

ECONOMIC EVALUATION OF HYDROTHERAPY FOR PATIENT WITH KNEE OSTEOARTHRITIS:  
A CASE STUDY OF SIRINDHORN NATIONAL MEDICAL REHABILITATION INSTITUTE

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บทคัดย่อและแฟ้มข้อมูลฉบับเต็มของวิทยานิพนธ์ตั้งแต่ปีการศึกษา 2554 ที่ให้บริการในคลังปัญญาจุฬาฯ (CUIR)  
เป็นแฟ้มข้อมูลของนิสิตเจ้าของวิทยานิพนธ์ ที่ส่งผ่านทางบัณฑิตวิทยาลัย

The abstract and full text of theses from the academic year 2011 in Chulalongkorn University Intellectual Repository (CUIR)  
are the thesis authors' files submitted through the University Graduate School.

A Thesis Submitted in Partial Fulfillment of the Requirements  
for the Degree of Master of Science Program in Health Economics and Health Care  
Management

Faculty of Economics  
Chulalongkorn University

Academic Year 2016

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การประเมินความคุ้มค่าทางเศรษฐศาสตร์ของการรักษาด้วยวิธีการธาราบำบัด

ในผู้ป่วยภาวะข้อเข่าเสื่อม:

กรณีศึกษาสถาบันสิรินธรเพื่อการฟื้นฟูสมรรถภาพทางการแพทย์แห่งชาติ



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

สาขาวิชาเศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ

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ปีการศึกษา 2559

ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย



Thesis Title	ECONOMIC EVALUATION OF HYDROTHERAPY FOR PATIENT WITH KNEE OSTEOARTHRITIS: A CASE STUDY OF SIRINDHORN NATIONAL MEDICAL REHABILITATION INSTITUTE
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ยุทธศาสตร์ กลิ่นกลัด : การประเมินความคุ้มค่าทางเศรษฐศาสตร์ของการรักษาด้วยวิธีการธาราบำบัดในผู้ป่วยภาวะข้อเข่าเสื่อม: กรณีศึกษาสถาบันสิรินธรเพื่อการฟื้นฟูสมรรถภาพทางการแพทย์แห่งชาติ (ECONOMIC EVALUATION OF HYDROTHERAPY FOR PATIENT WITH KNEE OSTEOARTHRITIS: A CASE STUDY OF SIRINDHORN NATIONAL MEDICAL REHABILITATION INSTITUTE) อ.ที่ปริกษานิพนธ์หลัก: รศ. ดร.ศิริเพ็ญ ศุภกาญจนกันติ, หน้า.

อุบัติการณ์ของโรคข้อเข่าเสื่อมเพิ่มขึ้นอย่างต่อเนื่องควบคู่ไปกับการเพิ่มขึ้นของประชากรผู้สูงอายุในประเทศไทยที่มีจำนวนมากกว่าร้อยละ 12 การรักษาทางกายภาพบำบัดเป็นหนึ่งในแผนการรักษาฟื้นฟูสำหรับผู้ป่วยที่มีอาการรุนแรงระดับต่ำถึงระดับปานกลางโดยมีเป้าหมายในการลดอาการปวด, อาการข้อติดขัด และเพิ่มความสามารถในการทำงานข้อเข่าเพื่อชะลอความรุนแรงของอาการที่อาจนำไปสู่การผ่าตัดเปลี่ยนข้อเข่า ธาราบำบัดเป็นหนึ่งในวิธีการทางกายภาพบำบัดที่มีการศึกษาอย่างแพร่หลายว่าให้ผลลัพธ์การรักษางานประการได้ดีกว่าการรักษาด้วยวิธีดั้งเดิม อย่างไรก็ตามในประเทศไทยมีหน่วยให้บริการธาราบำบัดจำนวนจำกัด และไม่เคยมีการศึกษาเพื่อประเมินความคุ้มค่าทางเศรษฐศาสตร์ การศึกษานี้จึงมีวัตถุประสงค์เพื่อประเมินต้นทุน-ประสิทธิผล และอัตราส่วนของส่วนต่างต้นทุนต่อประสิทธิผลส่วนเพิ่มของการรักษาด้วยวิธีการธาราบำบัดในบริบทสถาบันสิรินธรเพื่อการฟื้นฟูสมรรถภาพทางการแพทย์แห่งชาติ ซึ่งเป็นหน่วยงานเฉพาะทางด้านการฟื้นฟูสมรรถภาพทางการแพทย์ของรัฐเพียงแห่งเดียวในประเทศไทย

วิธีการศึกษาเป็นการทบทวนข้อมูลย้อนหลังในปีงบประมาณ 2559 เพื่อประเมินต้นทุน-ประสิทธิผลของการรักษาผู้ป่วยข้อเข่าเสื่อมด้วยวิธีการธาราบำบัด โดยเปรียบเทียบระหว่างกลุ่มความถี่ในการรักษาที่แตกต่างกัน; 1 ครั้ง ต่อสัปดาห์, 2 ครั้ง ต่อสัปดาห์ และ 3 ครั้ง ต่อสัปดาห์ โดยมีผลลัพธ์การรักษาคะแนนรวม WOMAC ซึ่งเป็นเครื่องมือระดับสากลในการวัดผลลัพธ์การรักษารักษาผู้ป่วยภาวะข้อเข่าเสื่อม(คะแนนรวมที่ลดลงชี้วัดถึงการพยากรณ์โรคที่ดีขึ้น) ร่วมด้วยการคำนวณอัตราส่วนของส่วนต่างต้นทุนต่อประสิทธิผลส่วนเพิ่มของกลุ่มที่มีความถี่ต่อสัปดาห์ในการรักษาจากน้อยไปมาก

ผลการศึกษาพบว่าการรักษาด้วยความถี่ 2 ครั้งต่อสัปดาห์มีอัตราส่วนต้นทุนต่อประสิทธิผลต่ำที่สุด (180.49 บาท/1 คะแนนWOMACที่ลดลง) มีความคุ้มค่าด้านต้นทุนต่อประสิทธิผลมากกว่าความถี่ 1 ครั้งต่อสัปดาห์ (183.98 บาท/1 คะแนนWOMACที่ลดลง) และความถี่ 3 ครั้งต่อสัปดาห์ (208.94 บาท/1คะแนนWOMACที่ลดลง) ตามลำดับ ส่วนการคำนวณอัตราส่วนของส่วนต่างต้นทุนต่อประสิทธิผลส่วนเพิ่มพบว่า จากความถี่ 1 ครั้งต่อสัปดาห์เพิ่มเป็น 2 ครั้งต่อสัปดาห์เท่ากับ 156.88 บาท/คะแนนWOMACที่ดีขึ้น 1 หน่วย และจากความถี่ 2 ครั้งต่อสัปดาห์เพิ่มเป็น 3 ครั้งต่อสัปดาห์ เท่ากับ 293.62 บาท/คะแนนWOMACที่ดีขึ้น 1 หน่วย

สรุปผลการศึกษาได้ว่า การรักษาผู้ป่วยโรคข้อเข่าเสื่อมด้วยวิธีการธาราบำบัดในบริบทสถาบันสิรินธรเพื่อการฟื้นฟูสมรรถภาพทางการแพทย์แห่งชาติที่ระดับความถี่ 2 ครั้งต่อสัปดาห์มีความคุ้มค่าด้านต้นทุนประสิทธิผลสูงที่สุด และมีอัตราส่วนของส่วนต่างต้นทุนต่อประสิทธิผลน้อยที่สุด จึงมีความคุ้มค่าทางเศรษฐศาสตร์สูงที่สุดเมื่อเทียบกับการรักษาที่ 1 ครั้ง และ 3 ครั้ง ต่อสัปดาห์ การศึกษานี้เป็นหนึ่งในหลักฐานเชิงประจักษ์สำหรับผู้กำหนดนโยบายของสถาบันสิรินธรฯ ผู้บริหารงานบริการทางคลินิก หรือผู้กำหนดนโยบายของสถานพยาบาลเฉพาะทางฟื้นฟูในประเทศไทยในอนาคตที่มีบริบทคล้ายสถาบันสิรินธรฯ อาจนำผลการศึกษานี้ไปใช้เป็นพื้นฐานในการตัดสินใจเพื่อบริหารจัดการทางการแพทย์ต่อไป

สาขาวิชา เศรษฐศาสตร์สาธารณสุขและการจัดการบริการ ลายมือชื่อนิสิต .....

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ปีการศึกษา 2559



## ACKNOWLEDGEMENTS

The journey towards the success of my thesis is reflection on the greatly assistance and support from many individuals which I would like to express my sincere gratitude to the following individuals.

My deepest gratitude to my beloved advisor, Assoc.Prof.Siripen Supakankunti, Ph.D., for her kindness, extraordinary wisdom and experiences advised me as well as the trust on giving me the chance to study in this program. Her support for all problem solutions had encouraged me to the achievement over the thesis completion.

I would be grateful to Assoc.Prof.Sothitorn Mallikamas,Ph.D., chairperson in my thesis committees, Assoc.Prof Narathip Chutivongse, Ph.D. and Dr.Pirus Pradithavanij, MD., my external examiner, for their valuable suggestions and comments toward improving my thesis. Especially in the crisis of my thesis performing, they understood and supported me to the successful of thesis completion.

Sincerely thanks to Prof.Pirom Kamolratanakul for his comment which is meaningfully to my conceptual framework including the kindness from all lecturers who share me the knowledge, skills, and crucial experiences in Health Economics field which is the really new thing in my life.

Additionally, my journey to M.Sc.Health Economics would not be a great memory if I do not have all those very good classmates who have become my life-long friends. Thank you to all staff of the faculty of Economics, Chulalongkorn University who always encourage and support me very well.

Importantly, this thesis would not have been completed without Sirindhorn National Medical Rehabilitation Institute, Department of Medical Services, Ministry of Public Health, Thailand that support me the scholarship, the field of data collection. Special thanks to all owners of data who participated in my thesis. Greatly thanks to my director, my leader, co-workers who support me to this studying. I promise that I will use this opportunity in responsible for my workplace and my country to the maximal benefits of Thai Citizens. Thank you very much to my special person who recommended me to study in M.Sc. Health Economics and Healthcare management.

Finally, Thank you my family; Dad, Mom, Brother and Sisters for encouragement to me when I give up. Thank you everything that lead me to this successful journey.



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## LIST OF ABBREVIATIONS

ABBREVIATIONS	FULL NAME
CEA	Cost Effectiveness Analysis
CUA	Cost Utility Analysis
ICER	Incremental Cost Effectiveness Ratio
OA	Osteoarthritis
PWD	People With Disability
QALY	Quality-Adjusted Life Year
SNMRI	Sirindhorn National Medical Rehabilitation Institute
TKA	Total Knee Arthroplasty
TMSE	Thai Mental State Examination
TUG	Time Up and Go Test
WOMAC	The Western Ontario and McMaster University Osteoarthritis Index

# CHAPTER I

## INTRODUCTION

### 1.1 Problem and its significance

The United Nation target of Sustainable Development Goal 3 “*To ensure healthy lives and promote well-being for all at all ages*” which enhances a global trend in health at sustainable development lead the World Health Organization (WHO) faces the challenges of the strategy performing to enhance well-being into all ages’ population. To making better quality of people’s life, preventing diseases and promoting health of world citizens as well as sustaining their well-being for all at all ages are the emphasizing roles of World Health Organization.

Globally, many countries have been affected from a fast growing in number of aging population. United Nations Department of Economic and Social Affairs, Population Division was reported the number of world aging population at 901 million in 2015 and expected to be 1.4 billion within 2030. In average people in longer-lived populations tend to spend more years living with disability than people in populations where the average lifespan is shorter. These situations related to the coming of co-morbidity diseases especially in non-communicable diseases as well as all other injuries from decreasing ability of functional movement and postural stability. Thus the demand for healthcare crucially for aging with disability definitely increased. (UN, 2015)

For this reason, WHO Rehabilitation Summary was concerned on the global trends in health and aging population required to a major scaling up of rehabilitation services in countries around the world especially in low and middle income countries which generally have the higher changes of budget limitation to provide the quality of care together with the affordable healthcare.(WHO, 2017)

Thailand also follows up with this global trend. The country has the aging population more than 8.4 million people (12.5 % of total population) in 2010 and expected to be 12.6 million people within year 2020. The growing on age normally go along with the non-communicable diseases. Of these prevalence shown the

relationship with degenerative disease and the Non communicable disease lead the increasing number of patients who required rehabilitation of the country. (Statistic, 2010)

Arthritis is one of a common condition that causing pain, functional limitation and impacting on a quality of life. (Wikman, Wardle, & Steptoe, 2011) The prevalence and impact of this disease is predicted to increase in the additional years due to the aging population and an increase in obesity. (Marks & Ray, 2003) Moreover, the arthritis is crucially related to the economic impact of workforce (Becker & Gary S, 2010). It is therefore important to explore and integrate in cost-effective treatment to reduce arthritis's impact, especially in aging adults. A recent United States Physical Activity Guideline specifically mentioned exercise for patients with arthritis. Many exercise programs have been studied to reduce pain and improve function in patients with hip and knee arthritis (Roddy et al., 2005). Studies have shown that after completing exercise-therapy land based programs; people with osteoarthritis have gained improvements in both their perception and performance of activities of daily living when compared with non-exercising control groups. (Marks & Ray, 2003) Furthermore, it has been shown that there are limited in some negative side effects to well-designed exercise-therapy programs (Marks & Ray, 2003) (Brazier & J. E., 1996) (Roddy et al., 2005) providing additional support for its use as a treatment option. Hydrotherapy, a core physiotherapeutic modality, is one of interested intervention. Clinical practice suggests that hydrotherapy has some advantage benefits when compared to land-based exercises (Bartels et al., 2007). The warm temperature of hydrotherapy pools can decrease pain and stiffness, as well as initiate relaxation (Bartels et al., 2007). Buoyancy force reduces the body weight loading directly through a joint, which enables patients to perform functional closed-chain exercises that may not be possible on land based (Hinman, Heywood, & Day, 2007). Moreover, correspondence with Arthritis Groups has suggested that access to hydrotherapy is the most facility request after suffered from arthritis (Arthritis New Zealand, 2010).

Sirindhorn National Medical Rehabilitation Institute (SNMRI) was the specialized medical rehabilitation hospital in public sector of Thailand, working under Department of Medical Services (DMS), Ministry of public health (MOPH). The general



roles were to fulfill the complicated care to patients who needed for rehabilitation and also working as a policy advocacy facilitator related to People with Disability in Thailand as well as providing academy services and created academic connection with all organization who are working related to PWD. SNMRI runs the business model as a solution shop like many different specialized hospitals of Department of Medical Services (DMS), has an ability to earn revenue and making profits. There are 5 groups of patients ranking by number of patients were 1) Orthopedic Patients (40%), 2) Stroke patient (28%), 3) Spinal Cord Injuries (16%), 4) Amputees (8%) 5) Child Cerebral Palsy (6%) the remaining was the other disability patients. Of these numbers, the first rank patient was orthopedic group (40%) who mostly were in Civil Servant Medical Benefit Scheme (CSMBS) or Out of pocket payment and the services prices commonly charged by Fee for Service (FFS), the remaining (60%) was the People with Disability who required rehabilitation in long term care. Almost 90% of orthopedic group has a chief complaint as pain and one in three of them was the group who diagnosis as the degenerative joint disease. The biggest number is knee Osteoarthritis (66%) (SNMRI, 2016).

In 2013, SNMRI finished the investment project of hydrotherapy building and opened for services in March 2013 the biggest group of patient is the Knee Osteoarthritis patient who require hydrotherapy program. The treatment protocol is the OA knee SNMRI basic program provided in walking corridor within the pool for 45 minutes under the instruction of physiotherapist. The groups of patient was measured the progression by WOMAC index (The Western Ontario and McMaster University Osteoarthritis Index) which is the worldwide using measurement tool and also translated for using in Thai language by The Royal College of Physiatrists of Thailand. More over the additional function score of TUG (Time up and Go) and applied 2 minutes-walk test was used for the outcome measurement. The outcome of OA knee management was presented that 72.83% of patient after treatment was decreasing in WOMAC index which is improving in overall outcome measurement (SNMRI, 2016).

However, there are 3 chances of development for better care process. 1) There has never been calculated actual cost of hydrotherapy. 2) No comparison in

effectiveness among different frequency of hydrotherapy program and 3) None study in cost-effectiveness evidence-based for treatment prescription as well as pricing the services. For this reason, they are reasonable motivation to perform the economic evaluation in cost-effectiveness of SNMRI's hydrotherapy specialty for OA knee. Moreover, the World Health Organization Rehabilitation Summary that mentioned about providing the quality of care together with the affordable healthcare, Hydrotherapy in Thailand was rarely setting and there was never been studied in cost-effectiveness analysis within the setting of rehabilitation hospital of Thailand and others before and SNMRI was a unique setting of the country hence this is a crucial situation for Sirindhorn National Medical Rehabilitation Institute to work more on economic evaluation to making better in quality of care together with affordable health care and can be a significant model in rehabilitation setting of the country.

## **1.2 Research Question**

### **1.2.1 Primary Research Question**

“What frequency of SNMRI's hydrotherapy program for patient with knee osteoarthritis is the most cost-effectiveness?”

### **1.2.2 Secondary Research Question**

1. What are the costs per 1 case of hydrotherapy for patient with knee osteoarthritis?
2. What frequency of hydrotherapy for patient with knee osteoarthritis is more cost-effectiveness?
3. What are the additional costs per additional outcome gained?

## **1.3 Research Objectives**

### **1.3.1 General Objective**

1. To analyze the cost-effectiveness of hydrotherapy for patient with knee osteoarthritis at SNMRI in term of money spent per one measurement score changed.
2. To compare the cost-effectiveness among different frequency of hydrotherapy for patient with knee osteoarthritis at SNMRI; 1 visit, 2 visits and 3 visits per week.

### **1.3.2 Specific Objectives**

1. To calculate unit cost of SNMRI's hydrotherapy for patient with knee osteoarthritis focuses on provider perspective.

2. To compare cost-effectiveness among different frequency of hydrotherapy for patient with knee osteoarthritis at SNMRI; 1 visit, 2 visits and 3 visit per week in term of money spent per WOMAC score decreased.

3. To calculate the additional cost per additional outcome gained.

#### 1.4 Scope of the Study

Table 1: Scope of Study

Question	Boundary
What	1) To analyze cost-effectiveness of hydrotherapy. 2) To compare cost-effectiveness among different frequency of hydrotherapy.
Where	Sirindhorn National Medical Rehabilitation Institute, Thailand
When	Fiscal Year 2016
Of which	Patient with Knee Osteoarthritis
Why	To identify the frequency of hydrotherapy that is the most cost-effectiveness?
How	To calculate the unit cost of hydrotherapy for OA knee To analyze cost-effectiveness of Hydrotherapy for OA knee. To compare cost-effectiveness of Hydrotherapy for OA knee among different frequency.

#### 1.5 Possible Benefits of the study

1. To identify the most cost-effectiveness frequency of hydrotherapy for patient with knee osteoarthritis in SNMRI which will be enhanced the evidence-based for treatment frequency prescription specialty in hydrotherapy for OA knee.

2. To support the decision maker in health technology assessment as well as the benefits for product pricing.

3. Evidence based for budget allocation in hydrotherapy facility.

## CHAPTER II

### LITERATURE REVIEW

#### 2.1 Background

##### 2.1.1 WHO Disability Situation and Disability in Thailand

World Health Survey and Global burden of Disease presented the number of People with Disability ages 15 years and older were around 785 million persons (15.6%) to 975 million persons (19.4%). Of these number, 110 million (2.2%) to 190 million (3.8%) experienced significant difficulties in functioning and needed rehabilitation. Including children over a billion people (15% of the world's population) were estimated to be living with disability. The increasing of Non-communicable Chronic Diseases observed all over the world reveal the profound effect on disability. (World Health Organization, 2011)

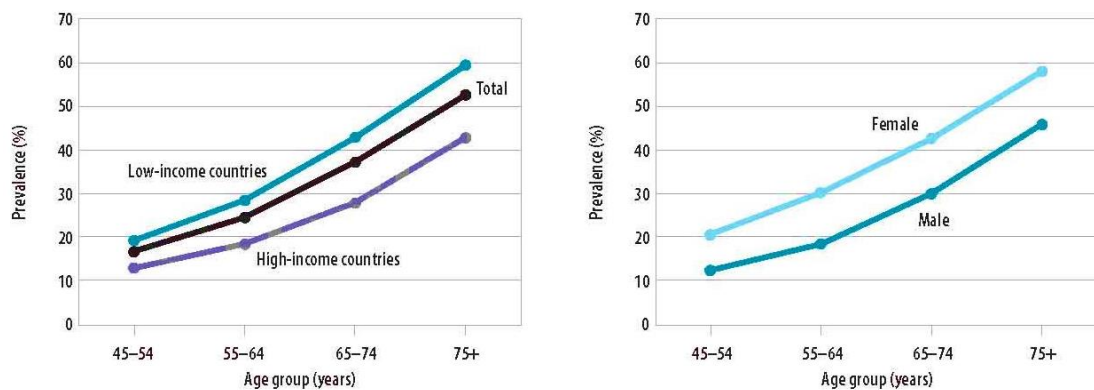


Figure 1: Age-specific disability prevalence

The graph derived from multi-domain functioning level in 59 countries, by country income level and sex, represent that the global aging has a major effect on disability trends. There is the risk of disability at older age in a 1998 population survey in Australia of people (all ages) with disabilities; stroke is one of the most common causes of disability-related health conditions. (World Health Organization, 2011)

The onset of disability can lead to the worsening of social and economic well-being and poverty through a multiple impact including the adverse impact on education, employment, earnings, and increased expenditures related to disability.

In Thailand, the recently reported on number of disability was 1.6 million persons. 20.3 % of them have a cause from Non-communicable chronic disease. 752,910 people were in the group of physical disability. (Statistic, 2010) Osteoarthritis is one of the top rank non-communicable diseases that related to the total health expenditure; cost of drug and medical instrument, cost of rehabilitation, cost of total knee replacement as well as the cost from patient perspective that related to the limitation in ambulation and transportation. The coming of osteoarthritis followed the aging population which is more than 12 percent in Thailand lead the increasing of total health expenditure due with the budget allocation for osteoarthritis.

#### 2.1.2 Osteoarthritis: Situation and Care Plan of Thailand

Arthritis is one of a common condition that induces pain, functional limitation and impacts on patient's quality of life. (Wikman et al., 2011) The prevalence of this disease is predicted to increase with the additional years due to the aging population and increase in obesity.(Marks & Ray, 2003) moreover, arthritis also induce the economic impact on workforce (Becker & Gary S, 2010). It is therefore important to clarify and study more in cost-effective treatment to reduce the arthritis's impact, especially in aging adults. A recent United States Physical Activity Guideline specifically mentioned exercise for patients with arthritis. Many types of exercise prescriptions have been found to decrease pain and improve function in patients with hip and knee arthritis (Roddy et al., 2005). Studies have shown that after finishing land based exercise programs; people with osteoarthritis have gained improvements in their perception and performance of activities daily living when compared with non-exercising control groups(Marks & Ray, 2003). Furthermore, it has been shown that there are some negative side effects to well-designed exercise-therapy programs (Marks & Ray, 2003) (Brazier & J. E., 1996) (Roddy et al., 2005) providing support for its use as a treatment protocol. Hydrotherapy, a core physiotherapeutic modality, is one of treatment. Clinical practice suggests that

hydrotherapy has some advantage benefits when compared to land-based exercises (Bartels et al., 2007). The warm temperature of hydrotherapy pools can reduce pain and stiffness, as well as increase relaxation (Bartels et al., 2007). Buoyancy force reduces the amount of weight bearing directly through a joint, which enables patients to perform functional closed-chain exercises that may not be possible on land (Hinman et al., 2007). Moreover, correspondence with Arthritis Groups has suggested that access to hydrotherapy is the common sought after request from sufferers of arthritis (Arthritis New Zealand, 2010).

Hydrotherapy is often suggested as an exercise intervention for people with arthritis. Few studies have been able to demonstrate that water-based exercises are superior to other forms of exercise. Inappropriate outcome measures may have affected hydrotherapy research; there is rare study of cost-effectiveness analysis for land-based and water based exercise because the criteria are normally different patient properties between OA knee patients who available to exercise as land-based and the case that require Hydrotherapy exercise program. Moreover the cost-effectiveness among different frequency of hydrotherapy program was never been study in Thailand.

### 2.1.3 Thailand Health Insurance Schemes วิทยาลัย

Thailand has three core Health Insurance Schemes based on the Bureau of Policy and Strategy, Ministry of Public Health, 2010; 1) Civil Servant Medical Benefit Scheme (CSMBS), 2) The Social Security Scheme (SSS) and 3) Universal Coverage (UC)

1) Civil Servant Medical Benefit Scheme (CSMBS) is a health care insurance that spent for government officers and their dependents' (parents, spouse and children) and permanent government employee. For state enterprise employee, local civil servant and public autonomous agencies that have their own employee health care benefit. This scheme was responsible for the Comptroller General's Department (CGD), Ministry of Finance in order to manage and allocate budget which come from tax-based mechanism. CSMBS is functioning as the government health

insurance welfare to the government officers. The people under this scheme were 5.4 million people in year 2011.

2) The Social Security Scheme (SSS) was established in 1990, the compulsory insurances in formal private employees including temporary government employees who has registered in SSS. The contribution is responsible by tri-party. (Insured person, employer, and government) The payment mechanism is the capitation due to the registered hospital selecting by insured person. The Ministry of Labor, the social security offices is the manager of this fund. The function of this fund is not only for medical benefits but also manage and performing the investment plan for the retirement of insured person. There was an attempt to expand the coverage of this fund by allowed the voluntary insurance due to the article 40 of the Social Security Act in year 1990. The implementation aims to extend social security coverage to the informal workers and offer some benefits package partially of the compulsory social security scheme.

3) Universal Coverage (UC) has been established and implemented in 2002 after the Asian financial crisis Tom Yam Kung. The National Health Security Office (NHSO) has been organized as the health agency to buy the medical care from hospital. The payment mechanism is capitation based on the registered location of people. UC is the health scheme that covers the remaining of people in the country especially in group of informal employees, aging people, children and disability people which were uninsured people before the Thailand healthcare reforming.

According to the Universal Coverage Scheme implementation, all People with Disability have been insured by this fund and remove barrier to access to healthcare by allowed all PWDs can access to all public hospital for all standard care with free of charged. The payment mechanism to compensate for PWD then becoming fee for services but in limited ceiling of reimbursement eventually the real situation of treatment for disability have the higher cost in average compared to general people.

#### 2.1.4 Sirindhorn National Medical Rehabilitation Institute

SNMRI: Location, Function, Vison , and Position

Sirindhorn National Medical Rehabilitation Institute is located in Nonthaburi province nearby the area of Ministry of Public Health, Thailand. The administration function is under Department of Medical Services (DMS), Ministry of Public Health (MOPH) Thailand. SNMRI has been the 48 beds specialized hospital for medical rehabilitation. Vision of SNMRI is aiming to be the leader organization in medical rehabilitation toward quality of People with Disability's life.

#### *Patients and Core Business*

SNMRI Function is the providing three roles as following.

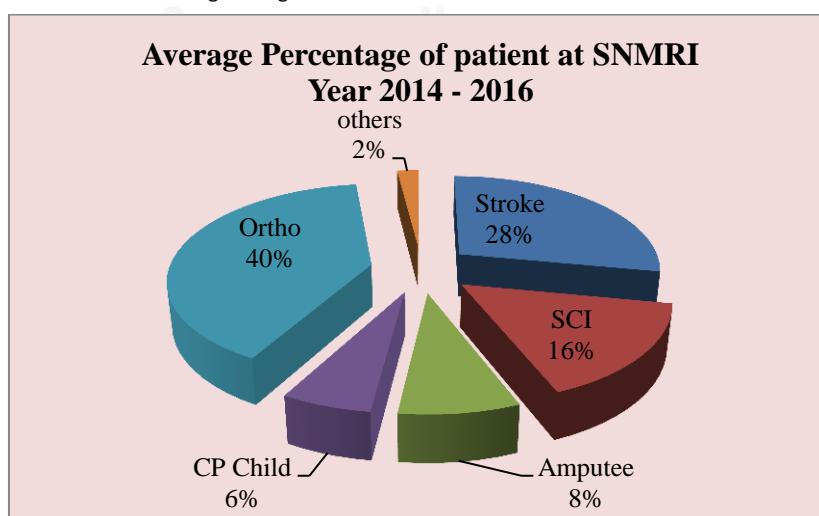
1) Provides medical services based on multidisciplinary rehabilitation team. The services are prioritized for People with Disability.

2) Function as the National Health Authority by enhancing policy advocacy related to PWD in Thailand.

3) Provides academy services as well as integrated academic linkage among rehabilitation setting and academic institutes all over the country.

In summary the core roles of SNMRI are providing medical rehabilitation services, enhancing policy related to PWD and providing academy services to society prioritized for People with Disability's right.

There are 5 core groups of patients and the percentage of total number of patients in the institute as following in [figure 3](#)



**Figure 2:** Average Percentage of total patient at SNMRI: Year 2013 – 2016



Figure 2 has shown the ranking of patient in SNMRI and the highest number of patient in SNMRI was orthopedic patients which is 40 percent of total patient. The group of orthopedic mostly access to health care facilities based on CSMBS and Out of pocket payment. This is the chance of SNMRI to gain revenue from providing services. The price of treatment has no limitation in reimbursement but the actual cost calculation was never performed by concerning in the capital cost. So pricing of treatment items in Hydrotherapy weren't reflect the actual cost of them.

#### SNMRI Hydrotherapy Services

Hydrotherapy was a recent technology investment (open for service in March 2013) of SNMRI to provide services for patient who require exercise program to enhance physical function, decrease pain and relaxation purpose. Hydrotherapy was one of treatment procedure using water as the treatment mechanism by exercise or initiate the mobility in the pool combined with the using of other properties of water; buoyancy, hydrostatic pressure, water flow, whirlpool to stimuli weakness muscle and encourage muscle movement by buoyancy and hydrostatic pressure, water flow mechanism to enhance postural stability, muscle strength and muscle flexibility. Moreover the temperature of water enhancing the blood circulation, relaxation and relief muscle tightness as well as joint stiffness (Avelar et al., 2013).

In SNMRI the most number of patients in Hydrotherapy is OA knee patient (44.48%) the treatment protocol is to exercise based on the SNMRI hydrotherapy program for OA knee within walking corridor based on the instruction of physiotherapist.

#### Financial Sources

**1. Yearly Investment Budget** was the yearly project or routine budget paid for routine payment of hospital; Medical Equipment, Material, Outsource Hiring, Human resources developing and Other Project investment.

**2. Yearly Labor Budget** has 3 financial sources due to the type of labors.

**3. Revenue from service providing:** Hospital has an ability to earn revenue from service providing. However the ceilings of reimbursement were different due to the Health Insurance Scheme of patient.

**4. Long Term Investment Budget** was the long duration plan budget for high cost project investment in long term: example; Building capital, new medical technology investment.

### 5. Donation

Table 2: Classification of Financial Sources of SNMRI

Group	Sub-group	Sources	Note
1. Yearly Investment Budget	1.1) Medical Equipment (Hi-Cost)	MOPH	Yearly Project budget plan
	1.2) Medical Supply and Material		
	1.3) Outsource Hiring		
	1.4) Other Project investment		
2. Yearly Labor Budget	2.1) Government officers salary	CGD	CGD = Comptroller General's Department
	2.2) Ministry employers salary	MOPH	
	2.3) Temporary employers salary	Hospital	
3. Revenue from service providing	3.1) CSMBS	CGD	Fee For Service Full rate
	3.2) UHC	NSHO	Fee For Service limit rate
	3.3) SSS	SSO	Fee For Service Full rate
	3.4) Out of Pocket Payment Patient	Patient	Fee For Service Full rate
4. Long Term	Building Capital New Technology investment	MOPH	5-10 Years budget plan

Investment Budget	<i>Human Resource Development</i>		
5. Donation	<i>Donation revenue exclude from SNMRI but perform as SNMRI foundation</i>	Donator	Support patient who needs assistive devices out of UC coverage

#### Cost Containment of SNMRI

SNMRI has the general method for cost containment as following.

##### **1. Earn Revenue**

- SNMRI is working together with orthopedic patients which is normally paid full average range due to CSMBS and Out of pocket payment.
- Open the overtime clinic to earn more money.

##### **2. Compensate among medical scheme**

- SNMRI use the money earned from CSMBS and out of pocket patient to compensate the lost from providing service to PWD in lower ceiling of reimbursement.
- Compensate revenue from overtime clinic for labor cost (Temporary employees)

##### **3. Value-Added to some services to earn more money**

- Invest in new technology to incentive patient's demand for specialty care. Hydrotherapy is one of the investment technologies for making revenue.

#### Limitation of SNMRI

1. No referral system, even position as the specialized hospital but limited in capacity to refer patients in others hospital for special needs. Moreover SNMRI is still limited in receiving referred from other hospitals.

2. Cost containment strategy of SNMRI would not be sustainable for financial risk prevention in the long run because the cost containment method was the temporary solution. The increasing number of PWD yearly and 60 percent of patient was PWD which has a limitation in the reimbursement.

3. All new technology investments were never calculated the actual cost and the capital spending directly from the MOPH. All high cost technologies are normally having high cost of maintenance. These might due to situation of “*supply induces demand*” in the future and lead to the financial risk in the following situation.

4. Many temporary projects was due to vertical program which commonly temporary implementation program but consume the human resource in the same group so the continuity of quality management is still faces limitation.

5. All capital spending had never ever calculated actual cost and impacts. The operation commonly performed by vertical program. This unclear situation makes institute is also lack of evidence-based for policy planning and implementation.

## **2.2 Previous Studies in cost-effectiveness of hydrotherapy**

### **2.2.1 Effectiveness Study**

(Bartels et al., 2007). Compared to *no exercise* controls, patients with combined knee and hip osteoarthritis demonstrated a small-to-moderate effect on function (SMD 0.26, 95% confidence interval (CI) 0.11 to 0.42) and a small-to-moderate effect on quality of life (SMD 0.32, 95% CI 0.03 to 0.61) immediately after exercise. There was no evidence of effect on walking ability or stiffness and no differences at 6 month follow-up with regards to pain, function, stiffness, mental health or quality of life. This systematic review identified only one trial that compared aquatic exercise with land-based exercise. Immediately after treatment, there was a large reduction in pain in group of hydrotherapy (SMD 0.86, 95%CI 0.25 to 1.47; 22% relative percent improvement), but no evidence of effect on stiffness or walking ability.

(Foley, Halbert, Hewitt, & Crotty, 2003) randomized participants into one of three groups: 1) hydrotherapy (n = 35), 2) gym (n = 35), or 3) control (n = 35). The two exercising groups had three exercise sessions a week for six weeks. At six weeks an independent physiotherapist unaware of the treatment allocation performed all outcome assessments (muscle strength dynamometry, six minute walk test, WOMAC

OA Index, total drugs, SF-12 quality of life, achieved with both exercise programs compared with the control group.

(Paola Castrogiovani & Musumeci, 2016) was studied as a systematic review and provided the suggestion that the protocol of hydrotherapy program mostly vary used in different clinical trials and difficult to make a generalization about the use of aquatic exercise in OA knee. Some studies that had not present a significantly changed in pathological condition of OA but still has a good results on the attenuation of the symptoms of the disease. Thus, even if aquatic exercise for OA knee seems not to have effects regarding walking ability or joint range of motion, it should be an option for exercise prescription in patient with OA knee (Bennell & Hinman, 2011; Musumeci et al., 2014). Moreover, adherence to aquatic exercise programs is usually very high, and no adverse effects are reported by participants, this was revealed that aquatic exercise can be effective in managing symptoms of OA knee. (Bressel, Wing, Miller, & Dolny, 2014) In addition, aquatic training is considered a potentially effective treatment intervention for OA knee patient, and it is recommended by the American College of Rheumatology (ACR) and European League Against Rheumatism (EULAR) as a non-pharmacological method of controlling OA symptoms. (Paola Castrogiovani & Musumeci, 2016)

### 2.2.2 Cost-Effectiveness Analysis in OA knee.

(Cadmus et al., 2010) a study in UK Hydrotherapy may cost in excess of US\$50,000 per quality adjusted life year gained. US\$50,000 per quality adjusted life year is commonly accepted as a threshold for interventions considered to being prohibitively expensive. Rare study of cost effectiveness in land-based exercise compared with hydrotherapy reveal hydrotherapy as more cost effectiveness. Rare studies discusses in hydrotherapy program in mild to moderate severity to prevent the total knee arthroplasty (TKA). Most studies focused on the cost effectiveness of total knee arthroplasty. The study design normally investigated the impact after total knee replacement practice. However, in real situation the cost of total knee replacement was very different from the conservative treatment in mild-moderate

severity, the patient's situation also different; most of patient who required for TKA progressed to high severity so the group of patient quite different in severity. Moreover the studies of impact after TKA basically performed in the short-term not over 1 year after operation but the long-term quality of life of patient (more than 5 years) was never been studied. On top of these, the cost of conservative treatment and cost of operation significantly different and the cost effectiveness analysis requirement also deviated to the higher cost of treatment. (Ferket et al., 2017) studied in impact of TKA by performed cost-effectiveness analysis and suggest that the improvement in quality of life depend on the severity of patients. The less severity of patient gained the lesser utility unit compared to the severe patient and the less severity group would be the economically unjustifiable. The researcher suggested that the limiting eligibility to patient with more symptomatic knee osteoarthritis will be benefit for the consideration for cost savings. So this is one of the guidance that other treatment for less severity should be concerned in lower cost treatment.

For the situation of SNMRI normally performs hydrotherapy services in different frequency per week. No study of cost effectiveness comparison among different frequency of hydrotherapy program for OA knee. Most of studies use 2 times a week as the protocol. The unclear situation in frequency of hydrotherapy in SNMRI should gained benefit from this finding.

None of published study in cost effectiveness of hydrotherapy in Thailand. This reason was caused by the limitation of the hydrotherapy facilities in the country so this study will be the first estimating in cost-effectiveness of hydrotherapy program for OA knee in Thailand.

### 2.2.3 Outcome measurement in OA knee.

(Lamer PJ, Bell J, O'Brien D, Dangen J, & P, 2014) was studied a systematic review in outcome measures for people with Arthritis and found that the most common tool performed for outcome measurement were the Pain Visual Analogue Scale and the Western Ontario and McMaster Universities Osteoarthritis Index

(WOMAC). The WOMAC measure can be scored by using a five point Likert scale or 100mm VAS scale. Many studies did not clarify the type of scale using in their studied. Some studies used Health Assessment Questionnaire (HAQ), The Arthritis Self-Efficacy Scale (ASES), the Short Form (SF-36), the Knee injury and Osteoarthritis Outcome Score (KOOS), the Physical Activity Scale for the elderly (PASE) and Euro-QOL. Many studied used disease specific measurement tools. This study suggests that we could not always know why clinicians and researchers select a particular outcome measurement tool. Mostly studies selected tool based on pragmatic decision. The WOMAC is widely promoted for its validity, reliability and responsiveness in patient with osteoarthritis of hip or knee. (Bellamy N, Buchanan WW, Campbell J, & LW, 1998)

(N F Woolacott & MS Corbett, 2010) from the Centre for Reviews and Dissemination, The University of York was studied by systematic reviews in the using of WOMAC measurement tool found that poor reporting of both the WOMAC pain subscale and the WOMAC index results in significant uncertainty in the interpretation of the results of trials and imposes limitations on the synthesis of the data across trials. Improved adherence to the standard use of the WOMAC scoring system, coupled with clear reporting of it in trials of osteoarthritis of the knee should be encouraged. However mostly studies all over the world use WOMAC as the instrument for outcome measure. So the caution on identify the type of scoring and interpretation is concerned for all studies.

Additionally, the WOMAC scoring was the self-address instrument and diseased-specific tool for arthritis patient. Various studies in economic evaluation use the measurement tool in unit of quality of life. So EQ-5D and WHOQOL were used for the full capacity measurement process. However the clinical research normally limited with the time of assessment process. Most of studies use disease specific instrument transform to the quality of life measurement tool. The uses of WOMAC transforming to EQ-5D was seen in many studies. Thus many researchers was trying to estimate the reasonable model for the transforming. (Wailoo, Alava, & Martinez, 2014) was studied by modeling the relationship between the WOMAC osteoarthritis index and EQ-5D and found that EQ-5D can be reliably estimated from WOMAC

subscale scores without any systematic bias and presented the results as the model for transforming. (Xie et al., 2010) was revealed the study by use of disease-specific instrument in Economic Evaluations: Mapping WOMAC onto the EQ-5D Utility Index that EQ-5D can be predicted using WOMAC domain scores with an acceptable precision at individual and group levels in patients with mild to moderate knee OA as well as the study of Barton (Barton et al., 2008) that did the estimates of cost-utility based on the EQ-5D differ from those based on the mapping of utility scores to convert scores from condition-specific measures into utility scores. With this method we can compare the QALY gained based on actual EQ-5D scores. This study presented the economic model to transform the WOMAC diseased specific score onto EQ-5D to calculate the Quality Adjusted Life Year gains. The model presented as following.

$$\text{Predicted EQ-5D score} = 0.746652555353163 + (0.000810215321934668* \text{total WOMAC}) + (-0.000119664323424435* \text{total WOMAC}^2)$$

The calculation was using the total WOMAC scoring in pre-test and post-test to estimate the EQ-5D which will be enable for finding utility outcome.



## CHAPTER III

### RESEARCH METHODOLOGY

#### 3.1 Step of Study

This conceptual framework shown an overview procedure in research plan and the data needed to collect and calculate for this study. Three steps of planning were included to the conceptual framework

**Step 1:** Data Collection

**Step 2:** Data Cleaning and classification

**Step 3:** Costing

Cost Center Identification and Grouping

Direct Cost Determination

Cost Allocation

Full Cost Determination

Unit Cost Calculation

**Step 4:** Outcome Measuring

Health Outcome Measuring

**Step 5:** Data Analysis

Cost-Effectiveness Analysis

Cost-Effectiveness Comparison

Sensitivity Analysis

**Step 6:** Conclusion and Discussion

**Step 7:** Policy implementation

### 3.2 Diagram of Conceptual Framework

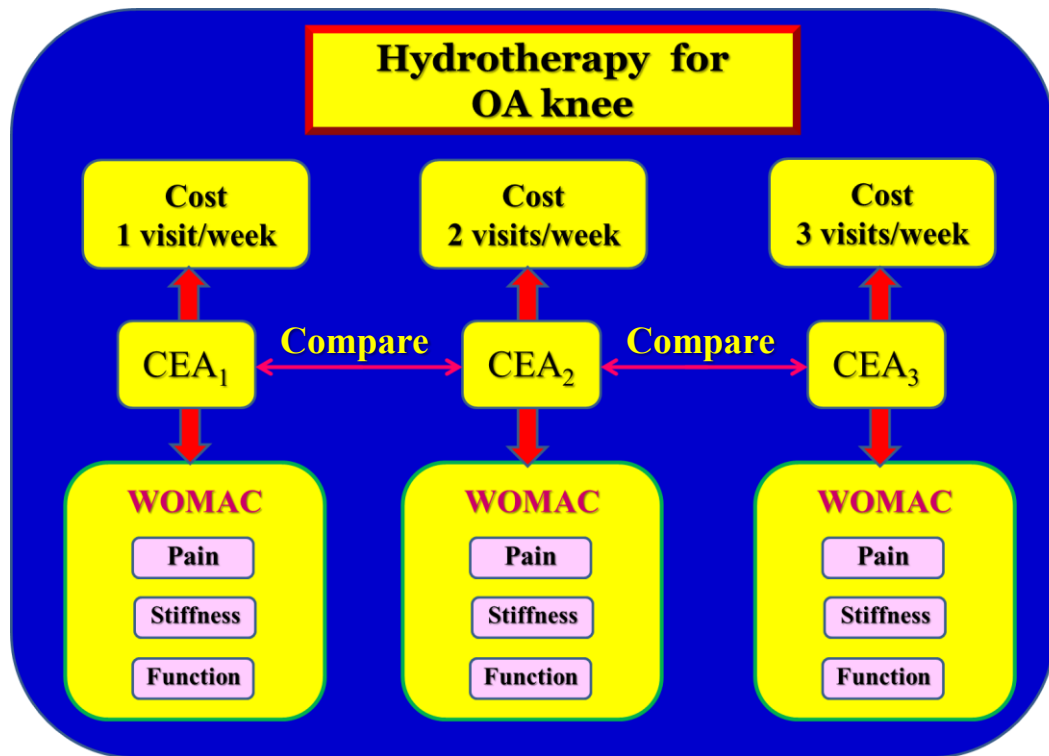


Figure 3: Conceptual Framework Diagram

### 3.3 Study Design

This study design is the Retrospective Observational Study to perform cost effectiveness analysis of hydrotherapy for patient with Knee Osteoarthritis in Sirindhorn National Medical Rehabilitation institute.

### 3.4 Data Collection

This study plans to use the primary sources data from hydrotherapy building at Sirindhorn National Medical Rehabilitation Institute. Group of patients at SNMRI investigated by physical medicine and rehabilitation doctor (PM&R) and provided hydrotherapy program by physiotherapist. The data collection is based on physiotherapy progression record and some case using hospital medical record to confirm unclear data.

### 3.4.1 Target Population

Osteoarthritis patients who attend hydrotherapy OA knee program at SNMRI in fiscal year 2016

### 3.4.2 Inclusion Criteria

1. Patient with OA knee diagnosis by PM&R Doctor
2. Age 45 – 80 years
3. Require exercise program to improve knee function.
4. No history of TKA
5. Chief complaint is at least related to pain problems

### 3.4.3 Exclusion Criteria

1. Thai Mental State Examination; TMSE  $\leq$  23
2. Comorbidity
  - Acute MI
  - Active TB
  - Unstable Epilepsy
  - Permanent disability (Stroke, SCI, Amputation, Cerebral palsy child)
3. On treatment program related to purpose of relief pain combined with hydrotherapy program. (Except patient who takes medication is available)
4. Patients who referred to another hospital due to serious adverse event or unstable health status as well as the patient who treated with hydrotherapy lesser than 6 visit.
5. Patients who miss the hydrotherapy program more than 2 week.

### 3.4.4 Research Tools

1. Data Collection Form
2. WOMAC index recording card

## 3.5 Data Analysis

### 3.5.1 Costing

According to the retrospective study, cost of operation focused on provider perspective. The study calculates the total cost of hydrotherapy procedure including

the direct cost and indirect cost. This study used reciprocal method for cost allocation based on cost allocation criteria among different cost unit.

### 1. Cost Centered Identification

Table 3: Cost Centered Identification

Group	Department/Service Unit	Total			Allocation Criteria	
		N.pt visit	N.staff	Working hour		
NRPCC	101-Administrator office	-	28.00	63,700.00	200.00	area(sq.m)
	102-Utility-supply&vehicle unit	-	26.00	59,150.00	50.00	work hours
	103-Human Resource	-	5.00	11,375.00	50.00	N.of staff
	104-Finance	-	17.00	41,275.00	50.00	N.of staff
	105-Quality Management	-	2.00	2,899.00	50.00	area(sq.m)
	106-IT	-	5.00	13,975.00	200.00	area(sq.m)
	107-Medical Record	-	12.00	31,200.00	400.00	N.of pt visit
	108-R&D	-	14.00	31,850.00	200.00	N.of staff
RPCC	201-Medical Organization	44,896.00	14.00	38,830.00	1,000.00	pt service hour
	202-Radiology	228.00	2.00	4,550.00	50.00	N.of pt visit
	203-Nutrition and Diet	356.00	2.00	4,550.00	200.00	N.of pt visit
PS	301-Pharmacy	13,754.00	8.00	22,100.00	400.00	
	<b>302-Hydrotherapy***</b>	<b>9,701.00</b>	<b>8.00</b>	<b>26,000.00</b>	<b>600.00</b>	
	303-Physiotherapy	67,572.00	39.00	101,725.00	2,000.00	
	304-IPD (n.visit=inpatient days)	12,264.00	46.00	152,570.00	1,200.00	
	305-OPD	32,632.00	27.00	71,825.00	2,000.00	
	306-Occupational Therapist	19,470.00	28.00	33,475.00	1,000.00	
	307-Child Rehab Center	4,468.00	9.00	2,663.00	1,000.00	
	308-Speech Therapy	6,182.00	8.00	20,800.00	500.00	
	309-Assistive Technology	841.00	13.00	29,575.00	1,000.00	
	310-Prosthetic and Orthotic	2,557.00	32.00	72,800.00	4,000.00	
	311-Day care Unit	3,903.00	10.00	22,750.00	500.00	
<b>Total</b>		<b>218,824</b>	<b>355</b>	<b>859,637.00</b>	<b>16,650</b>	

### 2. Total Direct Cost Calculation

The process to analyze unit cost is started by determining the total direct cost based on cost unit separately among departments which the SNMRI setting provides rehabilitation by many departments that involved in the process of multidisciplinary rehabilitation. For hydrotherapy cost unit was calculated direct cost separate in capital cost, material cost and labor cost. For the capital cost include the cost of building and operation system with medical equipment. The material cost involves with the cost of material used due to the number of services as well as repaired and maintenance cost from operation. The labor cost of office hour include the salary and fringe benefits, the overtime hiring is the fixed rated wage per shift and do not varied due to the number of patients.

Table 4: Direct Cost Category and Calculation

Component	Cost Category	Specific Calculation
Capital	1. Building	- Present value calculation - Depreciation by straight line method
	2. Investment	
	3. Medical Equipment	
Labor	1. Salary	- allocation of working hour
	2. Fringe Benefits	*Services, Administration Research
Material	1. Medical supply	- volume, dose, number
	2. Non-Medical Supply	- weight, volume
	3. Operation and Maintenance	- allocation: Time uses, space uses

### 3. Indirect Cost Allocation Based on Reciprocal Method

Table 5: Cost Centered and allocation criteria

Group	Department/Service Unit	Total			Allocation Criteria	
		N.pt visit	N.staff	Working hour		
NRPCC	101-Administrator office	-	28.00	63,700.00	200.00	area(sqm)
	102-Utility-supply&vehicle unit	-	26.00	59,150.00	50.00	work hours
	103-Human Resource	-	5.00	11,375.00	50.00	N.of staff
	104-Finance	-	17.00	41,275.00	50.00	N.of staff
	105-Quality Management	-	2.00	2,899.00	50.00	area(sqm)
	106-IT	-	5.00	13,975.00	200.00	area(sqm)
	107-Medical Record	-	12.00	31,200.00	400.00	N.of pt visit
	108-R&D	-	14.00	31,850.00	200.00	N.of staff
RPCC	201-Medical Organization	44,896.00	14.00	38,830.00	1,000.00	pt service hour
	202-Radiology	228.00	2.00	4,550.00	50.00	N.of pt visit
	203-Nutrition and Diet	356.00	2.00	4,550.00	200.00	N.of pt visit
PS	301-Pharmacy	13,754.00	8.00	22,100.00	400.00	
	<b>302-Hydrotherapy***</b>	<b>9,701.00</b>	<b>8.00</b>	<b>26,000.00</b>	<b>600.00</b>	
	303-Physiotherapy	67,572.00	39.00	101,725.00	2,000.00	
	304-IPD (n.visit=inpatient days)	12,264.00	46.00	152,570.00	1,200.00	
	305-OPD	32,632.00	27.00	71,825.00	2,000.00	
	306-Occupational Therapist	19,470.00	28.00	33,475.00	1,000.00	
	307-Child Rehab Center	4,468.00	9.00	2,663.00	1,000.00	
	308-Speech Therapy	6,182.00	8.00	20,800.00	500.00	
	309-Assistive Technology	841.00	13.00	29,575.00	1,000.00	
	310-Prosthetic and Orthotic	2,557.00	32.00	72,800.00	4,000.00	
	311-Day care Unit	3,903.00	10.00	22,750.00	500.00	
<b>Total</b>		<b>218,824</b>	<b>355</b>	<b>859,637.00</b>	<b>16,650</b>	

#### 4. Full Cost Determination

Table 6: Full Cost Determination Form

Group	Department/Service Unit	N.pt visit	Direct Cost	Indirect Cost	Full Cost
NRPCC	101-Administrator office	-			
	102-Utility-supply&vehicle unit	-			
	103-Human Resource	-			
	104-Finance	-			
	105-Quality Management	-			
	106-IT	-			
	107-Medical Record	-			
	108-R&D	-			
RPCC	201-Medical Organization	44,896.00			
	202-Radiology	228.00			
	203-Nutrition and Diet	356.00			
	301-Pharmacy	13,754.00			
PS	<b>302-Hydrotherapy***</b>	<b>9,701.00</b>			
	303-Physiotherapy	67,572.00			
	304-IPD (n.visit=inpatient days)	12,264.00			
	305-OPD	32,632.00			
	306-Occupational Therapist	19,470.00			
	307-Child Rehab Center	4,468.00			
	308-Speech Therapy	6,182.00			
	309-Assistive Technology	841.00			
	310-Prosthetic and Orthotic	2,557.00			
	311-Day care Unit	3,903.00			
<b>Total Budget SNMRI 2016</b>		<b>218,824</b>			

#### 5. Unit Cost Calculation

This study uses the particular duration of fiscal year 2016 collecting data. The unit cost calculation performed by the following formula.

$$\text{Unit Cost} = \frac{\text{Total Cost}}{\text{Total Output}}$$

$$\text{Hydrotherapy Unit Cost} = \frac{\text{Total Cost of Hydrotherapy}}{\text{Total Number Visit}}$$

#### 3.5.2 Outcome Measurement

##### Primary Outcome: WOMAC

The Western Ontario and McMaster University Osteoarthritis Index (WOMAC) was developed as an osteoarthritis specific measure of disability. The score comprises of three components: pain, stiffness, physical function, which can be reported separately or as an overall index. In 1994 a consensus meeting recommended the use of WOMAC as a primary measure of efficacy in osteoarthritis trials. (N F Woolacott & MS Corbett, 2010)

In this study uses the WOMAC Thai language version developed by The Royal College of Physiatrists of Thailand. The score comprises of 3 components; pain (5 items), stiffness (2 items), and function (15 items). The total WOMAC score (combined all components) will be counted as the health outcome of cost-effectiveness analysis and the transforming to EQ-5D to calculate the utility score.

**Secondary Outcome:**

**1.) TUG: Time up and Go**

TUG (Time up and go Test) is the measurement for the least time duration that patient can walk for 10 meters; the decreasing of time reveals the better progression.

**2.) Two Minutes Walks Test**

2 Minutes' walk test is the adjusted walking performance test by measure the distance of patient's walking ability within 2 minutes. This test was adjusted by SNMRI hydrotherapy development team; the test aims to measure basic functional ability of walking and did not mention about cardiovascular endurance. Most of patients were aging patient and due with pain on function so the test adjusted to 2 minutes' walk test will be safer for patient. The increasing of distance reveal the better progression of patient.

The secondary outcome will be used to describe the trend of WOMAC changed. Even WOMAC is the worldwide measurement tool but it is a self-address instrument which is quite subjective measurement. So using TUG and 2 minutes' walk Test to measure the trend of WOMAC changed is a benefit to the data discussion and conclusion.

**3.5.3 Cost Effectiveness Analysis (CEA)**

Based on the conceptual framework of this study, after finding outcome, the comparison of cost spent per one score gained among groups of different frequency (visit per week) will be compared. To find the solution that which group is more cost-effectiveness.

$$\text{Hydrotherapy Cost Effectiveness} = \frac{\text{Total Cost of Hydrotherapy}}{\text{Total WOMAC decreased}}$$

The cost-effectiveness analysis (CEA) will be revealed the final outcome in term of money spent per one total WOMAC score decreased. The comparison between different frequencies will be followed after the CEA each group.

#### 3.5.4 Incremental Cost Analysis

Incremental Cost Analysis aims to identify the ratio of the increasing of cost in order to the increasing of outcome to see the marginal cost of adding outcome whether the operation cost increased.

$$\textbf{Incremental Cost Effectiveness Ratio} = \frac{\textbf{Additional Cost}}{\textbf{Additional Outcome}}$$

$$\textbf{ICER (1 – 2)} = \frac{\textbf{Cost of 2 visit – Cost of 1 visit}}{\textbf{WOMAC decreased (2visit) – WOMAC decreased (1visit)}}$$

$$\textbf{ICER (2 – 3)} = \frac{\textbf{Cost of 3 visit – Cost of 2 visit}}{\textbf{WOMAC decreased (3visit) – WOMAC decreased (2visit)}}$$

*ICER (1 – 2) = Incremental Cost Effectiveness Ratio from group of 1 visit per week to group of 2 visit per week*

*ICER (2 – 3) = Incremental Cost Effectiveness Ratio from group of 2 visit per week to group of 3 visit per week*

#### 3.5.5 Sensitivity Analysis

Category 1: Increased Labor cost for 30 percent

Category 2: Decrease a reimbursement rate from 1,200.-/visit to 800.-/visit

Category 3: Change Depreciation to 10 year straight line calculation

Category 4: Combined category 1, 2 and 3



## CHAPTER IV RESULT

### 4.1 Descriptive Statistic

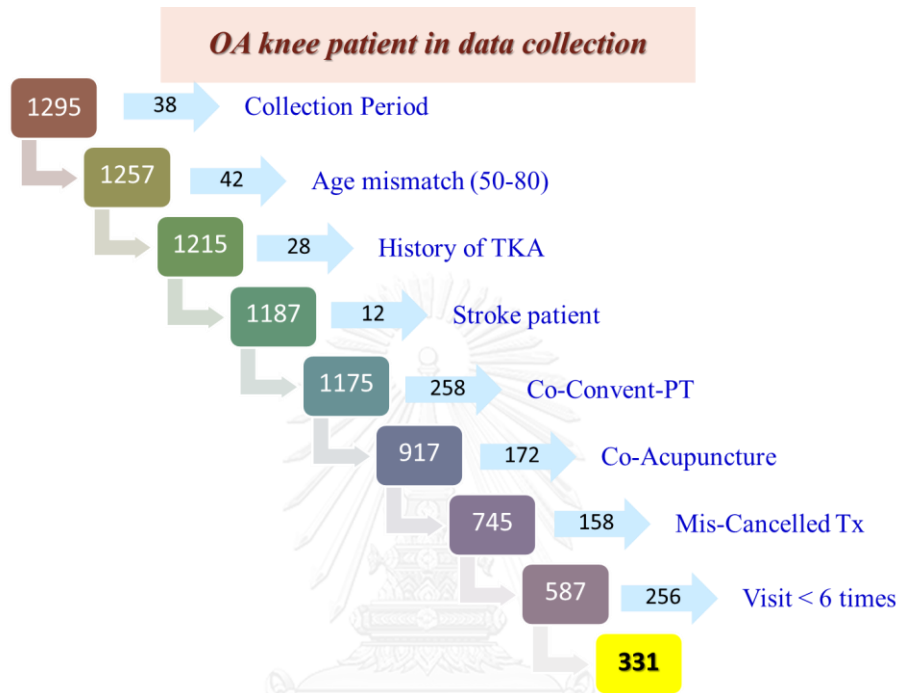


Figure 4: Number of OA knee patients in data collection of the study.

Figure 5 shown the overview of data collection which the number of OA knee patient population started from 1,295 cases but the terminal collection remaining 331 cases for analysis which is separate by the group of frequency in weekly visit as following table.

Table 7: Number of population each group of weekly treatment frequency.

Group	N. population
1 visit	119
2 visit	172
3 visit	40

The number of patients among groups presented the difference in population size among groups especially in group 3 visit per week which is the least number.

These data collected by the retrospective observational procedure and they showed the real practice of SNMRI.

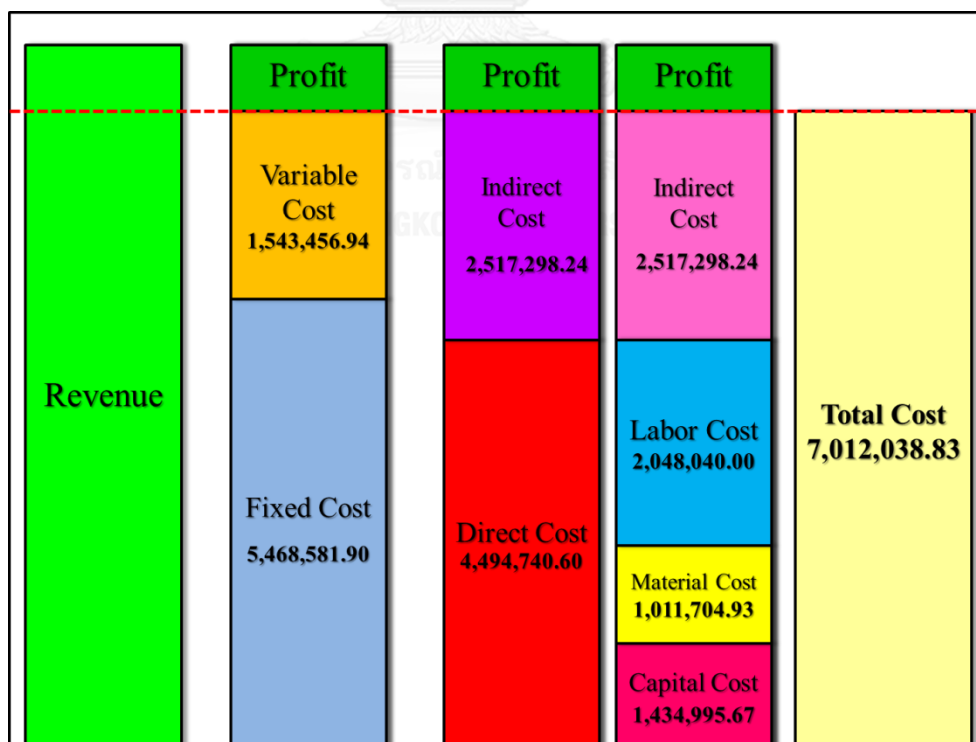
**Table 8:** Descriptive Statistic of population among different group of frequency  
(1 visit, 2visit, 3visit per week)

visit	age			BW			Height			BMI		
	1	2	3	1	2	3	1	2	3	1	2	3
Mean	65.34	65.32	65.33	69.10	68.84	59.95	1.60	1.61	1.59	27.03	26.80	24.19
SD	6.80	6.07	6.41	11.35	11.73	7.67	0.07	0.07	5.13	4.81	4.83	5.13
Max	80.00	79	79	95.00	97	92.4	1.80	1.78	45.2	39.51	43.37	45.19455
Min	52	53	51	50	49	49.5	1.48	1.45	17.48	18.21	17.55	17.48

The table presents the descriptive statistic of basic qualification of patient; age, body weight, height, and body mass index (BMI) among groups of patient in different frequency of visit. The patient qualification among groups was not significantly different by means.

## 4.2 Cost

### 4.2.1 Cost Structure



**Figure 5:** Cost Structure of hydrotherapy facility in different clarification.

## 4.2.2 Unit Cost

A. Concept of unit cost = (Direct Cost + Indirect Cost)/Total number of visit

Table 9: Direct method cost allocation

(Unit cost calculated by combined office hour service and overtime services)

Group	Department/Service Unit	N.pt visit	TDC	Total IDC	Direct+Indirect	N.pt visit	Unit Cost/visit
NRPCC	101-Administrator office	-	7,489,146.03	4,609,275.24	12,098,421.27	-	
	102-Utility-supply&vehicle unit	-	39,792,763.92	4,210,769.84	44,003,533.77	-	
	103-Human Resource	-	7,244,315.44	830,376.60	8,074,692.04	-	
	104-Finance	-	3,694,387.62	2,899,470.02	6,593,857.64	-	
	105-Quality Management	-	1,009,366.87	260,188.79	1,269,555.65	-	
	106-IT	-	5,649,016.57	1,044,379.91	6,693,396.48	-	
	107-Medical Record	-	2,487,797.73	2,741,501.98	5,229,299.71	-	
	108-R&D	-	3,513,696.60	2,355,679.74	5,869,376.34	-	
RPCC	201-Medical Organization	44,896.00	8,444,943.77	4,508,735.70	12,953,679.47	44,896.00	288.53
	202-Radiology	228.00	1,565,747.35	410,693.12	1,976,440.47	228.00	8,668.60
	203-Nutrition and Diet	356.00	713,083.58	490,044.51	1,203,128.10	356.00	3,379.57
PS	301-Pharmacy	13,754.00	18,030,972.26	2,280,693.35	20,311,665.61	13,754.00	1,476.78
	<b>302-Hydrotherapy***</b>	<b>9,701.00</b>	<b>4,494,740.60</b>	<b>2,517,298.24</b>	<b>7,012,038.83</b>	<b>9,701.00</b>	<b>722.82</b>
	303-Physiotherapy	67,572.00	14,340,598.09	10,760,434.34	25,101,032.43	67,572.00	371.47
	304-IPD (n.visit=inpatient days)	12,264.00	13,152,977.34	12,771,128.20	25,924,105.53	12,264.00	2,113.84
	305-OPD	32,632.00	12,435,252.40	7,435,006.88	19,870,259.28	32,632.00	608.92
	306-Occupational Therapist	19,470.00	10,220,022.24	4,826,137.64	15,046,159.87	19,470.00	772.79
	307-Child Rehab Center	4,468.00	2,608,994.33	1,149,016.68	3,758,011.02	4,468.00	841.09
	308-Speech Therapy	6,182.00	2,577,393.20	2,081,428.36	4,658,821.56	6,182.00	753.61
	309-Assistive Technology	841.00	6,930,769.40	3,000,076.71	9,930,846.11	841.00	11,808.38
	310-Prosthetic and Orthotic	2,557.00	10,535,370.54	8,180,672.52	18,716,043.05	2,557.00	7,319.53
311-Day care Unit	3,903.00	2,101,786.51	2,241,257.13	4,343,043.64	3,903.00	1,112.74	
<b>Total Budget SNMRI 2016</b>		<b>218,824</b>	<b>179,033,142.39</b>	<b>81,604,265.49</b>	<b>260,637,407.88</b>	<b>218,824</b>	

Based on this calculation the unit cost was combined direct cost and indirect cost of hydrotherapy building and divided by the total number of patient visits (office hour and overtime visit). Total direct cost of hydrotherapy facilities costs 4,494,740.60 baht, total indirect cost equal to 2,517,298.24 baht so summary of total cost of hydrotherapy building equal to 7,012,038.83 baht. The total number of visit of hydrotherapy facilities in fiscal year 2016 is 9,701 visits. So the unit cost/ visit equal to 722.82 baht per visit. This calculation based on the real situation of SNMRI that some patient did not visit the facilities only within an office hour or overtime hour. Most of them take the service in combination of office hour and overtime service hour to fulfill the number of visit per week. So 722.82 is the unit cost in combination of office hour and overtime working.

B. Concept of unit cost by: Unit Cost = Fixed Cost + Variable Cost

Table 10: Unit cost in office hour and overtime shown as fixed cost and variable cost

	office hr					Over time				
	CC	MC	LC	IDC	All items	CC	MC	LC	IDC	All items
<b>FC</b>	130.45	24.76	209.84	228.60	<b>593.65</b>	130.45	24.76	214.53	228.60	<b>598.34</b>
<b>VC</b>	17.47	110.42			<b>127.89</b>	17.47	110.42		0.00	<b>127.89</b>
<b>TC</b>	147.92	135.18	209.84	228.60	<b>721.54</b>	147.92	135.18	214.53	228.60	<b>726.23</b>

$$\text{Office hour Unit cost} = \text{FC} + \text{VC} = 593.65 + 127.89 = \underline{721.54} \text{ baht/visit}$$

$$\text{Overtime Unit cost} = \text{FC} + \text{VC} = 598.34 + 127.89 = \underline{726.23} \text{ baht/visit}$$

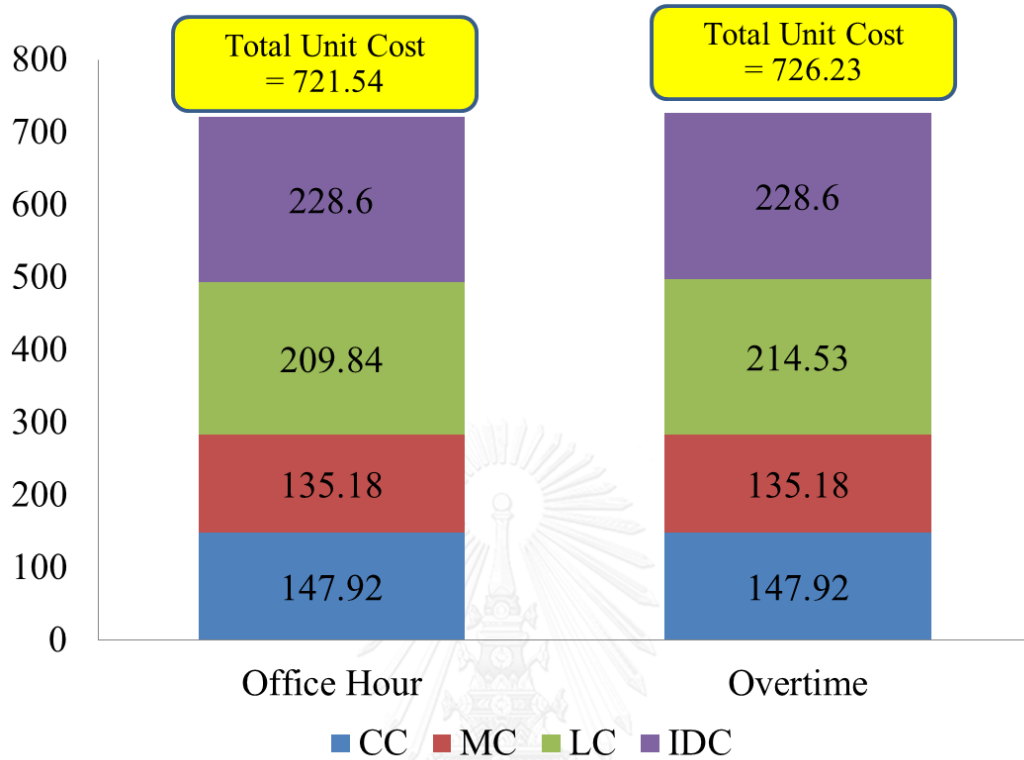


Figure 6: Unit Cost component of hydrotherapy in office hour and overtime service.

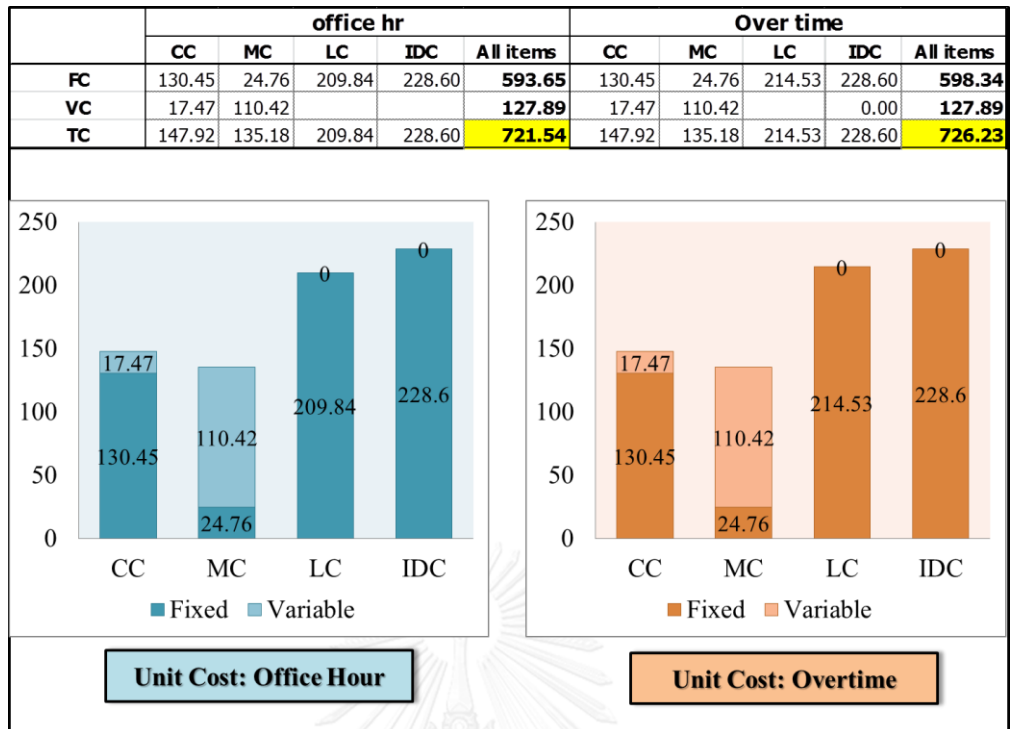


Figure 7: Fixed Cost and Variable Cost proportion of office hour and overtime working

## 4.2.3 Total Cost among different group

Table 11: Full Cost calculation among different group of frequency

Items	Group of Frequency/week		
	1 Visit	2 Visit	3 Visit
Number of visit	926.00	1,507.00	542.00
N. population	119.00	172.00	40.00
Cost	669,327.69	1,089,283.84	391,766.32
average cost/case	5,624.60	6,333.05	9,794.16

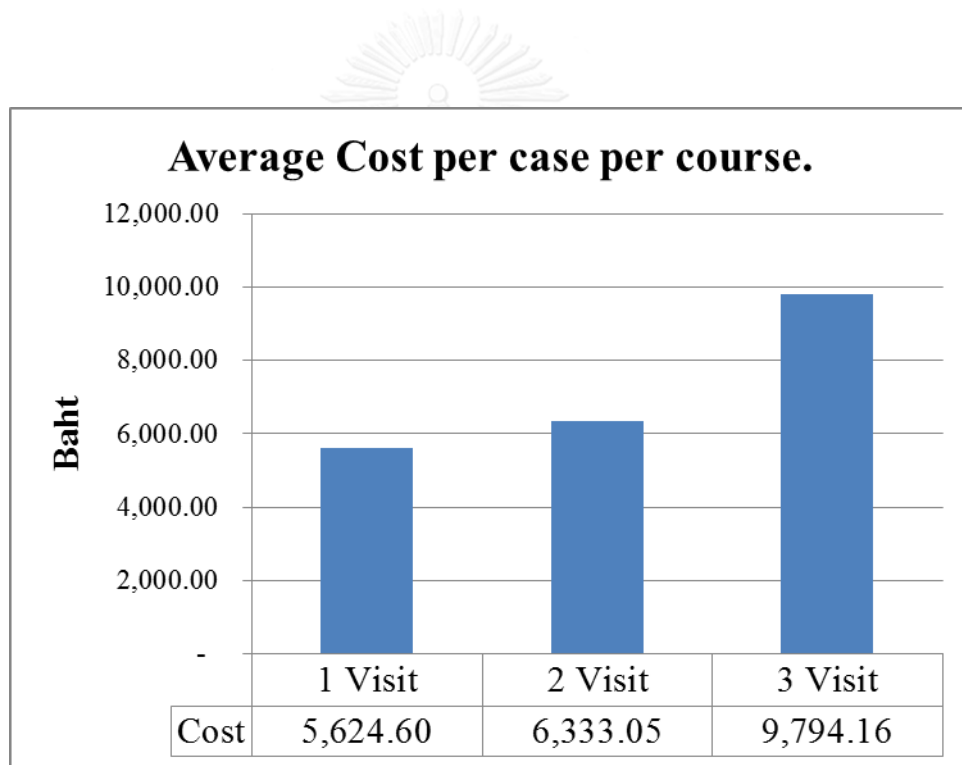


Figure 8: Graph shows the average cost of hydrotherapy program. (Baht per person per course)

### 4.3 Outcome

#### 4.3.1 Primary Outcome

##### WOMAC Score

Table 12: Summary of WOMAC score separate items among different groups

WOMAC items		1 visit/week			2 visit/week			3 visit/week		
		Pre	1 Month	Post	Pre	1 Month	Post	Pre	1 Month	Post
Pain	$\Sigma$	2,423	2,132	1,565	3,444	2,387	1,943	797.00	400.00	406
	$\bar{X}$	20.36	17.92	13.15	20.02	13.88	11.30	19.93	10.00	10.15
	SD	11.46	10.57	7.20	8.71	7.82	6.96	10.20	5.12	6.51
Stiffness	$\Sigma$	881.00	800.00	561.00	1,392	1,059	676.00	359.00	124.00	111
	$\bar{X}$	7.40	6.78	4.71	8.09	6.16	3.93	8.98	3.10	2.78
	SD	5.26	4.76	3.37	4.74	3.95	3.04	3.43	2.60	2.45
Function	$\Sigma$	7,364	6,556	4,904	10,416	8,273	6,598	2,408	1,430	1,172
	$\bar{X}$	61.88	55.09	41.21	60.56	48.10	38.36	60.20	35.75	29.30
	SD	31.17	55.13	18.57	28.24	22.71	20.41	31.74	21.00	17.47
Total WOMAC	$\Sigma$	10,668	9,488	7,030	15,252	11,719	9,217	3,564	1,954	1,689
	$\bar{X}$	89.65	79.73	59.08	88.67	68.13	53.59	89.10	48.85	42.23
	SD	46.72	63.41	26.69	40.41	32.45	29.09	42.60	25.42	23.65

Table 13: Health outcome changed (WOMAC Score decreased) among different group

Items	Frequency of Hydrotherapy Program			Unit
	1visit	2visit	3visit	
N.of population	119	172	40.00	Person
Average N.of visit	7.78	8.76	13.55	Visit/Treatment program
Average Duration of TX (Tx Period)	54.47	30.67	31.62	Days
Total WOMAC Decreased	3,638.00	6,035.00	1,875.00	WOMAC Decreased per overall group
Average WOMAC Decreased	30.57	35.09	46.88	WOMAC Decreased/case/course

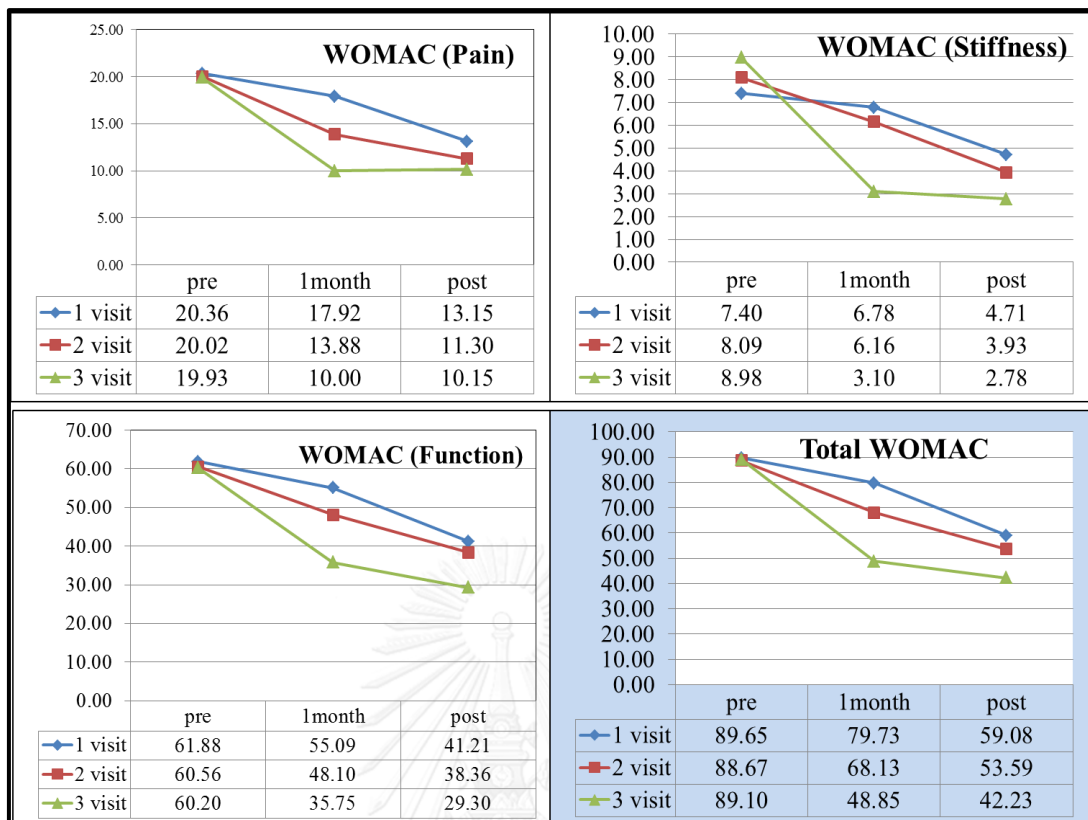


Figure 9: Graph shows the progression of WOMAC changed separated items and progression of total WOMAC changed.

#### 4.3.2 Secondary Outcome

##### TUG (Time up and go Test)

TUG is the measurement for the least time duration that patient can walk for 10 meters; the decreasing of time reveals the better progression.

##### 2 Minutes' walk test

2 minutes' walk test is the adjusted walking performance test by measure the distance of patient's walking ability within 2 minutes. The increasing of distance reveals the better progression of patient.



Table 14: Summary of Health Outcome among different groups

Health Outcome	1 visit/week			2 visit/week			3 visit/week			
	Pre	1 Month	Post	Pre	1 Month	Post	Pre	1 Month	Post	
Total WOMAC	$\Sigma$	10,668	9,488	7,030	15,252	11,719	9,217	3,564	1,954	1,689
	$\bar{X}$	89.65	79.73	59.08	88.67	68.13	53.59	89.10	48.85	42.23
	SD	46.72	63.41	26.69	40.41	32.45	155.00	42.60	25.42	23.65
TUG	$\Sigma$	1,370.42	1,066.90	1,045.15	1,841.99	1,641.39	1,507.85	431.28	392.31	373.53
	$\bar{X}$	11.52	8.97	8.78	10.71	9.54	8.77	10.78	9.81	9.34
	SD	5.76	1.88	1.58	2.49	1.90	1.91	2.56	2.05	2.27
Minutes Walk	$\Sigma$	15,247.5	16,632	16,983	21,584	23,138	24,254	4,849	5,191	5,490
	$\bar{X}$	128.13	139.76	142.71	125.49	134.52	141.01	121.23	129.78	137.25
	SD	34.01	25.73	22.77	24.76	24.11	22.69	22.10	22.12	17.72

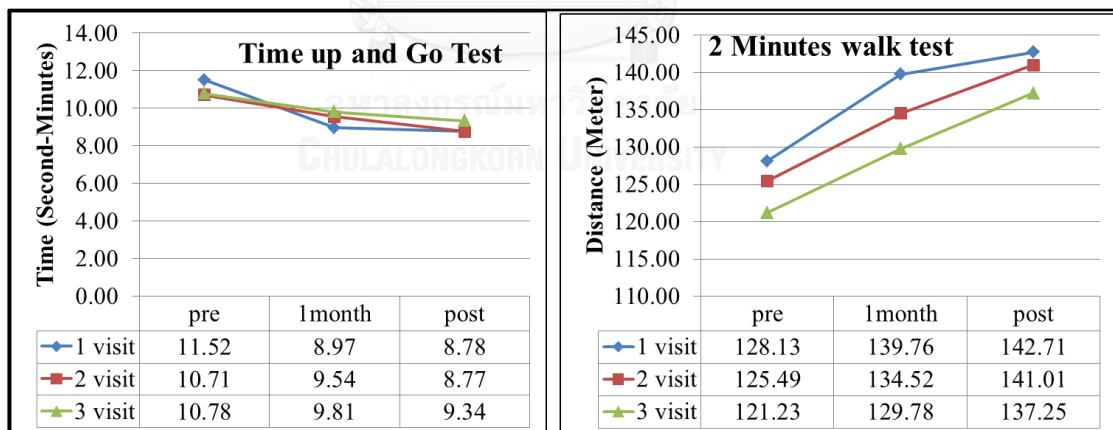


Figure 10: Graph shows progression of secondary health outcome measurement.

#### 4.4 Data Analysis

Table 15: Summary of data analysis; Cost Effectiveness Analysis, Incremental cost effectiveness ratio and Cost Utility analysis

Category	Items	Group of Frequency			Unit
		1 Visit	2 Visit	3 Visit	
Population	Total Number of visit	926.00	1,507.00	542.00	times/month
	N. population	119.00	172.00	40.00	person
Cost	Cost	669,327.69	1,089,283.84	391,766.32	baht
	Average Cost/case	5,624.60	6,333.05	9,794.16	
Effectiveness	WOMAC Decreased	3,638.00	6,035.00	1,875.00	score↓
	average WOMAC ↓/case	30.57	35.09	46.88	WOMAC ↓/person
	CEA	<b>183.98</b>	<b>180.49</b>	<b>208.94</b>	baht/1WOMAC ↓
ICER	From 1 visit		<b>156.88</b>		baht/1 additional
	From 2 visit			<b>293.62</b>	of WOMAC ↓
Utility	QALY Gained	96.65	139.68	32.55	baht/1 QALY Gained
	CUA	<b>6,925.00</b>	<b>7,798.50</b>	<b>12,035.24</b>	

Table 15 present the overview of the data analysis among different group of frequency; 1 visit/week, 2 visit/week, and 3 visit/week, comprises of the population number, health outcome measurement, cost-effectiveness analysis, incremental cost-effectiveness ratio and the cost utility analysis

#### 4.4.1 Cost Effectiveness Analysis

The cost effectiveness ratio at full duration assessment; 1 visit per week (183.98 baht/WOMAC decreased), 2 visit per week (180.49 baht/1 WOMAC decreased), and 3 visit per week (208.94 baht/1 WOMAC decreased) which the assessment after full treatment program (course of treatment) found that the group of 2 visit per week is the most cost effectiveness group.

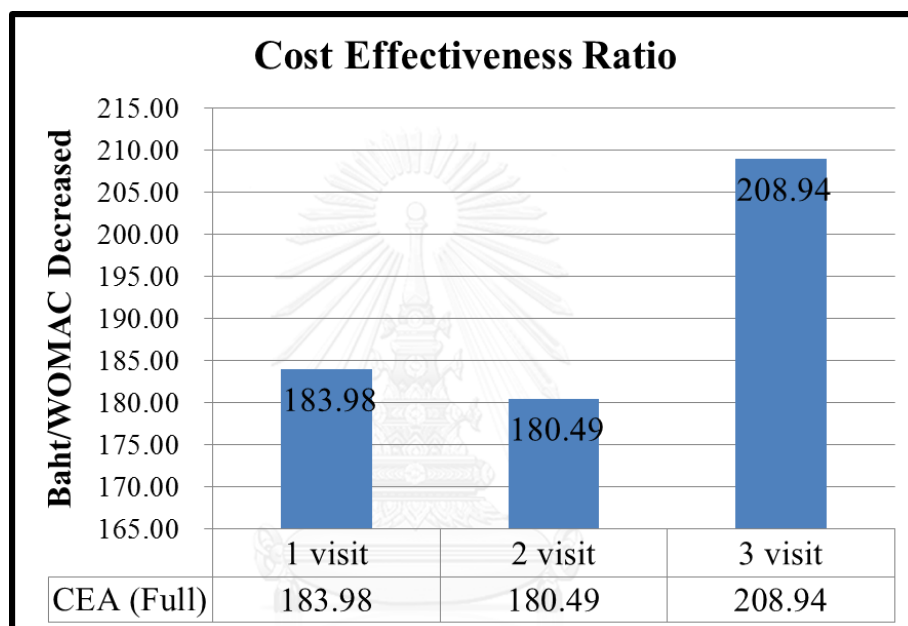


Figure 11: Graph presented CE Ratio among different group of frequency

Graph in figure 11 presented that the lowest cost per 1 WOMAC decreased (Health Outcome Gained) is the group of 2 visit per week which cheaper than group of 1 visit and 3 visit per week. The highest cost is the group of 3 visit per week.

So the group of 2 visit per week is the most cost-effectiveness in providing hydrotherapy program for OA knee in context of SNMRI.

#### 4.4.2 Incremental Cost Effectiveness Ratio

The assessment after full duration of treatment;

1 visit/week to 2 visit/week (ICER = 156.88 baht/1 additional WOMAC decreased), and 2 visit/week to 3 visit/week (ICER = 293.62 baht/1 additional WOMAC decreased).

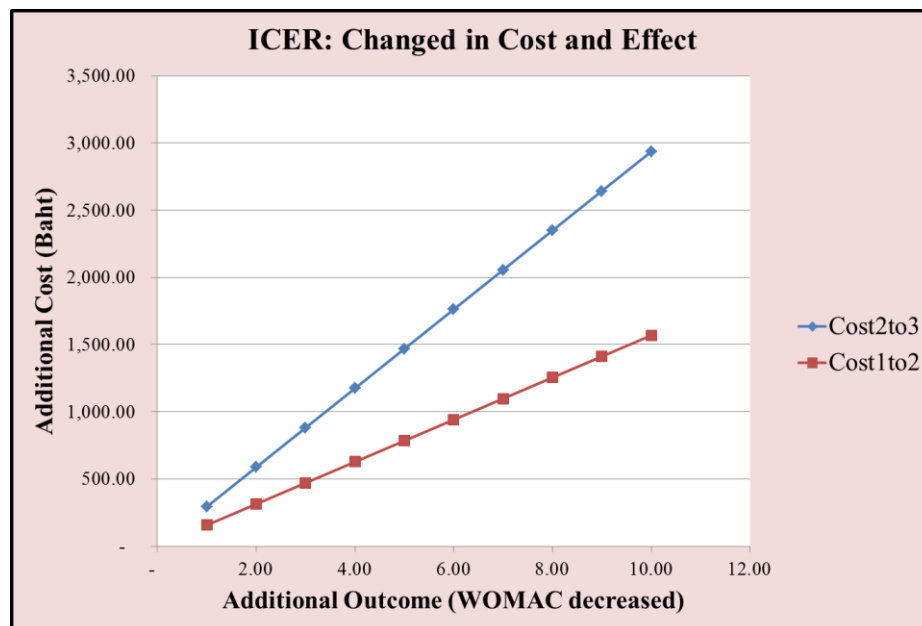


Figure 12: Graph presents ICER: Changed in cost and effect among 1 visit to 2 visit and 2 visit to 3 visit

Graph in figure 12 was reveal the different in slope of the blue is more than the slope of the red. It is shown that the aggregate of cost from 2 visit to 3 visit is more than the cost from 1 visit to 2 visit.

#### 4.4.3 Cost Utility Analysis

This type of analysis is important for the international comparison for utility gained after treatment program was implemented but this study did not set the objective directly to find cost utility analysis and the data set in Thailand still has a limitation for the study of utility of patient with OA knee after hydrotherapy program. Moreover the study of disease specific quality adjusted life years still has limitation for the reliability and the EQ5D in Thai version implemented by HITAP did not available to use for the routine service providing.

However, the international study in OA knee use WOMAC measurement tool which basically be able to transform to EQ5D to estimate the QALY gained from intervention. So this study performed the cost utility analysis based on the relation from the study of Barton et al 2008, The University of East Anglia, United Kingdom. This analysis aims to compare the trend of QALY Gained that either goes along with cost effectiveness study or not. This QALY calculation was based on the following relation.

$$\text{Predicted EQ-5D score} = 0.746652555353163 + (0.000810215321934668 * \text{total WOMAC}) + (-0.000119664323424435 * \text{total WOMAC}^2)$$

The calculation WOMAC pre-intervention and post-intervention (Full duration of treatment) was transformed to EQ5D and calculated QALY gained; found that group of 1 visit per week costs 6,925 baht/1 QALY gained, group of 2 visit per week costs 7,798.5 baht/1QALY gained, and group of 3 visit per week costs 12,035.24 baht/QALY gained.

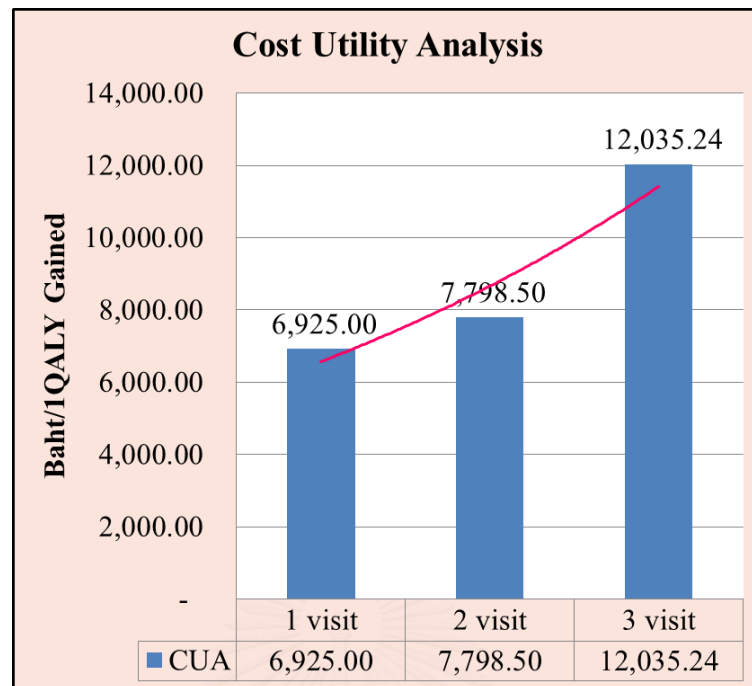


Figure 13: Graph shows cost utility ratio among different frequency of visit

Graph in figure 13 present the cost per Quality Adjusted Life Year gains among different group of visit. The cost of group 1 visit per week and group of 2 visit per week is a little bit different but the cost per QALY gained in group of 3 visit per week is almost double from 1 visit.

The cost-utility analysis is not contained as the objective of this study. The number represent here cannot use for reference in policy planning but researcher aims to observed the trend of Cost per Utility changed of this study based on the predicted model of (Barton et al., 2008). The model collecting based on the population of UK differ from Thailand, the unit of cost in EURO differ from THB so this finding definitely prohibited for reference in money unit.

However this analysis aims to observed the changed in cost over the utility among different group of frequency and found that the cost per utility did not directly go along with the cost effectiveness analysis but it can confirm that group of 3 visit per week is not a good choice of suggestion for policy implementation.

#### 4.4.4 Break-Even Analysis

This analysis aims to identify break-even point (total cost = total revenue) by the cost is the yearly total cost. This calculation will be predicted for the minimal number of service unit (number of patient visit) yearly and investigate the performance of fiscal year 2016 and predict for the better performance of service capacity.

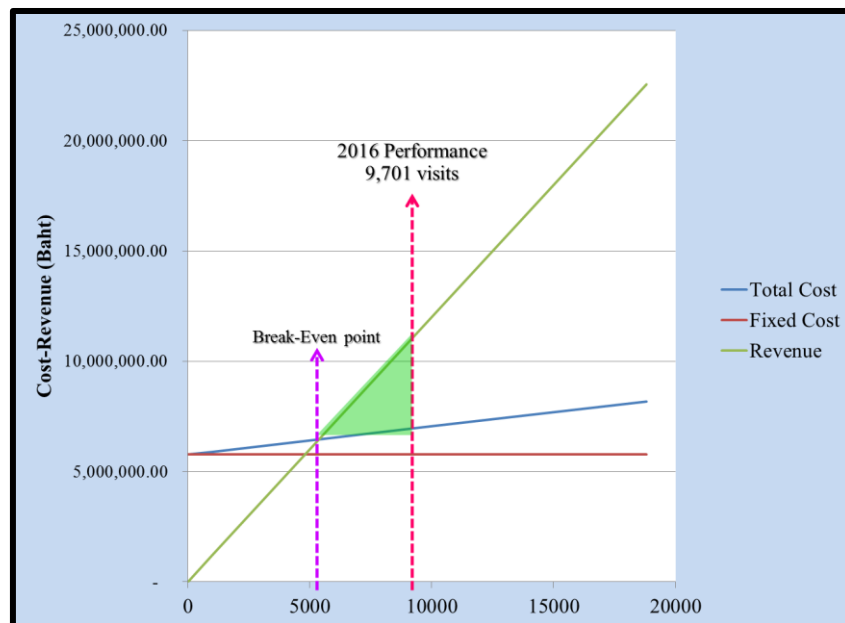


Figure 14: Break-Even Analysis of Hydrotherapy building fiscal year 2016

Break-Even Point of fiscal year 2016 is placed about 5,000 visits per year. The performance of SNMRI hydrotherapy building 2016 is 9,701 visits with the unit price of reimbursement rate equal to 1,200 baht per visit so the performance gained profit by the green triangle area but still perform lower than maximal capacity of facilities.

However, this is interesting for sensitivity analysis in some situation. If the labor cost increase for 30 percent or the reimbursement rate was decreased due to the limitation of The Comptroller General's Department (CGD), or the depreciation was changed to 10 year straight line calculation. Does hydrotherapy facilities will be gained profits or got losses.

#### 4.4.4 Sensitivity Analysis

Category 1: Increasing of Labor Cost for 30%

Category 2: Decreasing of reimbursement rate from THB1,200/visit to THB800/visit

Category 3: Change Depreciation to 10 year straight line calculation

Category 4: Combined category 1,2, and 3

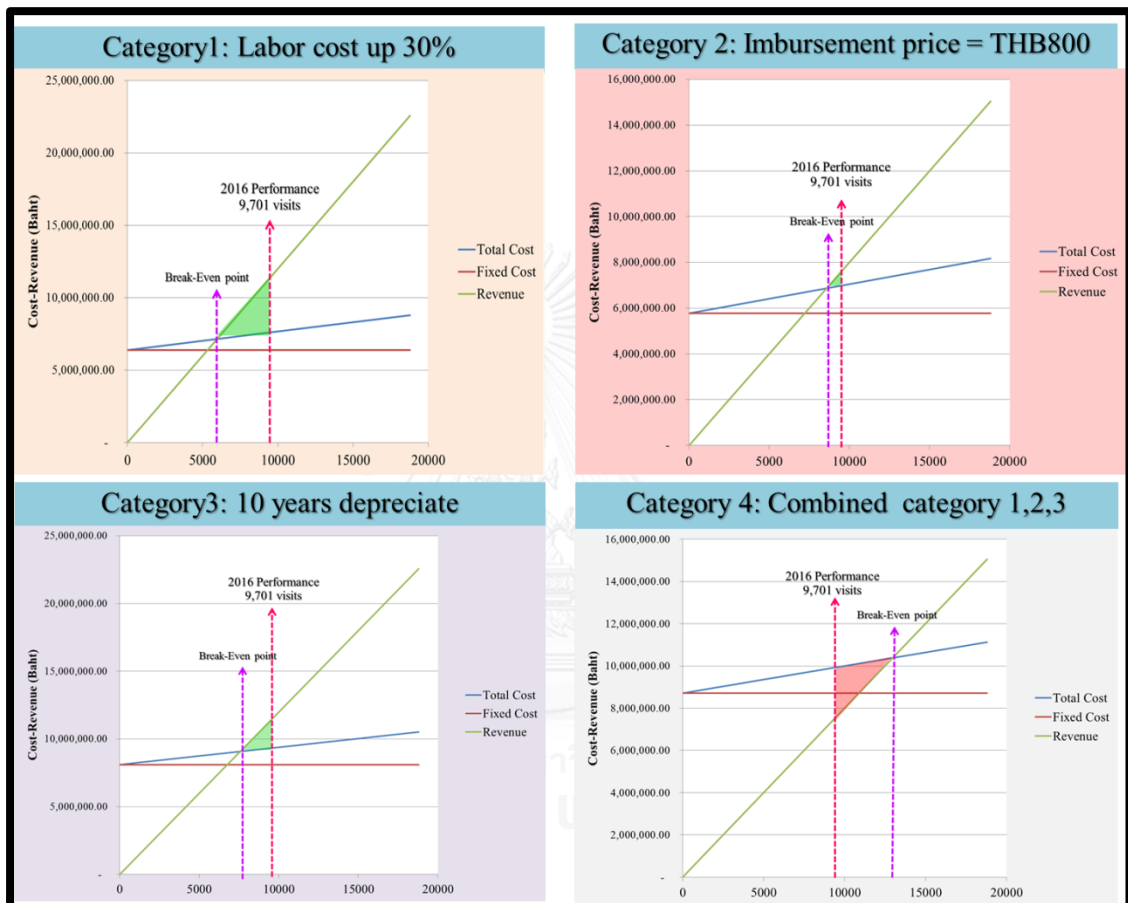


Figure 15: Comparison on Break-Even point after Sensitivity Analysis

Category 1: Increasing of Labor Cost for 30%

Break-Even point a little bit slide to right side due to the increasing of total cost, however the comparison for actual performance of 2016 presented the profit gaining in green area.

Category 2: Decreasing of reimbursement rate from THB1,200/visit to THB800/visit

Break-Even point significantly slide to right side due to the decreasing of total revenue (drop in reimbursement rate), however the comparison for actual



performance of 2016 presented the profit gaining in small green area but increasing risk of getting loss.

Category 3: Change Depreciation to 10 year straight line calculation

Break-Even point significantly slide to right side due to the increasing of total cost (changed depreciation to 10 years straight line calculation), however the comparison for actual performance of 2016 presented the profit gaining in the green area shown the profit area more that the category 2.

Category 4: Combined category 1,2, and 3 (LC up 30%, reimbursement rate drop to 800.-/visit and depreciate rate calculated at 10 years straight line method)

Break-Even point significantly slide to right side due to the combination of category 1, 2, and 3 which is presented the losses area (light red) compared to the actual performance of 2016. However this is not the maximal performance of hydrotherapy facilities so the increasing number of services can gain more revenue for this situation but limitation is the allowance of hydrotherapy is fixed. When patient had canceled the appointment the maximal capacity also decreased the allowance of gaining revenue. This is shown the precaution and possible risk of finance in hydrotherapy facility.

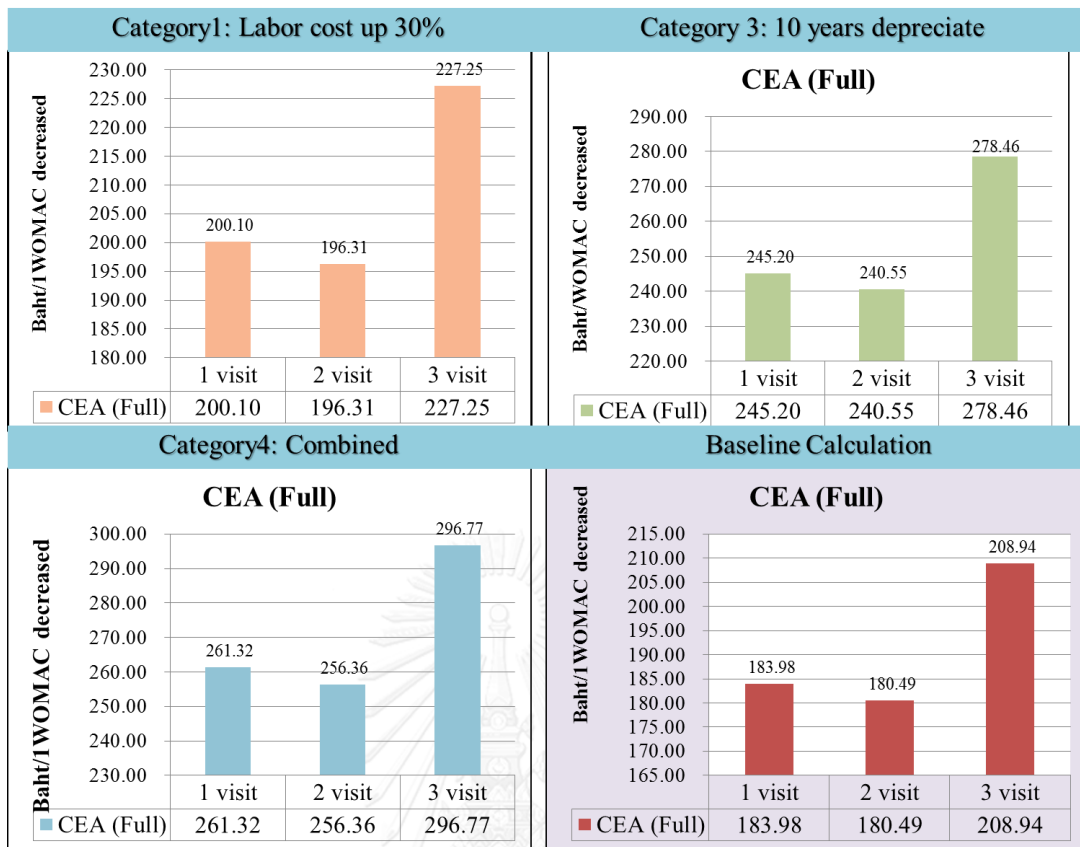


Figure 16: Cost Effectiveness Ratio among different category of sensitivity Analysis

The cost effectiveness analysis is not concerned on the revenue side so the sensitivity analysis in category 2 (drop reimbursement rate) does not effected to cost-effectiveness ratio. The category 1, 3 and 4 affected to cost side but the health outcome also the same.

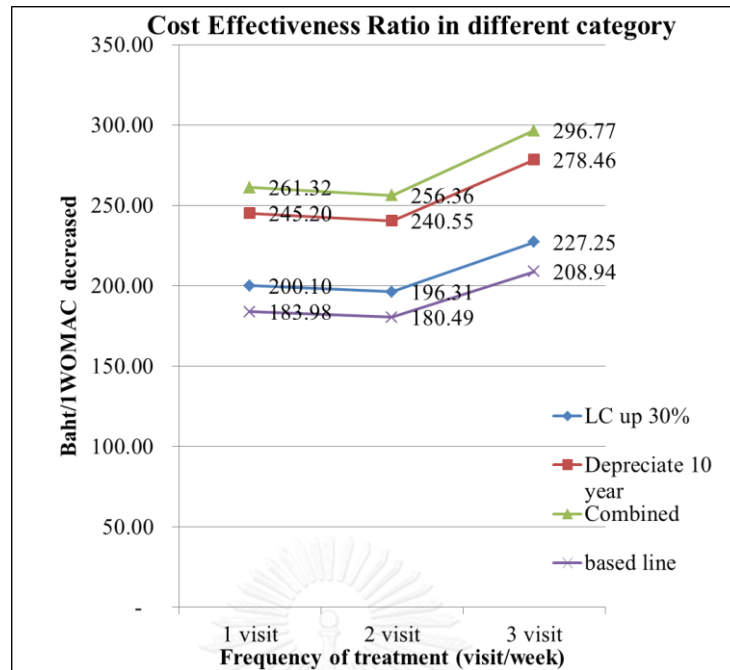


Figure 17: Cost Effectiveness Ratio among category of sensitivity analysis

According to figure 16 description that cost were changed but outcome still remained the same, figure 17 is the graph confirming the trend of cost effectiveness ratio changed in the same direction. The different was presented only in cost level.

## CHAPTER V

### DISCUSSION

#### 5.1 Finding of Cost-Effectiveness Analysis and ICER

After costing procedure by cost centered identification, total direct cost determination combined with indirect cost determination through direct method of cost allocation. The Unit cost of hydrotherapy equal to \$722.82 per visit. The unit cost in this study is calculated in the unit of cost per 1 visit. The design of this study classifies the different frequency of hydrotherapy because purpose of the study aims to answer the question that what frequency is the most cost-effectiveness protocol and would be referred to the reasonable criteria to prescribe the hydrotherapy program.

The Cost effectiveness analysis found that the most cost effectiveness ratio was presented at the group of 2 visits per week. Even the average WOMAC score decreased is highest in group of 3 visits per week but the clinical outcome of 2 visits per week is increase crucially and presented the most effectiveness when compared with cost. However the cost effectiveness ratio is not significantly different among group. (\$180.49 per one WOMAC decreased in group of 2 visits per week, \$183.98 in group of 1 visit per week, and \$208.94 in group of 3 visits per week)

According to this finding referred to the clinical decision maker for the frequency of hydrotherapy program. It seems to have the incentives for provider perspective to prescribe hydrotherapy program for 3 visits per week because the cost effectiveness shown the greatest health outcome with the cost that not a lot much higher than other group. Moreover the fast turn over patients is meaningfully to the higher number of gaining revenue. However in real situation, patients normally have many limitations to attend the treatment program as much as the criteria setting. (This suggestion can be observed by the total population among different group, group of 3 visit has only 40 patients who available for this frequency due to the inconvenience of patient but the other groups have the population more than a hundred cases.) So in policy implementation or the clinical decision in number of

visit still depend on other criteria such as the capacity of hydrotherapy facilities, the appointment and cancellation system together with the instead of fill in patient in the cancellation hour. This study is one of the evidence-based suggestions in perspective of cost effectiveness analysis. Moreover this study doesn't mention about the facilities available when increasing frequency of treatment. One of interesting choice is the 2 visit per week, the assessment has shown the most cost-effectiveness among groups and the number of visit is reasonable for patient to accomplish this frequency of visiting number.

Moreover, the calculation of incremental cost effectiveness ratio presented that ICER from 1 visit per week to 2 visit/week is cheaper than the additional cost from 2 visit per week to 3 visit per week by the different in accelerate on increasing of cost. This is shown that group 2 visit per week is more cost-effectiveness and also present a better incremental cost effectiveness ratio.

## **5.2 Finding of Cost-Utility Analysis**

The cost-utility analysis is not contained as the objective of this study. The number represent here cannot use for reference in policy planning but researcher aims to observed the trend of Cost per Utility changed of this study based on the predicted model of (Barton et al., 2008). The model collecting based on the population of UK differ from Thailand, so this finding definitely prohibited for reference in number.

However this analysis aims to observed the changed in cost over the utility among different group of frequency and found that the cost per utility did not directly go along with the cost effectiveness analysis but it can confirm that group of 3 visit per week is not a good choice of suggestion for policy implementation.

The suggestion for future study in this session is the performing in the utility data based for patient with OA knee based on the population of Thai patient will gained more benefit and can be represent the number of cost per utility gained as the actual number and gained more benefit as an evidence based for policy planning.

### 5.3 Finding of Break-Even Analysis

Break-Even Analysis has shown the minimum point of total number of visit (number of service) which is presented at more than 5,000 visit per year. The performance of SNMRI in fiscal year 2016 (9,701 visit) was achieved over this point and gain profit in service providing. However this number was not the maximum capacity of hydrotherapy building. The remaining capacity was loosed because of the cancellation treatment due to many situations of patient's limitation or the high season that most of patient ignored for treatment program and plan to travel because the rehabilitation is not emergency situation, it contains the quality of life but not serious as the life or surviving. Thus the number of patient who canceled treatment was increased. Moreover the finding from sensitivity analysis in break-even point found that the chance of services to get loss was combined with the 10 year depreciation calculation, labor cost increasing for 30 percent and the decreasing of reimbursement rate. Some uncontrollable situation are possible in the future; labor cost increasing is a basically situation of operation, the decreasing of reimbursement rate also possible because of the scarcity of health budget and the reimbursement rate at SNMRI is the highest rate compared to other hydrotherapy facilities.

The way to gain more profits is to increase the number of service within the maximal limit and cost minimizing. The cost structure of SNMRI Hydrotherapy building shown that the fixed cost was more significant compared to variable cost. The management in variable cost is not the key for the cost minimizing. The increasing in unit of output is more reasonable for this situation. However the possible risk should be the uncontrollable situation of patient that might lead to cancellation appointment, the limitation of equipment capacity, the situation of equipment doesn't work due to broken or maintenance period should be direct effect to the service capacity.

This study calculated only in provider perspective. The benefit is to understand the income statement of hydrotherapy facility. The cost and possible pricing in reasonable number that policy maker can plan to gain profit to the hospital and cost containment methodology. The next interesting issue for future study is the

pricing and willingness to pay of patient. Moreover this calculation was based on cost of provider perspective only. The cost in patient perspective is interesting to study because the group of patient is the group of patient who has a limitation in ambulation and transfer. The cost in patient perspective might aggravate the change in cost-effectiveness ratio among group.

One another issue in concerning after finding the most cost-effectiveness frequency per week of treatment is the compulsory for the ideal number of visit in the hydrotherapy building. The doctor prescription is one of the fixed and possible factors to achieve the target number of visit but in real situation, limitation of individual patient situation is much more important. The interesting issue for the following study is the customer relation management in medical services.



## CHAPTER VI

### CONCLUSIONS AND RECOMMENDATIONS

#### 6.1 Conclusion

Based on the context of Sirindhorn National Medical Rehabilitation Institute; the hydrotherapy in OA knee patient performing for 2 visit/week is the most cost-effectiveness > 1visit/week > 3visit/week.

The frequency at 1 visit per week costs 6,925 baht per 1 QALY Gained more effectiveness than 2 visit (7,798.50 baht per 1QALY Gained) and 3 visit (12,035.24 baht per QALY Gained).

Break-Even Point of service providing in fiscal year 2016 showed the number of visit over than 5,000 visit per year which is lower than the actual number of performance. The suggestion for making more revenue is the increasing number of services which is significantly than minimizing variable cost.

However the risk of financial can be able to occur due to the cost of equipment repair and maintenance which is a large cost and when this incident is occurred the cost will be increased but the capacity of earning revenue would be decreased.



## 6.2 Recommendations and policy implication

### *Technology assessment and clinical service management*

The study to understand the quality, efficacy, and effectiveness of treatment procedure is part of technology assessment and lead to the evidence-based guideline for clinical service management.

The study in cost effectiveness perspective can bring one perspective of the solution for uncertainty situation in general practice. In this situation, performing hydrotherapy for OA knee in rehabilitation hospital for 2 visits per week is the most effective protocol in perspective of cost comparing to outcome.

### *Making better quality of care with affordable health care*

We have already known that the health expenditure is scarcity. To accomplish quality care along with affordable health care would bring the better benefits to the whole system of healthcare. The health system that bearing cost of care due to the limitation of budget or the limitation of patient's afford should generate the facility that can earn revenue more for cost containment and upgraded the potential to be possible on competition in the healthcare market. The understanding well in cost and effectiveness is the key to the quality care together with affordable health care.

In context of rehabilitation hospital in Thailand, earning revenue to compensate for the burden of cost in some group of patient is possible but based on the study of cost, outcome and utility gained. This understanding will aggregated to the ability of pricing in reasonable price and reasonable profit, the choice of decision for the quality of care in provider perspective by comparing the resource spent per outcome gained as well as the financial risk prevention in long term clinical service management.

### 6.3 Suggestion for future study

1. The study in combination treatment is interesting because the number of patient who combined treatment among conventional treatment, acupuncture and hydrotherapy is a big amount of number.

2. The quality of life measurement is important to identify the disability situation because OA knee is related to the quality of patient's living. Thailand does not have the data set of OA knee patient transforming to EQ-5D. The QALY transformation from the outcome is required for future study.

3. Cost in patient perspective is interesting for future study because the group of OA knee patient basically due with limitation on ambulation and transfer. Cost in societal perspective may induce the new finding of cost effectiveness analysis.

4. The cost allocation method is require more accuracy; step down and simultaneous method is considered instead of the direct method of this study.

5. The understanding of target number of visit is easier than convincing patient to attend the treatment in the target number of visit. The future study is interesting to correct the problem of patient cancellation and cancel appointment with non-clinical reason.

6. The willingness to pay is one of interesting issue for future study because this facility is not the basic package and free of charge for all medical benefit scheme. The payers on this service are 2 groups; out of pocket group and CSMBS group. The studying in willingness to pay will be conducting the better evidence for service pricing.

## REFERENCES

- Arthritis New Zealand. (2010). Report on Arthritis Conference.
- Avelar, N. C., Ribeiro, V. G., Mezencio, B., Fonseca, S. F., Tossige-Gomes, R., da Costa, S. J., . . . Lacerda, A. C. (2013). Influence of the knee flexion on muscle activation and transmissibility during whole body vibration. *J Electromyogr Kinesiol*, 23(4), 844-850. doi:10.1016/j.jelekin.2013.03.014
- Bartels, E. M., Lund, H., Hagen, K. B., Dagfinrud, H., Christensen, R., & Danneskiold-Samsøe, B. (2007). Aquatic exercise for the treatment of knee and hip osteoarthritis. *Cochrane Database Syst Rev*(4), CD005523. doi:10.1002/14651858.CD005523.pub2
- Barton, G. R., Sach, T. H., Jenkinson, C., Avery, A. J., Doherty, M., & Muir, K. R. (2008). Do estimates of cost-utility based on the EQ-5D differ from those based on the mapping of utility scores? *Health and quality of life outcomes*, 6(1), 51.
- Becker, & Gary S. (2010). The economics of discrimination. *University of Chicago press*.
- Bellamy N, Buchanan WW, G. C., Campbell J, & LW, S. (1998). Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patient with osteoarthritis of the hip or knee. *Journal of rheumatology*, 15(12), 1833-1840.
- Bennell, K. L., & Hinman, R. S. (2011). A review of the clinical evidence for exercise in osteoarthritis of the hip and knee. *Journal of Science and Medicine in Sport*, 14(1), 4-9.
- Brazier, & J. E. (1996). Using the SF-36 and Euroqol on an elderly population. *Quality of Life Research*, 5.2, 195-204.
- Bressel, E., Wing, J. E., Miller, A. I., & Dolny, D. G. (2014). High-intensity interval training on an aquatic treadmill in adults with osteoarthritis: effect on pain, balance, function, and mobility. *The Journal of Strength & Conditioning Research*, 28(8), 2088-2096.

- Cadmus, L., Patrick, M. B., Maciejewski, M. L., Topolski, T., Belza, B., & Patrick, D. L. (2010). Community-based aquatic exercise and quality of life in persons with osteoarthritis. *Medicine & Science in Sports & Exercise*, *42*(1), 8-15.
- Ferret, B. S., Feldman, Z., Zhou, J., Oei, E. H., Bierma-Zeinstra, S. M., & Mazumdar, M. (2017). Impact of total knee replacement practice: cost effectiveness analysis of data from the Osteoarthritis Initiative. *bmj*, *356*, j1131.
- Foley, A., Halbert, J., Hewitt, T., & Crotty, M. (2003). Does hydrotherapy improve strength and physical function in patients with osteoarthritis—a randomised controlled trial comparing a gym based and a hydrotherapy based strengthening programme. *Annals of the rheumatic diseases*, *62*(12), 1162-1167.
- Hinman, R. S., Heywood, S. E., & Day, A. R. (2007). Aquatic physical therapy for hip and knee osteoarthritis: results of a single-blind randomized controlled trial. *Phys Ther*, *87*(1), 32-43. doi:10.2522/ptj.20060006
- Lamer PJ, Bell J, O'Brien D, Dangen J, & P, D. (2014). Hydrotherapy outcome measures for people with arthritis: A systematic review. *Newzealand journal of Physiotherapy*, *42*(2), 54-67.
- Marks, & Ray. (2003). Hip fractures among the elderly: causes, consequences and control. *Ageing research reviews*( 2.1), 57-93.
- Musumeci, G., Loreto, C., Imbesi, R., Trovato, F. M., Di Giunta, A., Lombardo, C., . . . Castrogiovanni, P. (2014). Advantages of exercise in rehabilitation, treatment and prevention of altered morphological features in knee osteoarthritis. A narrative review. *Histology and histopathology*, *29*(6), 707-719.
- N F Woolacott, & MS Corbett, S. R. (2010). The use and reporting of WOMAC for the assessment of treatment benefit for the pain of osteoarthritis of the knee. *Center for Reviews and Dissemination, University of York*.
- Paola Castrogiovanni, & Musumeci, G. (2016). "Which is the best physical treatment for Osteoarthritis. *Functional Morphology and kinesiology*(1), 54-68.
- Roddy, E., Zhang, W., Doherty, M., Arden, N. K., Barlow, J., Birrell, F., . . . Richards, S. (2005). Evidence-based recommendations for the role of exercise in the

- management of osteoarthritis of the hip or knee--the MOVE consensus. *Rheumatology (Oxford)*, 44(1), 67-73. doi:10.1093/rheumatology/keh399
- SNMRI. (2016). Sirindhorn National Medical Rehabilitation Institute: Hospital Profile.
- Statistic, T. N. H. (2010). Disability Statistic Report.
- Wailoo, A., Alava, M. H., & Martinez, A. E. (2014). Modelling the relationship between the WOMAC Osteoarthritis Index and EQ-5D. *Health and quality of life outcomes*, 12(1), 37.
- WHO. (2017). Rehabilitation in Health Systems.
- Wikman, A., Wardle, J., & Steptoe, A. (2011). Quality of life and affective well-being in middle-aged and older people with chronic medical illnesses: a cross-sectional population based study. *PLoS One*, 6(4), e18952.
- World Health Organization. (2011). World Report on Disability.
- Xie, F., Pullenayegum, E. M., Li, S.-C., Hopkins, R., Thumboo, J., & Lo, N.-N. (2010). Use of a disease-specific instrument in economic evaluations: mapping WOMAC onto the EQ-5D utility index. *Value in Health*, 13(8), 873-878.



APPENDIX

จุฬาลงกรณ์มหาวิทยาลัย  
CHULALONGKORN UNIVERSITY

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