแนะนำอย่างเคร่งครัด และหากกล่องยาอัจฉริยะมีปัญหาเมื่อท่านใช้กล่องยาที่บ้านท่าน ท่านสามารถโทรศัพท์ติดต่อผู้วิจัยได้ตลอด 24 ชั่วโมงที่หมายเลขโทรศัพท์ 084 752 8211</p>					

วัตถุประสงค์เชิง พฤติกรรม	กระบวนการสอน	เวลา	กิจกรรมการเรียนรู้		สื่อการ สอน	การ ประเมินผล
			ผู้สอน	ผู้ร่วม วิจัย		

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Appendix V

MANUAL ON HOW TO USE THAI-INTELLIGENT PILL BOX



คู่มือการใช้กล่องยาอัจฉริยะช่วยส่งเสริมการรับประทานยารักษาความดันโลหิตสูง สำหรับผู้สูงอายุ

1. คุณสมบัติของกล่องยาอัจฉริยะ

1. มีช่องบรรจุยาที่เหมาะสมกับยาที่ท่านรับประทานอยู่ จำนวน 9 ช่อง (ราง) ท่านสามารถบรรจุยา

ได้ตามขนาดเม็ดยาที่ท่านรับประทานอยู่ ซึ่งแต่ละช่องสามารถบรรจุยาขนาดต่าง ๆ ดังนี้

ลำดับ	ขนาดเม็ดยา เส้นผ่าศูนย์กลาง x ความหนา	จำนวนที่สามารถบรรจุได้	ตัวอย่าง ชนิดของยา
0.	1x0.5 ซม.		สารป้องกันความชื้น (Silica gel) ห้ามรับประทาน
1.	1x0.5 ซม.	16	ยาเบาหวาน Metformin 500 mg.
2	0.8x0.2 ซม.	30	ยาความดันโลหิตสูง Amlodipine 5 mg.
3	0.9x0.3 ซม.	23	ยาเบาหวาน Glipizide 5 mg.
4	0.9x0.4 ซม.	21	ยาความดันโลหิตสูง Enalapril 5, 10 mg.
5	0.9x0.5 ซม.	20	ยาความดันโลหิตสูง Propalol 10 mg. หรือ HcTz 10 mg.
6	0.9x0.2 ซม.	30	ยาป้องกันการอุดตันของหลอดเลือด Aspirin
7	1.2x0.3 ซม.	24	ยาลดไขมัน Simvastatin 20 mg.
8	1.1x0.3 ซม.	24	ยาลดความดันโลหิต Losartan 50 mg.

2) สามารถตั้งเวลาได้ 4 กลุ่มเวลาที่มีเสียงเตือน 4 แบบ เพื่อเตือนเวลาในการรับประทานยาตามที่แพทย์สั่ง และสังเกตเวลาที่ต้องรับประทานยาแต่ละมื้อจากสี ที่บริเวณรางยาของถาดยา โดย มื้อเช้า แดบสีส้ม มื้อเที่ยง แดบสีน้ำเงิน มื้อเย็น แดบสีเขียว และก่อนนอน แดบสีเหลือง

3) เสียงเตือน 4 แบบและหน้าจอ LCD ที่มีการกะพริบเตือน เพื่อเตือนการรับประทานยาให้ตรงเวลา

4) นาฬิกาที่สามารถตั้งค่าได้แบบ 12 และ 24 ชั่วโมง

5) มีระบบการกดเพื่อชะลอเวลาการรับประทานยา และการเตือนซ้ำ

2) การตั้งระบบการเตือน:

1. การตั้งเวลานาฬิกา

1) กดปุ่มที่ 1 เพื่อตั้งเวลาตามเวลาจริง ตามเวลา จากนั้น กดปุ่ม 4

2) กดปุ่ม 5 เพื่อตั้งเวลา ชั่วโมง และ กดปุ่ม 6 เพื่อตั้งนาฬิกา จากนั้น กด ปุ่ม 4 (จุดสีแดง) เพื่อ ยืนยัน

3) กดปุ่ม 4 เพื่อเลือกเวลาเป็นแบบ 12 ชั่วโมง หรือ 24 ชั่วโมง

2. การตั้งเวลาเตือนการรับประทานยา

1) กด ปุ่ม 2 เพื่อเข้าสู่การตั้งเวลา แล้วเลือกเวลาเตือน ครั้งที่ 1 ครั้งที่ 2 ครั้งที่ 3 และครั้งที่ 4

2) ที่ครั้งที่ 1 สามารถตั้งเวลาครั้งแรกในแต่ละวัน กดปุ่ม ชั่วโมง (ปุ่ม 5 เพื่อตั้งเวลาเป็นชั่วโมงและกดปุ่ม 6 เพื่อตั้งเวลาเป็นนาฬิกา จากนั้นกดปุ่ม 4 ซึ่งเป็นปุ่มที่จะยืนยันการตั้งเวลา

3) สำหรับ ครั้งที่ 2 ครั้งที่ 3 และครั้งที่ 4 ทำได้โดยการเริ่มต้นที่ปุ่ม 2 อีกครั้ง แล้วทำเหมือนในข้อ 2 ครบตามเวลาการรับประทานยาของท่าน ตามที่แพทย์สั่ง

4) กดปุ่ม 1 เพื่อกลับหน้าจอไปเป็นนาฬิกาอีกครั้ง หากไม่กดปุ่ม 1 หน้าจอจะกลับไปสู่หน้าจอนาฬิกาได้เอง ในเวลา 1 นาที

5) เมื่อถึงกำหนดเวลาที่ตั้งไว้ เสียงเตือนจะดังขึ้นต่อเนื่องเป็นเวลา 1 นาที ปิดเสียงเตือนโดยกดปุ่ม 4

6) การชะลอเวลา หากไม่มีการกดปุ่ม 4 เพื่อปิดเสียงเตือนและรับประทานยา เสียงเตือนจะดังขึ้นทุก ๆ 3 นาที ติดต่อกันเป็นเวลานาน 30 นาที

3. การยกเลิกการตั้งเวลา แจ้งเตือนการรับประทานยา

1) กดปุ่ม 2 เพื่อเลือกกลุ่มเวลาที่ต้องการยกเลิก จากนั้นกดปุ่ม 4 เพื่อยกเลิกการตั้งเวลาเตือนรับประทานยา (ถ้ายกเลิกสำเร็จ รูปกระดิ่งบนหน้าจอ จะหายไป) แล้วกด ปุ่ม 4 อีกครั้ง เพื่อยกเลิกการตั้งเวลาอื่นที่ต้องการอันถัดไป ด้วยการกดปุ่ม 2 เพื่อเลือกกลุ่มที่ต้องการยกเลิกเหมือนขั้นตอนแรก

4. การตั้งค่า การจดจำเวลา

1) ทุกครั้งที่ท่าน กดปุ่ม 3 จะมีเสียงดังสั้น ๆ ขึ้น ตัวเครื่องจะจดจำเวลา และจะมีการเตือนทุก 24 ชั่วโมงเมื่อถึงเวลา โดยกด ปุ่ม 3 จะมีเสียงดัง สั้นๆ “บีบ” เวลาเตือนครั้งที่ 1 จะถูกบันทึก เมื่อ กดปุ่ม 3 อีกครั้ง จะมีเสียงดัง “ บีบ บีบ” เวลาเตือนครั้งที่ 2 จะถูกบันทึก ทำต่อไปเช่นเดิมในการบันทึกเวลาครั้งที่ 3 และ 4

2) กดปุ่ม 3 ครั้งที่ 5 จะเป็นการยกเลิก การเตือนครั้งที่ 1 และกดครั้งถัดไปจะเป็นการยกเลิกการเตือน ครั้งที่ 2 และ ครั้งที่ 3 และ 4 ต่อไป

3) กดปุ่ม 3 ค้างไว้ 3 วินาที เมื่อได้ยินเสียง “บีบบบบบ” ยาว การตั้งเวลาการเตือนทุกครั้งจะถูกยกเลิก

5) การเปลี่ยนแบตเตอรี่

กลับด้านหลังของกล่องยาขึ้นมา ดึงถาดแบตเตอรี่ด้านหลังออกมา แล้วเปลี่ยนแบตเตอรี่กล่องยา ใช้ แบตเตอรี่ ลิเทียมขนาด 3 โวลต์ (3V CR2025) ควรระวังการใส่แบตเตอรี่ผิดด้าน

6) ข้อควรปฏิบัติ

ควรวางกล่องยาไว้ในที่แห้งและห่างจากบริเวณที่เด็กจะสามารถหยิบจับได้ ควรวางกล่องไม่ควรห่างจากบริเวณที่ผู้ใช้อยู่เกิน 15 เมตร เพื่อให้ได้ยินเสียงเตือนเวลารับประทานยา ที่ดังจากกล่องได้ดี

7) ข้อพึงระวัง

ควรเปิดกล่องยาโดยดันฝาทั้งสองข้างพร้อมกัน และไม่ควรวางกล่องในบริเวณที่มีอากาศร้อน หรือ ตากแดดเป็นเวลานาน

8) การทำความสะอาดและการเก็บรักษา

ใช้ผ้าแห้งสะอาด หรือสำลีสะอาดเช็ดบริเวณตัวกล่องและรางยา ไม่ควรใช้ผ้าเปียกหรือ
ผ้าชุบน้ำเช็ดกล่องยา เก็บถาดยาเข้ากล่องพลาสติกเก็บถาดยาทุกครั้งหลังใช้





จุฬาลงกรณ์มหาวิทยาลัย
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VITA

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Mrs. Woodham is a public health professional with degrees in Nursing and Public Health. Her career started as a nurse and moved to working in the public health sector. She has extensive experience in community health research, clinical nursing, reproductive health, HIV counseling and public health program management, in both the government sector and NGO.

Since 2002, Mrs. Woodham has worked primarily in the Mekong delta region of Thailand. Her assignments have required her to work with migrants and immigrants focusing on community health issues. Her experience includes:

- Public Health Specialist, INTERNATIONAL RESCUE COMMITTEE (IRC), Thailand (January 2011– October 2012) Collaborate with health agencies in the nine refugee camps on the Thailand-Burma border to develop a strategy for promoting healthy behavior.
- Deputy Avian Influenza (AI) Coordinator, IRC Assisted the Senior Health Coordinator in the oversight, provision of technical assistance, and monitoring of the avian influenza component of a USAID funded project working in the nine refugee camps on the Thailand-Burma border.
- Community Nurse, BUNGKAN HEALTH OFFICE, Nongkhai Province, Thailand (April 2002- May 2007) focus on communicable and non-communicable diseases in the Thailand-Laos PDR border, developed health education materials and provided training to community health volunteers.