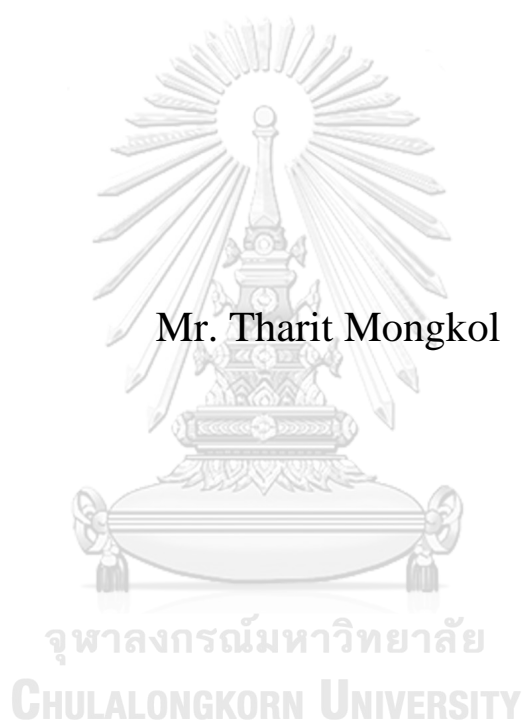


**UNIT COST ANALYSIS OF ACUTE RESPIRATORY  
INFECTION (ARI) CLINIC FOR COVID-19 SCREENING AT  
BANGBUATHONG HOSPITAL, NONTHABURI,  
THAILAND**



A Thesis Submitted in Partial Fulfillment of the Requirements  
for the Degree of Master of Public Health in Public Health  
Common Course  
COLLEGE OF PUBLIC HEALTH SCIENCES  
Chulalongkorn University  
Academic Year 2020  
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การวิเคราะห์ต้นทุนต่อหน่วยของคลินิกตรวจโรคระบบทางเดินหายใจเพื่อคัดกรองผู้ติดเชื้อไวรัสโคโรนา 2019 โรงพยาบาลบางบัวทอง นนทบุรี ประเทศไทย



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต  
สาขาวิชาสาธารณสุขศาสตร์ ไม่สังกัดภาควิชา/เทียบเท่า  
วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย  
ปีการศึกษา 2563  
ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย



ชาริต มงคล : การวิเคราะห์ต้นทุนต่อหน่วยของคลินิกตรวจโรคระบบทางเดินหายใจเพื่อคัดกรองผู้ติดเชื้อไวรัสโคโรนา 2019 โรงพยาบาลบางบัวทอง นนทบุรี ประเทศไทย. ( UNIT COST ANALYSIS OF ACUTE RESPIRATORY INFECTION (ARI) CLINIC FOR COVID-19 SCREENING AT BANGBUATHONG HOSPITAL, NONTHABURI, THAILAND) อ.ที่ปรึกษาหลัก : ศ. ดร.สถิรกร พงศ์พานิช

การระบาดของไวรัสโคโรนา 2019 ส่งผลกระทบต่อทำให้บริการของโรงพยาบาลทุกแห่งในประเทศไทย โดยเฉพาะด้านการเงินและการคลังของโรงพยาบาล แม้ว่าการบริหารต้นทุนในด้านการให้บริการสุขภาพสำหรับผู้ป่วยโควิดอย่างมีประสิทธิภาพจะสามารถช่วยลดความเสี่ยงนั้นได้ แต่ปัจจุบันยังคงมีการวิจัยและวิเคราะห์ปัญหาเหล่านี้ไม่มากนัก การศึกษานี้จึงมีวัตถุประสงค์เพื่อระบุต้นทุนรวม ต้นทุนต่อหน่วย และอัตราต้นทุนของคลินิกตรวจโรคระบบทางเดินหายใจ สำหรับการตรวจคัดกรองโควิด-19 (ARI clinic) ที่โรงพยาบาลบางบัวทอง งานวิจัยนี้เป็นการศึกษาเชิงพรรณนาโดยการรวบรวมข้อมูลย้อนหลังจากบันทึกของโรงพยาบาลและฐานข้อมูลค่าใช้จ่ายของคลินิกระหว่างเดือนมีนาคมถึงพฤษภาคม 2564 ซึ่งเป็นช่วงก่อนและระหว่างการระบาดของไวรัสโคโรนา 2019 ระลอกที่ 3 ในประเทศไทย ข้อมูลถูกวิเคราะห์จากมุมมองของผู้ให้บริการโดยพิจารณาเฉพาะต้นทุนทางบัญชีเท่านั้น ผลการศึกษาพบผู้ป่วยใน ARI Clinic จำนวน 1,955 รายพบว่า มีต้นทุนรวม 1,136,605.48บาท แบ่งเป็น ต้นทุนค่าแรง 868,417.75 บาท ค่าวัสดุ 257,844.87 บาท และ ค่าลงทุน 10,342.87 บาท แต่ละเดือนมีต้นทุนแตกต่างกัน พบว่าในเดือนมีนาคมที่มีผู้ป่วยเพียงไม่กี่รายนั้นมีต้นทุนต่ำสุดอยู่ที่ 244,288.96 บาท ในขณะที่เดือนพฤษภาคมซึ่งมีผู้ป่วยในคลินิกมากที่สุด มีต้นทุน 507,549.67 บาท สำหรับต้นทุนต่อหน่วยนั้นเท่ากับ 550.37 บาทต่อการเข้ารับบริการ แต่เมื่อพิจารณาในแต่ละเดือนพบว่า เดือนมีนาคมสูงสุดอยู่ที่ 744.78 บาท ส่วนอัตราค่านั้นเท่ากับ 0.54 (0.23, 0.66 และ 0.57 ต่อเดือนตามลำดับ) ซึ่งต้นทุนและอัตราต้นทุนของ ARI Clinic จะแตกต่างกันไปในแต่ละเดือน ผู้อำนวยการและประธานเจ้าหน้าที่ฝ่ายการเงิน (CFO) ควรพิจารณาปรับการจัดการทรัพยากรให้คุ้มค่าที่สุด

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ปีการศึกษา        2563

ลายมือชื่อนิติ .....  
ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

# # 6374014053 : MAJOR PUBLIC HEALTH

KEYWORD Unit cost analysis, COVID-19, ARI Clinic

D:

Tharit Mongkol : UNIT COST ANALYSIS OF ACUTE RESPIRATORY INFECTION (ARI) CLINIC FOR COVID-19 SCREENING AT BANGBUATHONG HOSPITAL, NONTHABURI, THAILAND. Advisor: Prof. SATHIRAKORN PONGPANICH, Ph.D.

The COVID-19 outbreak has affected the services of all hospitals in Thailand, especially making their financial position at risk of bankruptcy. Although managing the cost of health care services for COVID-19 effectively can help reduce that risk, but very few researches has been done and analyzed on these issues. This study aimed to identify the unit cost and cost recovery of Acute Respiratory Infection (ARI) clinic for COVID-19 screening at Bangbuathong Hospital. This research was a descriptive study by retrospective data collection from hospital recorded and database of costs of ARI clinic between March to May 2021, which was the period that covered before and during the 3<sup>rd</sup> wave of COVID-19 outbreak in Thailand. Data was analyzed from the provider perspective by considering only the accounting cost. The results showed the total of 1,955 cases in ARI Clinic. Total direct cost was 1,136,605.48 baht, divided into Labor cost (LC) 868,417.75 baht, Material cost (MC) 257,844.87 baht and Capital cost (CC) 10,342.87 baht. Each month had different costs. It was found that in March, with only few patients, the lowest cost was 244,288.96 baht. As of May, which had the highest number of patients in the clinic, the cost was 507,549.67 baht. Unit cost was 581.38 baht per case. But considering each month, March's highest was 744.78 baht. Finally, cost recovery which refers to the ratio of accrued revenue from National Health Security Office (sample collection fee 100 baht per case) and material cost was 0.54 (0.23, 0.66 and 0.57 per month, respectively). Summarizing, the cost and cost recovery of the ARI Clinic varies from month to month. Director and Chief Financial Officer (CFO) should be aware to consider adjusting resource management for the most cost-effective.

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Field of Study: Public Health

Student's Signature

Academic 2020

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Advisor's Signature

Year:

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## ACKNOWLEDGEMENTS

This research was successfully accomplished thanks to all relevant personnel of Bangbuathong hospital who provided information for research purpose. I would like to thank my research advisor Dr.Sathirakorn Pongpanich for giving advice until making this research successful.

Tharit Mongkol



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# CHAPTER I

## Introduction

### Background

The outbreak of COVID-19, which infected nearly one hundred million people worldwide and about 2 million deaths in the past year<sup>(1)</sup>, has affected all dimensions around the world. Health systems are also affected by this pandemic, especially health care financing. Hospitals and healthcare services around the world face the serious financial challenges associated with the COVID-19 outbreak.<sup>(2)</sup> The American Hospital Association estimates the financial impact of lost revenues from American hospitals and healthcare systems about \$ 323.1 billion over 2020, or an average of \$ 27 billion per month.<sup>(3)</sup> In addition, low and middle-income countries spend as high as \$ 52 billion per month (equal to \$ 8.60 per person) to provide effective healthcare responses to COVID-19.<sup>(4)</sup>

In Thailand, COVID-19 has a significant impact on the economy. The World Bank estimates the Thai economy contracted by 6.5 percent through 2020.<sup>(5)</sup> In March 2020, the government approved an additional budget of 6,302 million baht (US \$ 203.3 million) to tackle the COVID-19 outbreak, and an additional 1020 million baht (\$ 32.9 million) to the National Health Security Office (NHSO) to subsidize COVID-19-related services.<sup>(6)</sup> In addition, the rising number of unemployed people as a result of the economic contraction has raised the demand for health resources in the Universal Health Coverage (UHC), which is held by the NHSO. However, the outbreak cannot be controlled until mid-2021<sup>(7)</sup> which certainly put pressure on government's ability to fund public health care.<sup>(8)</sup>

Hospitals, as part of the healthcare system, also face the same problem. They also have to provide more health care services, especially screening for COVID-19 patients.<sup>(9)</sup> ARI Clinic has been set up in all hospitals to properly screen patients for COVID-19 and also help prevent the spread of the virus to patients and communities.<sup>(10)</sup> The model of this clinic, which has been in operation for more than a year, has consumed a large amount of hospital resources, from medical personnel to materials and equipment. Furthermore, hospitals cannot charge their patients for services but only need to charge the NHSO instead.<sup>(8)</sup> These factors have greatly

affected the financial system of each hospital. One of the tools that can help solve this problem is the hospital cost analysis. This will help us to know how much resources are used in the hospital service. It is also able to set a service charge from the paying organization at a cost-effective rate for the hospital to be able to operate continuously. This has also led to the development of both policy and financial management systems of hospitals to be more efficient<sup>(11)</sup> in order to prepare for the consequences, especially hospital finance from the COVID outbreak. However, very few researches have been done and analyzed on the cost and cost recovery or reimbursement of the ARI Clinic.

Therefore, this research aims to identify the unit cost and cost recovery of Acute Respiratory Infection (ARI) clinic for COVID-19 screening. The findings could be useful not only to improve appropriate resource utilization for COVID-19 screening at hospital, but also to develop and optimize reimbursement models from central organization.

### **Research question**

1. What is the unit cost of Acute Respiratory Infection (ARI) clinic for COVID-19 screening at Bangbuathong Hospital?
2. What is the cost recovery of Acute Respiratory Infection (ARI) clinic for COVID-19 screening at Bangbuathong Hospital?

### **Research objective**

1. To identify the unit cost of Acute Respiratory Infection (ARI) clinic for COVID-19 screening at Bangbuathong Hospital
2. To identify the cost recovery of Acute Respiratory Infection (ARI) clinic for COVID-19 screening at Bangbuathong Hospital

### Scopes of the study

This research analyzed the unit cost of Acute Respiratory Infection (ARI) clinic for COVID-19 screening from a provider perspective, conducted in Bangbuathong hospital, Nonthaburi province, Thailand. Using information from Hospital recorded and database of costs between March to May 2021.

### Possible Benefit

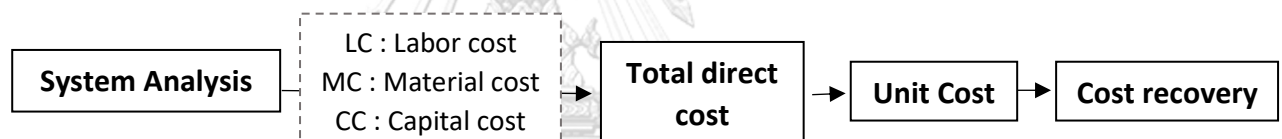
- Hospital will have a database of costs of ARI clinic and can be used to improve and develop the cost-effective and appropriate resource utilization.
- Hospital can use the information to plan for further budgeting.
- The data can be used to assess the cost-effectiveness of COVID-19 healthcare services and develop centralized pay rates to further determine a cost-effectiveness model.

### Operational definition

- **System analysis** : First step of unit cost analysis by studying and analyzing the structure of the hospital system to classify work centers as cost centers.
- **Cost** : refers to expenses or resources that can be measured in monetary terms and used for work or any activity of ARI clinic at Bangbuathong Hospital
- **Labor cost (LC)** : Expenses paid to staff as compensation for their performance related to ARI clinic services include salaries, compensation for personnel working for service units of the Ministry of Public Health (No.11), extra money for special-emerging positions of public health workers (PTS), extra compensation for working in a service unit under the Ministry of Public Health without doing personal medical clinic and or working in a private hospital and contingent compensation for COVID-19 received during the research period.
- **Material cost (MC)** : All materials used in ARI clinic and disbursed by the central and pharmacy of Bangbuathong Hospital. Water and electricity costs were not included.

- **Capital cost (CC)** : All types of medical and office equipment cost used in ARI clinic. Capital cost was calculated from depreciation cost.
- **Total direct cost** : Sum of Labor cost (LC), Material cost (MC) and Capital cost (CC) of ARI clinic during the research period.
- **Unit cost (UC)** : Total direct cost of ARI clinic divided by total visit of patients.
- **Cost recovery**: the ratio of the accrued revenue (revenue that has been earned by providing services from NHSO, but for which no cash has been received) compare with the material cost of ARI clinic.
- **ARI Clinic** : Clinic that screen patients who are infected with COVID-19 at Bangbuathong hospital.

### Conceptual framework



## **CHAPTER II**

### **Literature review**

Scope of this chapter includes review of:

- 1) COVID-19
- 2) Bangbuathong Hospital and ARI clinic at Bangbuathong hospital
- 3) Cost concepts and cost classification
- 4) Unit cost analysis
- 5) Related research

#### **1) COVID-19**

##### **1.1) General information**

COVID-19 is a highly contagious disease caused by the most recently discovered coronavirus. This emerging virus and disease were never known before the outbreak in Wuhan, China, in December 2019. There has been an outbreak and went to many countries around the world. Symptoms can range from fever, cough, fatigue, anosmia and ageusia. Severe symptoms can lead to acute respiratory failure. There are currently no antiviral drugs registered to treat COVID-19. Therefore, preventing infection and spreading is essential to help stop this outbreak.<sup>(12)</sup>

The World Health Organization has introduced a range of public health measures<sup>(12)</sup>, including

- Quarantine (limiting activities or the isolation of people who are not sick but may have a history of closed contact with COVID-19), the aim of which is to prevent the spread of the disease at the time when people began to experience symptoms
- Isolation refers to the isolation of a patient with COVID-19 symptoms and potentially contagious, thus preventing the spread of the disease
- Social distancing, the World Health Organization recommends at least one meter distance from others, which is a common measure everyone should take, even if they are healthy.

- Contact monitoring to identify people with a history of exposure in order to quickly isolate

In addition, the COVID-19 outbreak affects the economy and society for all groups of people. But it undermines the most vulnerable populations, including the poor, the elderly, the disabled, the youth and ethnic groups, which could also spark more inequality and social poverty.<sup>(13)</sup>

In Thailand, the first COVID-19 outbreak occurred in early 2020. Ministry of Public Health confirmed cases of COVID-19 infection In Thailand for the first time, it was a 61 year old Chinese female tourist who arrived from Wuhan.<sup>(14)</sup>

After that, there was an epidemic in the country again in late 2020 until the end of one year, more than 13,000 people were infected and more than 70 died.<sup>(15)</sup>

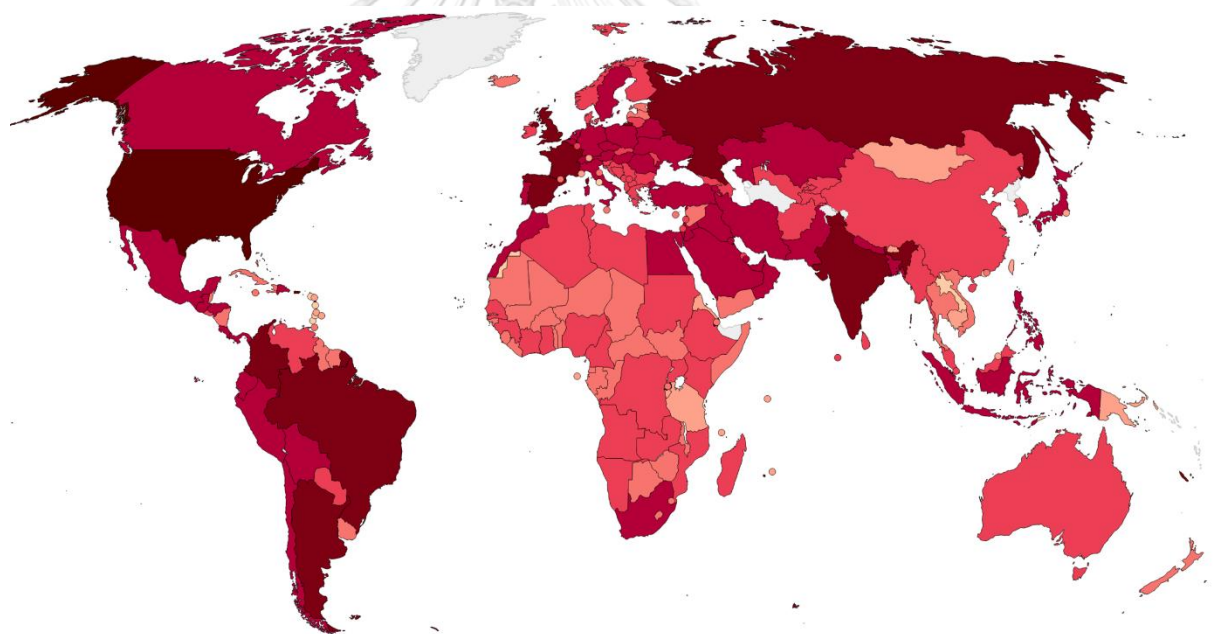


Figure 1 : Mapping the Coronavirus outbreak across the world.<sup>(16)</sup>

## 1.2) Covid-19 and its Fiscal Impact on Health Systems

The outbreak of the novel coronavirus has created a crisis in the health system. Strengthening the frontline service for dealing with the epidemic is therefore of great importance to the government. It is very important to have an appropriate health funding policy.<sup>(17)</sup>

At the moment, organizational management, planning, and the reconfiguration of the service to meet immediate needs is critical. Health funding measures can be contributed to facilitate the rapid and systematic response to outbreaks. In particular, the healthcare funding response must support the scale and delivery of demographic and individual services in two key ways: ensuring adequate funding for health services and Remove financial barriers to Health services.<sup>(18)</sup>

Additionally, the ongoing COVID-19 epidemic has plagued US hospital operations. Several states have issued executive orders requiring the termination or postponement of certain health services to prioritize hospitals' ability to maintain personal protective equipment for COVID-19 care and to ensure the safety of patients and medical staff.<sup>(19)</sup>

With concerns about possible exposure to the infection, patients are also limiting hospitalization. Hence, the hospital has to face a sharp drop in revenues. So many hospitals have started layoffs and cut salaries in order to maintain costs and maintain their financial capabilities.<sup>(20)</sup>

A study from the United States<sup>(20)</sup> analyzed the costs of hospitals before the COVID outbreak to prepare to adjust the fiscal policy of each hospital to meet the consequences of this outbreak. It found that private hospitals had a total operating cost of \$ 732.2 billion in 2018, capital and overhead costs accounted for almost half (48.0%) and the remainder of inpatient and outpatient care accounted for 52.0%.

Based on the cost type, labor costs and capital costs accounted for 41.3% and 4.0% of the hospital's operating costs, respectively. Units that provide patient services cost approximately one-third of the hospital's total operating expenses. Additionally, reduced surgery and hospitalizations due to COVID-19 reduced revenues from these services and incentivized hospitals to cut costs from these services. At the same time, administrative and general overhead costs, which account for more than a fifth of total operating costs, can provide cost management options as well.

It can be seen that having hospital cost data can be used to analyze the hospital's financial situation accurately. It is also the basis for adjusting fiscal policy to better prepare for the COVID-19 epidemic.

### 1.3) Management of COVID-19 in health services system in Thailand

#### Diagnosis, Treatment and Prevention of Coronavirus 2019 (COVID-19) Infection in Hospitals<sup>(21-25)</sup>

##### A. Patient under investigation (PUI) criteria

- Patients with any of the following symptoms; Have a history of fever or have a temperature measurement of 37.5 ° C or higher, coughing, runny nose, sore throat, unable to smell, tongue loss, rapid breathing, tired or difficult breathing, red eyes, rash, and diarrhea and had a history of risk in the 14 days prior to the onset of illness, either as follows

a) travel to or from or live in a country where the case is reported in the past 1 month from the date of leaving the area.

b) contact with patients with confirmed COVID-19

c) go to a gathering place or gathering place, such as entertainment place, flea market, shopping mall, hospital or public transport where COVID-19 confirmed cases have been reported in the 1 month retrospective from the date of departure.

d) work in a quarantine facility

- Patients with pneumonia which suspected of COVID-19 (examined by doctor)

- Being medical and public health personnel in hospitals, clinics, district health promoting hospitals, laboratory, pharmacy, disease investigation team or work in a quarantine facility with one of the following respiratory symptoms: cough, runny nose, sore throat, unable to smell, tongue not taste, rapid breathing, tired breathing, or trouble breathing and / or a history of fever or a temperature measurement of 37.5 ° C or higher that the clinician suspects COVID-19 infection.

- Five or more people with respiratory tract infections were found in the same site during the same week with epidemiological links (e.g. in a school in the same classroom).



- High-risk people with and without symptoms (According to the definition of the Department of Disease Control).

*B. Guideline for treating PUI*

- Patient wears a surgical mask, stays at the set-up area or waits for results at home by giving advice on how to act. If there is an indication for inpatient admission, stay in a single room or isolation room
- Personnel wear PPE as appropriate. In general, use droplets and contact precautions [goggles, gloves, face masks and face shield]. If aerosol generating procedure was performed, e.g. sample collection nasopharyngeal swab, instruct personnel to wear airborne protective clothing and contact precautions.
- Consider basic laboratory examinations as appropriate (designated receiving area are not required for non-airway specimens, comply with laboratory standards)

*Sample collection for testing for SARS-CoV-2*

- In the absence of symptoms of pneumonia, one nasopharyngeal swab is collected in a UTM or VTM tube (at least 2 mL)
- In the case of the patient having pneumonia and not having endotracheal tube.
  - o Collect sputum in sterile container containing VTM or UTM.
  - o Children <5 years old or those unable to collect sputum, a nasopharyngeal swab or suction is placed in a UTM or VTM tube.
- In case of patient having pneumonia and intubation, sputum is collected by tracheal suction or cut the end of UTM or VTM tube.

*C. Results for the detection of SARS-CoV-2*

If SARS-CoV-2 is not detected:

- 1) Consider appropriate treatment

- 2) Outpatient treatment can be provided. For patients with high risk groups to consider home-quarantine continuously until the criteria set by the Department of Disease Control (as of the date of this guideline is 14 days after exposure) while low-risk patients may not need to be isolated but must follow preventive measures: wear a mask, wash your hands, and keep social distance
- 3) If symptoms are severe, they should be admitted to hospital for appropriate diagnosis and treatment, and droplet precautions are used pending the final diagnosis
- 4) If symptoms do not improve within 48 hours, re-examination of SARS-CoV-2 and other causes as appropriate
- 5) In case of asymptomatic high-risk exposure, a second test for SARS-CoV-2 should be performed 7 days after the first test or 13 days after the date of the last confirmed case, whichever comes first.

If SARS-CoV-2 is detected

- 1) Admit in a single isolation room or cohort ward (with confirmed patient only) at least 1 meter distance between beds
- 2) Severe symptoms or aerosol generating procedure required for Aerosol Infection Isolation Room (AIIR)
- 3) provide treatment according to clinical guidelines

*D. Practical advice for the patient when detecting infection*

1. Avoid staying in close contact with other people in the residential area, especially the elderly, young children, and various chronic diseases. In addition, the patient should wear a mask at all times if he / she continues to cough and sneeze.
2. If you need to get close to others, you must wear a mask and stay at least 1 meter away.

3. In case of breastfeeding mothers, they can still breastfeed because no infection was found in the milk. Mothers should wear a mask and wash their hands strictly before touching babies or breastfeeding.
4. Separate personal items not to share with others, such as dishes, bowls, cutlery, glasses, towels, phones, computers.
5. Do not share meals with others. Should be eaten separately
6. Separate wash your clothes, bed linen or towels, etc. with water and soap or detergent.
7. Separate their garbage bags. Tie the mouth of the bag tightly before discarding it with general waste, after which it must always wash your hands with soap and water.
8. Use the bathroom separately from others. If you need to share a bathroom, use it last and close the toilet lid before flushing the water.
9. During separation, the accommodation area and frequently contacted materials, such as furniture, appliances (e.g. beds, tables, chairs, telephones), with water and detergent, should be cleaned as appropriate for the material.
10. Get plenty of sleep in a room that is not too cool and well-ventilated.
11. If there is a new illness or more of the same symptoms such as high fever, coughing, tiredness, gasping for breath, loss of appetite, call the hospital immediately. If traveling to a medical facility, do not use a public car or boat. It is advisable to use a private vehicle and keep the car windows open or ask for an ambulance.

### **Recommendations on the preparation of hospitals for the coronavirus disease 2019<sup>(9)</sup>**

From the epidemic situation of the coronavirus disease 2019 (COVID-19) which has infected a large number of infected and sick people. Healthcare facilities must make arrangements to accommodate these patients. Therefore, there are guidelines for developing preparation in various fields that will enable the organization of work systems and operations to provide services to patients suffering from COVID-19

successfully. Medical personnel general patient and relatives who receive services at the hospital are safe no risk of infection. This guidance contains many elements of hospital preparation development as follows:

*Principles of management of hospitals in epidemiological*

- Place: Clear zoning ILI (Influenza like illness) and Non-ILI to reduce contamination between respiratory and general patients (Clear Zoning).
- Personnel: Strict adherence to prevention, control and quarantine measures. Divide operations into sets at high-risk points. Do not mix personnel between high-risk missions and general missions. It can be switched and rotated through the clearance protocol.
- Medical equipment: Clear separation of medical devices used in each patient zone. Use according to indications. Clean according to the instructions of the Ministry of Health.
- Management system: Reducing government procedures if it is a reason for the safety of personnel and service recipients. Networking between health care facilities in the area to exchange information. Establish guidelines for sharing resources to support the referral of infected and non-serious patients to appropriate hospitals or critically ill referrals.

*Management and general service; to prepare medical resources to support the increasing number of COVID-19 patients*

- Refrain from providing medical services that are not urgent or consider referring patients who are not urgent to receive services to other hospitals in the network.
- Use online/video consultation and logistic systems to provide general patient services, such as mailing medicines to patients if the patient is stable and without any abnormal symptoms.
- Provide a hotline number or website to provide health information services and answer patient questions.
- Open the necessary medical services (diseases in which the waiting period for treatment affects lives), such as emergency rooms, intensive care unit,

chemotherapy, dialysis room, operating room (emergency patient), surgery oncology, delivery room, etc. at medical facilities or prepared areas without mixing with patients with respiratory symptoms.

- Implement social distancing measures (1-2 meters) at the waiting hall, the restaurant, and the drug pickup area, or other service areas strictly.
- Personnel meeting to communicate, understand, review operations and assigned to communicate in their own departments to all personnel for acknowledgment
- Prepare ICU, Isolation room, Cohort Ward to support COVID-19 patients
- Check the ventilation system, air conditioning and sewage systems by engineers and technicians
- Dispose of infectious waste with standard care by placing two layers of infectious waste bags, emphasizing cleaning staff on safety and disease control measures.
- Develop a long-term preparation plan (work systems, personnel and resources) to support patients from the COVID-19 situation, and prepare a Business Continuation Plan (BCP) in case of an increasing number of patients or have personnel exposed and at risk of infection or found to be infected with COVID-19
- Develop a network of service centers, local coordination systems, guidelines for supporting low-symptom COVID-19 patients, and referrals for critically ill patients.
- Set guidelines for general patients, relatives, and all staff to wear cloth masks or hygienic masks at all times in the hospital. Develop guidelines to maintain distance between people in hospitals. Do not allow congestion to occur in any point of the hospital by strictly adhering to Standard Precaution principles in caring for all patients.

*Management of the Acute Respiratory Infection Clinic (ARI Clinic)<sup>(10)</sup>*

Given the current situation with the COVID-19 outbreak, the first line of hospitals is to screen patients at risk to isolate those who are sick with COVID-19 for

further treatment. At present, the number of patients undergoing examinations and screenings is increasing beyond the hospital's capacity. Healthcare workers cannot know in advance whether the person being examined is at high or low risk. While the full protection against virus protection may not be sufficient. This creates a risk of COVID-19 infection, which will affect the performance and morale of healthcare workers. Therefore, the establishment of an ARI Clinic to properly screen patients who are infected with COVID-19 (but do not show symptoms) is useful in preventing the spread of the COVID-19 virus to other patients or medical personnel.

#### 1. Establishment of ARI Clinic

To develop a new model of respiratory clinic service system that is suitable for the COVID-19 epidemic situation and helps medical personnel to be safe in their operations and use resources cost-effectively.

Guidelines for establishing a respiratory disease clinic include: Preparation of facilities, personnel, and supporting resources such as PPE

- The service unit should be an outdoor area or separate from the general OPD and be well ventilated. Set the proper wind direction (from the doctor through the patient and go outside or through an air filtration system) or as a technically improved room, modular screening and swab unit.
- There are areas for swab diagnostics: RT-PCR may be combined with a CXR (portable x-ray) / blood test, a basic laboratory test. Sufficient waiting area to allow 1-2 meters distance between the patient and the examination table.
- Collecting samples for testing for the COVID-19 virus
  - In the absence of symptoms of pneumonia, one nasopharyngeal swab is collected in a UTM or VTM tube (at least 2 mL)
  - In the case of the patient having pneumonia and not having endotracheal tube.
    - Collect sputum in sterile container containing VTM or UTM.
    - Children <5 years old or those unable to collect sputum, a nasopharyngeal swab or suction is placed in a UTM or VTM tube.

- In case of patient having pneumonia and intubation, sputum is collected by tracheal suction or cut the end of UTM or VTM tube.
- Advise the patient to wear a mask and wait at the designated area or wait for the results at home with advice on how to behave. If there are indications for admission as an inpatient, stay in a single room or isolation room, not necessarily AIIR.
- Personnel wear PPE as appropriate. In general, use the droplet with contact precautions (lab, gloves, mask, and face shield). If an aerosol generating procedure is performed such as sampling nasopharyngeal swab, personnel are required to wear airborne protective clothing together with contact precautions (waterproof gown, gloves, N95 mask, face shield or goggle and hair cap).
- Determine the flow of the patient's walk as one way.
- Clearly divide the patient's area, i.e. high-risk and low-risk areas
- Provide one stop service
- There should be a hand washing point and the patient's restroom separate from the medical personnel.
- Place alcohol gel at various points such as screening points, pre-examination points, on the examination table.
- The equipment is cleaned and place regularly with 70% alcohol or sodium hypochlorite
- Try to reduce the use of paper and unnecessary touch

## 2. Protective gown

- a. Isolation gown is a gown made of CPE (chlorinated polyethylene) plastic. It may be closed only on the front or closed around the body.
- b. Surgical gown is a waterproof gown that can only be worn on the body of the dress. But the joints may not be completely waterproof.
- c. Surgical isolation gown is waterproof for both the body and joints. Most of the time, it's best to use a cover-up design. There is a strap to tie on the side of the waist, but in some cases, such as at the ARI clinic outside the examination room, it may be possible to use a closed-front CPE only.

### 3. Checklist for ARI Clinic

- a. Set up a screening clinic outside the building or separate from general OPD and have good ventilation.
- b. Adequate space for examination and waiting area. The distance between the points is about 1-2 meters.
- c. Set the flow for walking the patient as one way.
- d. Organize each zones of activities performance according to the risk area by using appropriate protective equipment
- e. Service establishment. One stop service from screening until the end of treatment
- f. Doctors, nurses and healthcare professionals should wear personal protective equipment (PPE) as required by standards.
- g. Place alcohol gel at various points.
- h. The equipment is cleaned and place regularly
- i. There should be a hand washing point. The patient's restroom is separated from the medical personnel.

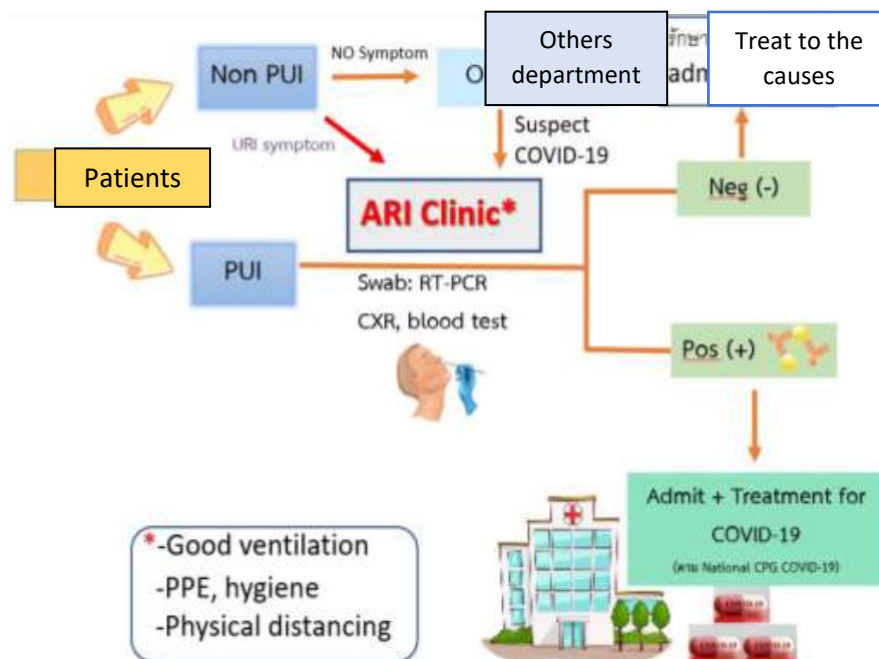


Figure 2: Flow chart of ARI clinic



*Modifying Outpatient department (OPD) Care Services Models in the COVID-19 Outbreak Situation<sup>(26)</sup>*

The new approach to providing outpatient services is to bring experience in the epidemic situation of COVID-19 to adjust the service system to ensure the safety of both patient and provider (2P safety) to increase convenience and speed for service visitors and reduce congestion in the service unit. Ministry of Public Health, Thailand has created two separate key steps:

1) Key steps to support a new outpatient care service (OPD) model to guide the development of systems for use in both the epidemic and non-COVID-19 outbreaks.

And 2) Key steps to address the epidemic of respiratory disease as a complementary measure to be used only during COVID-19 or other respiratory disease outbreaks:

*Key steps to support the new outpatient care service (OPD) model*

1. Screening points for people with respiratory symptoms
2. Acute Respiratory Infection (ARI) clinic services separate from general outpatient clinics.
3. Make sure patient who have respiratory symptoms should wear a mask at all times.
4. The system is registered online or via kiosk and has a backup system to replace immediately after IT system failure.
5. Health insurance authentication system online or through kiosk
6. Online appointment system or via kiosk
7. Queue calling system online or queuing time-lapse to see a doctor.
8. Have sufficient hand washing points or alcohol gel.
9. Telemedicine system

10. Separate the high-risk operating room that produces aerosol from the general procedure room by providing a 6-12 Air Change / Hour (ACH) recirculation system.
11. Fast track system for refill medicine
12. Postal drug delivery system or drug delivery by village volunteers. Or receive medicines at a local drugstore or drive thru (in case of mailing or by village volunteers, the hospital must have a system to check that the patient is receiving the correct medication)
13. Service and drug payment system by scanning QR code

*Key steps to support the epidemic of respiratory disease*

1. Make sure that all service users wear a face mask or a cloth mask at all times.
2. Make a place to be spaced at least 1 meter apart.
3. Healthcare personnel and staff wear surgical masks during service hours.
4. Improve the work area of staff separated from patients by using plastic / acrylic screen barriers or, if unable to do so, staff can wear face shield
5. Clean the exposed areas with disinfectant. E.g. door knob, stair handrail, handrail, chair backrest, elevator button, counter top at least twice a day

**Criteria and conditions for receiving expenses of COVID-19 for health care services (in Thailand by NHSO)<sup>(27)</sup>**

*Rules, conditions and rates of payment of expenses for Screening and laboratory testing to confirm COVID-19 infection for health promotion and disease prevention (for all Thai citizens)*

The groups eligible for screening and confirmation are:

1 Criteria for risk groups as prescribed by the Department of Disease Control, Ministry of Public Health.

2 Screening before the procedure as specified by the Department of Medical Services, Ministry of Public Health.

3 The physician assesses whether it is necessary at the discretion of the physician in specific cases, performed within the service unit.

#### Compensation for screening and confirmation of COVID-19 infections

1. Realtime RT examination by nasopharyngeal and throat swab samples
  - a. Laboratory test to confirm infection by RT-PCR method is actually paid per service (not more than 1,600 baht).
  - b. Other service fees related to the infection confirmation laboratory are payable at the rate of 600 baht per service.
  - c. Sampling fee for laboratory examination, payable at the rate of 100 baht per service.
2. Pooled saliva samples (not more than 5 saliva samples per group)
  - a. Laboratory examination fee: Actual payment of not more than 320 baht per sample.
  - b. Other laboratory service fees: paid by a flat fee at the rate of 100 baht per sample.
  - c. Samples collection fee: Paid as a flat fee at the rate of 40 baht per sample.
3. Pooled nasopharyngeal and throat swab samples (Sample not more than 4 cases per group)
  - a. Laboratory examination fee: Actual payment of not more than 400 baht per sample.
  - b. Other laboratory service fees: paid by a flat fee at the rate of 75 baht per sample.
  - c. Samples collection fee: Paid as a flat fee at the rate of 100 baht per sample.
4. Confirmation of COVID-19 infection in case of Pooled Sample test positive

- a. Laboratory testing for infection confirmation by RT -PCR method from saliva samples or nasopharyngeal and throat swab sample is actually paid not more than 1,600 baht per service time
  - b. Other service fees include sample collection service and laboratory service fees paid as a fixed fee at the rate of 200 baht per service time.
5. Antibody testing
- a. Cost of laboratory testing to confirm infection Includes collection of specimens: a fixed fee of 350 baht per service time.
6. Antigen testing
- a. Cost of laboratory testing to confirm infection Includes specimen collection fee: actual payment of not more than 1,200 baht per service

*Compensation for health care costs for patients with COVID 19 in the National Health Security System*

Scope and conditions for claiming expenses

1. For service to persons in the National Health Coverage who are confirmed or suspected case of COVID-19 infection
2. It is a payment to the National Health Coverage Service unit that provides services to those covered by the National Health Coverage.
3. For service in both outpatient and inpatient

Pay rate

For OPD:

1. Laboratory tests confirm infection
  - a. Same as Screening rate
2. Medicines for the treatment of COVID 19 patients
  - a. Actual payment not exceeding 7,200 baht per person
3. Transportation fee for transferring patients between service units between the house, airport checkpoint, border checkpoint, port, quarantine facility, field hospital, and service units

- a. Personal protective equipment (PPE) cost includes cleaning and disinfection of vehicles. Actual payment not more than 3,700 baht per referral

For: IPD

1. Laboratory tests confirm infection
  - a. Same as Screening rate
2. Room rates include meals.
  - a. Inpatient room fees include meals, actual expenses not exceeding 2,500 baht per day.
  - b. COVID 19 Specialized Ward fees actually paid not more than 1,500 baht per day.
3. Cost of personal protective equipment (PPE) actually paid not more than 740 baht per set
  - a. Mild to moderate symptoms, pay according to the actual service, not more than 15 sets per day.
  - b. Severe symptoms pay according to the actual service, not more than 30 sets per day.
4. Medicines for the treatment of COVID 19 patients are actually paid, not more than 7,200 baht per person.
5. Transportation fee
  - a. Same as OPD

## 2.) Bangbuathong Hospital

### General information<sup>(28)</sup>

- Address : 4 Moo 3, Tessaban 6 Road, Tambon Sano Loi, Bang Bua Thong District, Nonthaburi 11110
- Type / level : Community Hospital / Secondary, Level M2 (There is a plan to develop as a secondary hospital M1 level in 2022)
- Owner/Affiliate: Nonthaburi Provincial Public Health Office, Office of the Permanent Secretary, Ministry of Health

- Number of beds: 63
- Service Coverage: 14 Sub-district health promoting hospitals
- Service field: examination and treatment for general and specific diseases such as internal medicine, pediatrics, general surgery, orthopedic surgery, obstetrics and gynecology, ophthalmology, physiotherapy and alternative medicine services. It also provides health promotion services, disease control, disease prevention and rehabilitation, linking inpatient care with community care and taking proactive actions in the community. Recently, after a new wave of COVID-19 outbreak in December 2020, Bangbuathong Hospital was set up to serve 150 beds for COVID-19 Infected patients using Building 5 as Cohort ward for treating mild to moderate symptom.

**Population in the area of responsibility:**

- 8 sub-districts, 81 villages
- The total population is about 280,000 people.
- The population of Universal Health Coverage (UHC) in Bangbuathong District is approximately 160,000 people. But the UHC under Bangbuathong Hospital is only about 70,000 people.

**Number of staffs**

- The total number is 263 people, consisting of 18 doctors, 11 dentists, 13 pharmacist, 93 nurses, 6 physical therapist, 5 public health personnel, etc.

**Organization chart**

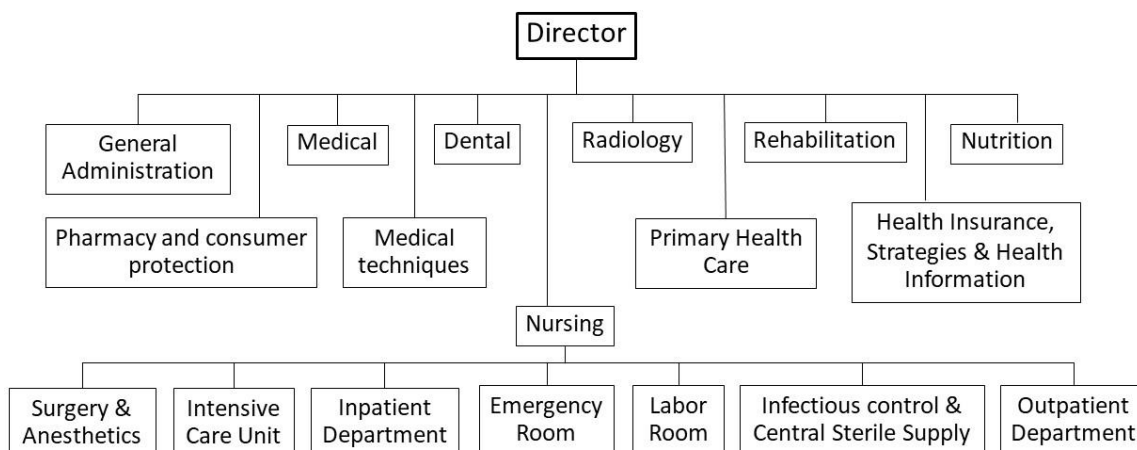


Figure 3: Organization chart of Bangbuathong Hospital

### Building

Bangbuathong Hospital covers an area of approximately 6 rai. The important buildings consist of

- Building 1 (1 Floor) Labor room
- Building 2 (4 Floor)
  - 1st floor: emergency room, operating room, radiation room
  - 2nd floor: Inpatient ward (1 positive pressure sterile room)
  - 3rd Floor : Special Ward, General Administration Department
  - 4th Floor : Meeting Room, Library
- Building 3 (3 Floor)
  - Floor G : ARI Clinic
  - 1st Floor : Outpatient, Pharmacy, Insurance, Medical Records Room
  - 2nd Floor : Dental, Lab, Intensive Care Unit
  - 3rd Floor : Meeting Room
- Building 4 (5 Floor)
  - 1<sup>st</sup> Floor : Primary care unit

2<sup>nd</sup> Floor : Drug Addinction Therapy, Mental Health and Counseling, Physical Therapy, Thai Traditional Medicine, Traditional Chinese Medicine

4<sup>th</sup> Floor: Nutrition

5<sup>th</sup> Floor : Central Distribution Unit

- NCD Building      NCD services
- Building 5 (7 Floor)      Cohort ward

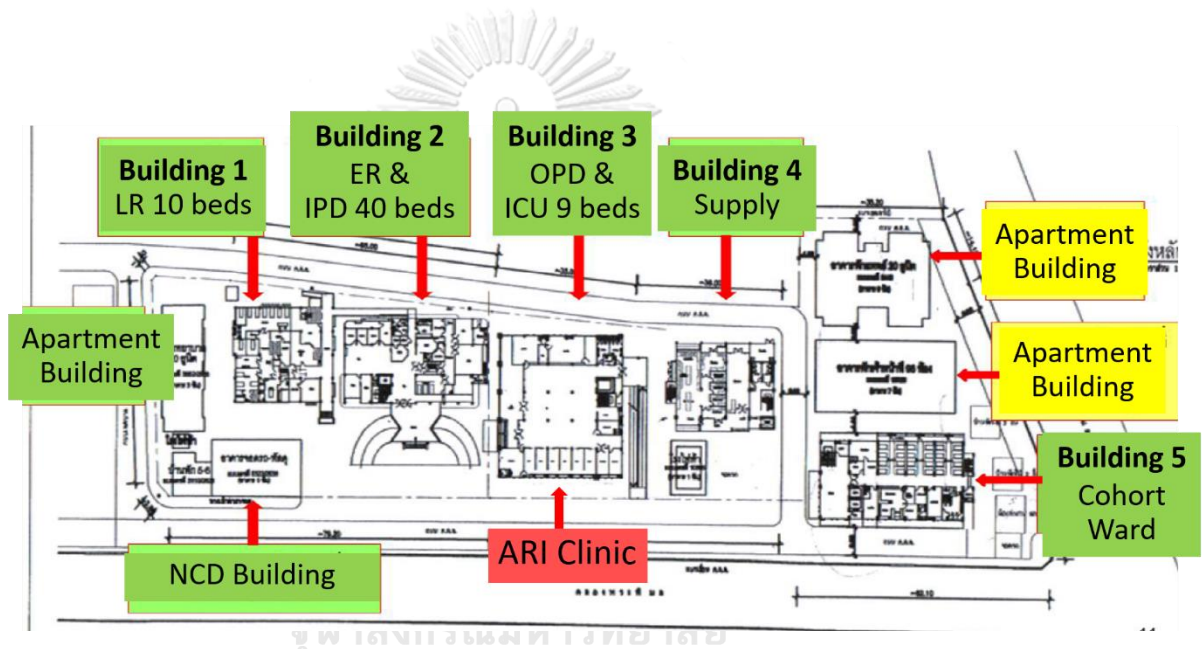


Figure 4 : Building map of Bangbuathong Hospital

### ARI clinic at Bangbuathong hospital

Acute Respiratory Infection (ARI Clinic), Bangbuathong Hospital is one of the facilities set up under Building 3 to screen patients at risk for COVID-19 who come to the hospital as shown in Figure 5.

It was activated for the first time as ordered by the Ministry of Health since the first wave of the coronavirus outbreak (around April 2020) until now. This clinic is open only during office hours from 8:30 a.m. to 3:30 p.m.



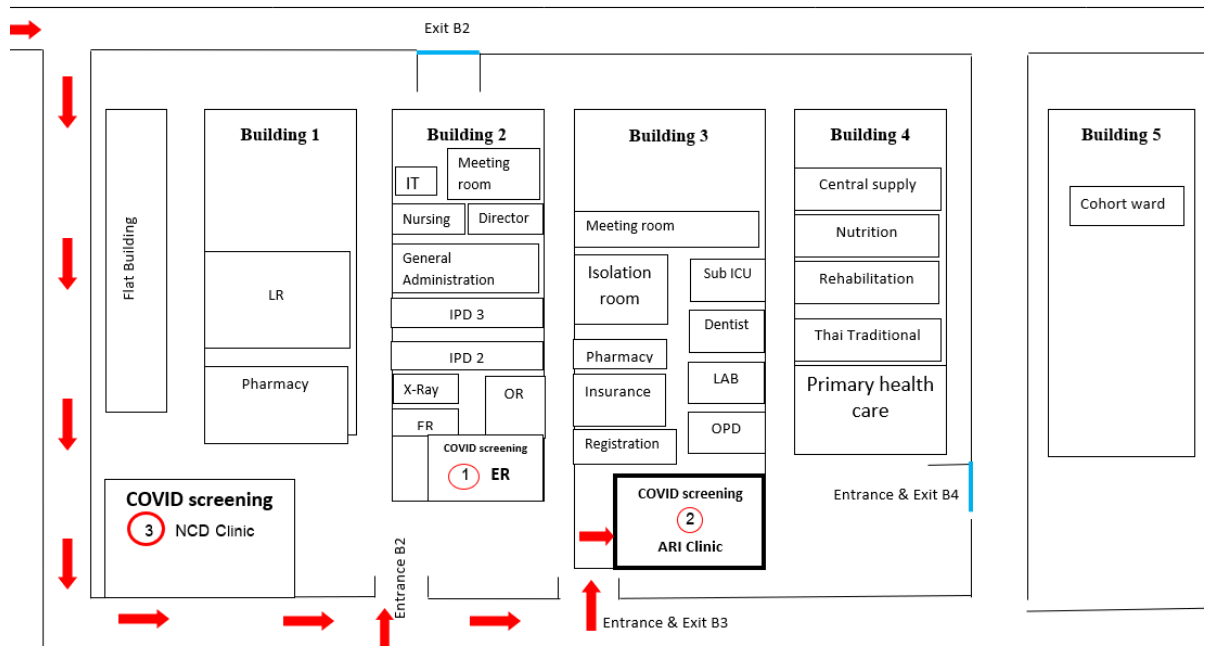


Figure 5: ARI Clinic as a screening point of patients at risk for COVID-19 infection

ARI Clinic is under the responsibility of OPD (Nursing), which is supported by other units including Labor from the Medical Organization, Primary health care, and Pharmacy and Material & Equipment from the Central supply unit, Pharmacy, and General administration.

For the patient service process. First of all, all patients must pass preliminary screening by ARI clinic, which is one of the hospital's 3 screening points for COVID-19. The staff at the screening point inquired about the initial symptoms and measured body temperature. If it meets the specified risk criteria, patients must continue to be screened and examined at the ARI Clinic. If not, patients to be able to receive services from other departments in the hospital.

The screening criteria for those who are at risk of COVID-19 at Bangbuathong Hospital have been adapted from the announcement of the Department of Disease Control, with details as follows:

- 1) Acute respiratory symptoms within 14 days (cough, runny nose, sore throat, anosmia, ageusia, dyspnea and difficult breathing)

- 2) Fever (body temperature  $> 37.5$  c) with at least one risk history within 14 days prior to symptom onset:
  - a. Have a history of traveling/returning abroad
  - b. Occupation with close contact with foreign tourists/entering boxing stadiums/night entertainment venues/attending activities with more than 50 people gathered
  - c. Close contact or contact with suspected or confirmed COVID-19 patients or as a medical personnel
  - d. History of being tested for COVID-19 within 14 days

In addition, patients who must be screened for COVID-19 before surgery or procedures are also sent to the ARI Clinic.

After the patient has passed the screening criteria to enter the ARI Clinic, each group is responsible for the following tasks:

Patient

- Use Surgical Mask for both patients and relatives / rub hands with alcohol gel
- Maintain a distance of at least 1 meter from other patients.

Screening nurse

- Wear 5 PPE kits: gown, surgical mask, face shield, head cover and gloves
- Questioning symptoms and exposure history of COVID-19 / body temperature, blood pressure, pulse, O2 saturation / phone number recorded on OPD card
- Do not touch the patient and anything from the patient without wearing protective equipment.

Doctor

- Wear 5 PPE kits: gown, surgical mask, face shield, head cover and gloves
- History taking/physical examination

After completing the history taking and physical examination process. Patients are divided into 2 groups, Patient Under Investigation (PUI) and Non-PUI. For Non-PUI, the doctor threat according to the cause. If patients are in a high-risk group but do not have symptoms, it is recommended to go home for 14 days to observe the symptoms.

In the case of PUI, screening nurse notify the card room and SRRT. For severe symptoms, send for ER examination in the Resuscitation Zone. After that, all PUI patients must receive specimen collection for SARS-CoV2. Specimen collectors wear 6 PPE kits: leg cover, cover all, gloves, N95, face shield, hair cover. Then, collect nasopharyngeal swab, throat swab and put both swabs in one UTM or VTM tube. Change gloves after every swab. For Surveillance and Rapid Response Team (SRRT), taking history according to the Novelcorona-3<sup>(29)</sup> form to request the SAR-CoV-2 code from the Disease Control Department, Nonthaburi Province. After completing the swab, the patient will be discharged to self-quarantine at home according to the guidelines of the Department of Disease Control to wait for the results of the COVID-19 test.

### **3.) Cost concepts and cost classification**

#### **3.1) Definition**

Cost is the expense, both explicit cost and not paid out in real money (Implicit Cost) in order to obtain a product or service.<sup>(30)</sup>

But in terms of healthcare services, cost is the total cost of all types of agencies involved in providing healthcare services to patients with specific methods and procedures. In general, the nature of the public health facility, the units within the public health service center are related to all agencies. Cost determination therefore has a different approach to determining business costs.<sup>(31)</sup>

#### **3.2) Perspective**

In a cost analysis, there can be three types of views<sup>(32)</sup>:

- Provider perspective refers to expenses incurred from providing services to patients. This includes labor, material and investment costs, so they are not equal to service charges charged to patients.

- Consumer perspective is the total expenditure that a patient has to pay for the services, including expenses resulting from illness such as absence.

- Social perspective is the sum of all costs incurred, such as environmental destruction, the occurrence of serious communicable diseases in society, lack of work, etc.

### 3.3) Accounting Costs and Economics Costs<sup>(33)</sup>

- Accounting Cost refers to the monetary cost and explicit cost.

- Economics Cost refers to all costs incurred in production, whether actually paid out or not. Economic cost is also defined as the sum of all other benefits that can arise from the same amount of resources applied to an activity. In other words, the concept of opportunity cost is taken into account in cost analysis, so economic costs are often higher than accounting costs.

### 3.4) Cost classification

Cost elements can be classified in different ways. A good classification must be consistent with the situation or purpose of its implementation. No overlap, but all types of costs are covered. It can be divided into several ways<sup>(30)</sup>:

- Classified by input characteristics

It is the most basic classification by bringing inputs with the same characteristics in the same group. Divided into large groups as follows:

- Capital Cost is the cost of obtaining resources that last more than 1 year, including buildings, constructions, and some kind of equipment.
- Operating Costs (or Recurrent Costs or Running Costs) are costs to obtain depleted resources and will need to be provided on a regular basis, including staff wages, materials, utilities, short-term training fees, etc.

- Classified by purpose of work :

For the benefit of performance analysis. Cost may be classified according to activities such as training, supervision, management, monitoring, evaluation, support /

transportation, etc. or in the order of use, such as national level, district level, provincial level, district level or by source such as the Ministry of Public Health, etc.

- Classified by activity criteria such as
  - Direct costs - Material and labor costs that are directly related to a production or service and can be specific as a product or service. This cost is eliminated when production is discontinued or the service is cut off.
  - Indirect costs - Costs that cannot be determined specifically for a particular product or service because they are used in conjunction with the production of various products or services, such as utilities, depreciation, office rental, etc.
- Categorize costs for cost control such as
  - Fixed Cost - This is the cost that the total cost does not change when there is a change in activity level or service volume.
  - Variable Cost - It is the cost that varies with activity level, such as the cost of medical supplies used to care for patients.
  - In addition, they are further subdivided into either Controllable & Noncontrollable cost or Traceable costs & Non traceable cost etc.

#### 4.) Unit cost analysis

##### 4.1) Definition

A unit cost analysis is a comparison of the amount of resources used with the results or throughput. It is a tool for monitoring resource efficiency, budget planning, rate setting, and determining whether certain activities are preserved or canceled.<sup>(30)</sup>

##### 4.2) Unit cost analysis and applied in the Ministry of Public Health, Thailand<sup>(34)</sup>

After Thailand has initiated the Universal Health Coverage Program or 30 baht to treat all diseases, which began in 2001, it is regarded as reforming the country's public health system and reforming the traditional budget allocation system.

Since then, the collection and analysis of financial information has been developed systematically and continuously. But the analysis shows that many services are facing financial difficulties. Partly due to administrative efficiency and insufficient budget allocation to meet service needs. Therefore, the Ministry of Public Health encourages a policy to define efficiency.

One of the indicators is that the service unit has a complete database of basic costs by using the unit cost analysis, so that every service unit can study and know their costs.

In addition to being useful for service units in terms of use of information for providing efficient services and improving service quality, it is also beneficial to the central management unit to monitor operations, control unit costs to meet goals, evaluate signs of problematic cost per unit increase, audit performance assessments, compare costs and results, calculate the cost recovery or rate of return and. Most importantly, it can be used as a supplement to formulating a budget allocation policy for future services.

#### **4.3) Method for determining the unit cost of a medical facility<sup>(30, 32, 35)</sup>**

There are three most commonly used cost methods: Cost-to-charge ratio, Traditional method, and Activity-based costing (ABC) method.

##### **- Cost-to-charge ratio**

It is the simplest cost estimation method, regardless of what sub-departments are in a healthcare facility. Using the assumption that the cost is a fixed proportion compared to the price charged, this method is commonly used in healthcare facilities of all levels. But the disadvantage is that in reality, the ratio between the costs and the prices charged for each service is different. The resulting cost is the average cost of all services, and the difference in service costs cannot be expressed under each sub-unit.

##### **- Traditional Method**

It is a cost estimation method by looking for the cost of the hospital sub-unit. The costs of support units are eventually distributed down to the service provision up to sub-service, known as the "top-down approach". This method divides the

organization's sub-units by organizational chart into two categories: Revenue producing cost center (RPCC) and Non-revenue producing cost center (NRPCC).

For in hospitals, the production unit is the organization that produces services for patients such as wards, diagnostic radiology units, etc., sometimes in the past research is divided into sub-categories. There are different names, such as patient service, ancillary services, while the support unit is an agency that has a mission to support the production department in providing patient services such as finance, accounting, management, etc.

Total cost of service output can be obtained from labor cost, material cost and depreciation cost. This is often referred to as direct cost combined with overhead cost, which is the distribution of the cost of support units into production units, often referred to as indirect cost.

There are three methods for distributing costs from support unit to production unit:

1. Direct method

In this way, the support units do not pass costs between them, they only pass costs to the production units which does not match the reality. But has the advantage of being easier to do than other methods in the traditional method group

2. Step down method

In this way, the support units distribute the final costs one by one to the remaining support and production units until the total cost of the support units is zero. The production unit then determines the cost of the sub-product.

3. Reciprocal (simultaneous equation) method

In this way, support units distribute costs back and forth using mathematical methods. This is because the supporting cost units also work for each other, not just receiving costs from other agencies.

- Activity-based costing (ABC) method

It is a method of estimating service cost by looking at the cost of the minor activity that results in the final service productivity. It could be called a “Bottom up approach”. Because this method starts with the cost of sub-activities that use what resources. The cost of the sub-activities is then added to the final product-service cost.

This is a new approach to costing organizations. It aims to find a more accurate solution to the cost distribution of support units by binding the costs of support units to their subsidies. It then determines how much productive services, such as each type of treatment, are used by sub-unit activities. This makes it possible to set more accurate costs. However, this method of costing calculations requires a very detailed information system and is very costly to operate. Therefore, it was found that not many agencies were able to do this cost-finding

The difference in service cost per unit of Traditional costing and ABC is due to resolution in the overhead distribution. Generally, the distribution threshold for supporting cost units is usually only one. But ABC, which is divided into multiple activities, has its own cost driver, making the costing more detailed.

In this research, we used traditional method by direct method.

#### **4.4) Unit Cost Analysis by the Office of the Permanent Secretary, Ministry of Public Health**

The Office of the Permanent Secretary of Public Health has established guidelines for calculating the cost of productivity for hospitals by expanding them to cover both budgetary and non-budget funds for all sources of hospital income, based on the principles of international cost accounting standards used in healthcare facilities in Foreign countries And in accordance with the guidelines for calculating production costs of the Comptroller General's Department. The cost data is separated by two major cost centers: production and support units.

By the supporting unit, the Comptroller General's Department called “Support cost centers”. These types of cost centers are considered Transient Cost Centers (TCCs) that distribute costs to the entire production unit. The production unit is called “Primary cost centers” are the final cost units Absorbing cost centers (ACCs). In the



case of healthcare facilities with a complex organizational structure, the main cost centers are divided into three sub-categories: the revenue producing cost center (RPCC), the patient service (PS) group, and the Non-patient service (NPS). The "Support Cost Center" section is called the Non-revenue producing cost center (NRPCC).

*How to prepare a healthcare cost accounting*

1) Determine the cost center

Studying and analyzing the structure of the hospital system (System analysis), the budget management system structure and the hospital's allowance. To classify work centers as cost centers according to the nature of their duties and the actual relationship in the service and support of each work center.

Initially, the cost center should be set in accordance with the withdrawal center according to the service center's parcel issue system. A cost center assignment is too rough or too small, making it impossible to answer the questions it wants to know, and the resource used cannot be distributed in detail enough to truly reflect the flow of resources. Excessive or too detailed cost center assignments can make it difficult to collect cost data and distribution criteria, resulting in considerable cost analysis workloads, and the responsible person takes a lot of storage time as well.

The hospital must define the primary cost center and support cost center. Primary cost center is a cost center that is directly responsible for generating productivity or participating in work center productivity. It consists of three groups:

- Revenue producing cost center (RPCC or Charging to patient for their service)
- Cost unit providing direct service to patients (Patient service area: PS)
- Cost units that provide other services (Non-patient service area: NPS)

The supporting cost center is the cost center that provides services to the primary cost center or supports which is the nonrevenue producing cost center (NRPCC or Non-charging directly to patient).

## 2) Cost center data preparation

The healthcare facility must classify its expenses by cost centers, with costs in each cost center comprising labor costs, material costs and depreciation costs. The details are as follows:

### - Preparation of labor cost information

The labor costs of each cost center consist of the wages of the workers at each cost center. In case of personnel operating more than one cost center, Salary and other money paid in the same manner as salary, such as position allowance, POT's money, non-personal practice Etc. shall be allocated in proportion to the actual operating time of each cost center. For remunerations that are paid for working outside office hours, such as compensation for working outside office hours, afternoon-night compensation, counseling fees, etc., shall be calculated as the wages of the actual operating cost center.

### - Preparation of material information

The healthcare facility must identify the actual material costs of each cost center and must organize an internal system to ensure complete and consistent verification of the transactions between accounting system information and source information from the dispatch center.

As for the material cost in the cost analysis, it means the cost of materials purchased / hired by the service unit, including materials that are supported by external agencies, such as drugs received from the NHSO, drugs supported by various departments, etc.

For utilities such as electricity, water bill and overall service center wages such as cleaning contract, there are options for classifying material costs as follows:

I. Deposit all such costs at the general management cost center and continue to distribute them to other cost centers as indirect costs.

II. Setting cost centers to accommodate the above expenditures, such as utility facilities in electricity, utility centers, postal and transportation, cleaning center and use the distribution criteria to other cost centers Is the next indirect cost

III. Estimate the allocation of such costs as direct material costs of the cost center consumed, the cost of that material, using the allocation-based basis, number of personnel, or other better criteria.

- Preparation of depreciation data for equipment and buildings

In the case of a construction with several cost centers, the main utilization Depreciation shall be allocated according to the usable area of each cost center.

### 3) Direct cost calculation

The healthcare facility collects Total Labor Cost, Total Material Cost, and Total Capital Cost calculated as Total Direct Cost (TDC) of each cost center in order to continue to distribute the direct costs of the support center to the indirect costs of the main cost center.

### 4) Cost distribution and data preparation for applying the allocation criteria

Cost distribution is the cost movement of the supporting cost center to the cost center serving the patient. The main reason is

1. So that all costs come to the patient service cost center, which makes cost per center comprehensively calculated. There is no cost omitted.

2. To reflect the mutual support relationship of various cost centers This will lead to the assessment of the performance as close to reality as possible.

The key point is that the direct cost of the NRPC, the supporting cost center or the temporary cost center, is distributed as the indirect cost of the primary cost center, RPCC, PS and NPS, according to the service relationship using appropriate criteria.

Hence, the primary cost center has the full cost equal to its own direct cost plus allocated indirect costs from supporting cost centers or temporary cost centers.

What is used as a basis for distributing costs from one work center to another, commonly known as Allocation factor criteria are information that shows the relationship of support or service delivery between work centers. Most of the time, there is information about the workload of the distributors work center, such as price, service charge, number of patients, etc.

The suggested cost distribution method is Simultaneous equation method, which is cost distribution using straight-line algebraic equations to solve the distribution problem and obtain costs simultaneously.

#### 5) Calculate the total cost

The total cost of each cost center is equal to the sum of the total costs directly and the indirect total cost that is distributed from the other cost centers which can be written as an equation as follows

$$\text{Full Cost (FC)} = \text{Total Direct Cost (TDC)} + \text{Indirect Cost (IDC)}.$$

All these costs will be used to continue calculating the Unit cost analysis.

#### 6) Unit cost calculation

Total cost (full cost) of the cost receiving unit when divided by activity quantity or product quantity Is going to be the cost per unit.

$$\text{Unit cost (UC)} = \text{total cost (FC)} / \text{amount of activity or output (output)}$$

#### 7) Cost recovery calculation

Cost recovery or Rate of return refers to the ratio of income to cost, possibly calculated as a percentage.

$$\text{Cost recovery} = \text{Income} / \text{Cost}$$

### 5) Related research

There are researches that have analyzed unit costs related to COVID-19 in some countries as follows:

The research conducted in Kenya by *Barasa et al.*<sup>(36)</sup> estimated unit costs for COVID-19 case management for patients with asymptomatic, mild-to-moderate, severe and critical COVID-19 disease. They estimated per-day unit costs by using a bottom-up approach to estimate full economic costs. They obtained data of inputs and quantities from data provided by three COVID-19 public hospitals in Kenya and supplemented with guidelines. They received import prices from a recent cost survey of 20 hospitals in Kenya and from market prices for Kenya.

The results showed that daily cost per patient unit for asymptomatic and COVID-19 patients Mild to moderate levels of home care were \$18.89 and \$18.91, respectively. When these patients are managed in an isolation center or hospital, the same unit cost for asymptomatic patients and patients with mild to moderate disease was \$63.68 and \$63.70, respectively. The daily unit cost for severe COVID-19 patients treated in general hospital wards and critically ill patients admitted to the intensive care unit are \$124.53 and \$599.51, respectively.

In Myanmar, *Thant et al.*<sup>(37)</sup> estimated the cost of clinical management of COVID-19 infected patients based on their severity by exploring the resources used in care provision. A multicenter retrospective cost analysis of treatable COVID-19 patients was performed using a micro-costing approach from a health system perspective. The input and quantity data are derived from the Ministry of Health and Sports's COVID-19 treatment guidelines and administrative and financial records of resource utilization of designated hospitals in Yangon Region. The valuation of these resources was based on a price list from the Department's procurement department.

They founded that unit cost of clinical management of a patient with asymptomatic COVID-19 infection was \$717 USD, with mild to moderate symptoms \$869 USD, and critically ill up to \$4,290 USD. Average daily patient costs were \$65 for asymptomatic patients, \$79 for mild-to-moderate patients, and \$214 for severe critically ill patients. Since the first case was detected until December 31, 2020, the cost of clinical management of COVID-19 has been \$104 million, for a total of 124630 confirmed cases.

There was a research study that analyzes the cost of Personal Protective Equipment (PPE). *Walters et al.*<sup>(38)</sup> collected data from Bevan Healthboard to assess how many clinical procedures were carried out over a one-year period. Then, multiplied by the additional cost of PPE required due to the COVID-19 situation to estimate the overall cost. Increased PPE costs were calculated per patient. All physicians and assistants wear additional sterile surgical gowns and FFP2 or FFP3 masks.

The additional cost of PPE due to current COVID-19 guidelines totals £11.50 per patient. Multiplied by 2,808 patients, the total cost of the one year period is £32,292.

Several studies have been done on unit cost analysis and are comparable in the area of research (Community hospital or district hospital) such as:

Study of Saensunthai<sup>(39)</sup> was a study of the cost per individual health insurance for community hospitals in Nakhon Ratchasima Province from the viewpoint of service providers. The data collected between October 1, 2013 and September 30, 2014 were specific to the accounting cost estimation, not taking into account economic costs. Using the method for calculating individual patient costs according to the model of the Office of the Permanent Secretary, Ministry of Public Health (2013). The sample group consisted of 15 community hospitals (F2) in Nakhon Ratchasima Province.

The research results were found that F2 level community hospitals have different costs per health insurance. The cost of medical care civil servants had an average cost of outpatient 561.89 baht per time, the average cost of inpatient 2,836.83 baht per day. From the social security insurance, the average cost of outpatient 392.24 baht per time, the average cost of inpatient 2,620.55 baht per day. the universal health insurance cost an average of 543.97 baht per time outpatient, the average cost of inpatient 2,428.55 baht per day.

From the study of Saybuathong<sup>(40)</sup> who studied the cost and unit cost of Puainoi Hospital (community hospital) in Khon Kaen Province. In view of the service provider, the data were collected from June 1 to August 31, 2010. Cost units are

divided into 3 categories: 1) non-revenue producing cost center (NRPCC), 2) revenue producing cost center (RPCC) and 3) patient service (PS). The total NRPCC and RPCC costs are distributed among the cost units serving patients using simultaneous equation method. The cost of the outpatient, emergency, and inpatient care units was studied divided by the total cost of each service unit by the number of services.

The study found that the total cost of the patient service unit was 7,054,693.19 baht, the total direct cost was 2,620,662.69 baht and the indirect cost was 4,434,030.51 baht. Outpatient is 245.21 baht per time, cost per unit of emergency accident service is 433.42 baht per time and the cost per unit of inpatient service was 1,611.21 baht per day.

According to Songwai's research<sup>(41)</sup>, the cost was studied for the plan of the Small General Hospital (M1) from the viewpoint of service providers. The historical data was collected from 1 October 2014 to 30 September 2015. The population used in the study was 57 units of the cost of Fang Hospital, divided into 3 groups: 1) NRPCC, 2) RPCC and 3) PS. Using the Simultaneous Equation Method.

The results of the study showed that the total direct cost of the Fang Hospital Cost Unit for the fiscal year 2015 was 338,184,971.71 baht. Labor cost ratio: Material cost: Capital cost was 48.06: 45.84: 6.10, with the clinical pathology department having the highest total direct cost 13.26 percent. When classified by type of labor cost, material cost and investment cost, it was found that the most costly service units were medical organizations, clinical pathology and obstetrics-gynecology ward, respectively. As for the cost per unit of the outpatient care unit, it was found that the Thai traditional and alternative medicine service units had the highest cost per visit 1,563.91 baht / time. The highest cost is 146,896.65 baht / person, and the intensive care unit has the highest cost per day to sleep at 24,273.21 baht / day.

From Thongruk's study<sup>(42)</sup> was a cost study of outpatient and inpatient service units at all community hospitals in Nong Bua Lam Phu Province. In the view of the service provider, using a shortcut cost analysis based on the standard cost analysis standard of the Ministry of Public Health. The results of the study showed that in fiscal year 2008, 5 community hospitals in Nong Bua Lam Phu Province had a total

operating cost of 276.21 million baht, classified as the average of 30-bed hospital, which was 43.20 million baht, the average size of 60 hospital beds was 73.29 million. The operating costs per outpatient service unit of 30 and 60 beds were the average of 425.32 and 375.18 baht per time, respectively, the provincial average was 405.26 baht per time. Operating costs per inpatient service unit of hospital size 30 and 60 beds, the average was 5,954.48 and 5,252.52 baht per person, the province's average was 5,763.64 baht per person.

There are several studies looking at unit cost analysis in medical service activities, such as:

Eamratsameekool's study<sup>(43)</sup> investigating cervical cancer screening cost in Roi Et Province. It is a retrospective descriptive study. The total cost of labor, material cost and Capital cost of cervical cancer screening of hospitals in Roi Et Province were analyzed which consists of General hospitals and Community Hospital 60 beds and 30 beds in fiscal year 2009.

The results of the study showed that the total cost of cervical cancer screening at 7 hospitals was 3,046,127.00 baht, 15,577 cases were screened for 195.55 baht per case. The cost of screening using the Single Visit Approach (SVA) method was 119.56 baht or 0.54 times the Pap Smear method with 223.41 baht. The cost of screening for general hospitals, community hospitals 60 beds, and 30 beds was 158.95, 170.83 and 241.44 baht, respectively. Moreover, SVA screening in the province had a higher unit cost than the compensation received from the centralized health promotion and disease prevention services.

Based on the research by Hutamai et al.<sup>(44)</sup>, the composition and unit cost of dengue prevention and control of the health region 10 was examined in the view of the provider. Collecting data for the past 1 year, using the Simultaneous Equation Method cost-sharing method by setting the Allocation criteria with Full time equivalence (FTE).

The study found that the sample provinces had total cost of dengue prevention and control operations. 46,674,168.85 Baht. Cost per population unit is 39.43 baht /



person and is 132.41 baht / household. The proportion of labor costs: material costs:

Capitation cost = 7.61: 5.46: 1

Chanjaruporn's research<sup>(45)</sup> investigated the cost per unit activity of the Thai traditional medicine health promotion and disease prevention services. Choose a specific research area (health service center), totaling 4 provinces. The researcher chose to use the Activities Based Costing method because there are quite a lot of activity units. Analyze from the perspective of the service provider. Collect cost data for fiscal year 2017.

The results of the study showed that the total cost had a median of 171,055.48 baht, the direct cost had a median of 142,546.24 baht, and the indirect cost had a median of 32,061.90 baht or 81.64 percent and 18.36 percent, respectively. For health services, labor costs accounted for the highest cost, between 29.63% - 88.84%. The cost per unit of service activities was quite different from each setting. It was found that the median cost of teaching compress practice was 361.30 baht and the median cost of introducing practice in Thai traditional medicine among children aged 0-5 years was the lowest at 2.76 baht.

In addition to the unit cost analysis, several studies have looked at the cost recover ratio as well.

Mookkhan et al.<sup>(46)</sup> studied Unit cost and cost recovery ratio of Thai Traditional Medical Service at Kudchum Hospital. There are two main service areas: herbal steam service and Thai massage service from the provider perspective. Data were collected from October 1, 2003 - September 30, 2004. The cost distribution was used Simultaneous equation method. Cost analysis was used in accordance with the IHPP manual.

The results of the study showed that the unit cost of herbal steam was 173.13 baht per session, the average cost of all massages was 361.78 baht per time, the payback ratio was only 32.03%. The herbal steam service and Thai traditional massage have a 44.14% and 29.17% payback ratio respectively. This study shows that administration or service rates should be improved, or additional funding will be required to make it worthwhile.

Tarasombat's research<sup>(47)</sup> analyzes the unit cost and cost recovery rate of dental services at the dental clinic of Bang Kruai Hospital. Using information from the hospital database in fiscal year 2013 calculated as unit cost and cost recovery rate. The dental work group is divided into two main units: four service support units and 12 dental service units. Cost allocation from support groups is based on the direct apportionment method. The income is calculated from the actual income received from each health insurance group.

The results of the study showed that the total cost was 12,140,020.68 baht or 375.19 baht per time, the ratio of labor cost, material cost and investment cost was 81.11: 14.40: 4.49. Implant dentistry has the highest cost per unit (2,486.29 baht per time), the total cost recovery rate of services is 56.33 percent, with operative dentistry the highest cost recovery rate of 90.93 percent.

Based on research by Samart et al.<sup>(48)</sup> that studied dental care costs for dental caries at Khon Kaen Dental Hospital, and compared them with compensation income from the National Health Security Office (NHSO) in fiscal year 2013. It is a quantitative study retrieving data from secondary sources. The cost center are divided into four groups: non-revenue producing cost center (NRPCC), revenue producing cost center (RPCC), patient service (PS) and non-patient services (NPS). In this study, only the PS cost of each agency was studied using cost distribution from NRPCC and RPCC to PS and NPS using the top-down method of cost distribution.

The results of the study showed that the cost of medical treatment of 1,201 patients was 2,789,279.72 baht, while the income received from the compensation from Srinagarind Hospital, Faculty of Medicine, Khon Kaen University was only 1,442,789.50 baht (51.73% of the total cost in Treatment) which was insufficient for the expenses incurred.

## CHAPTER III

### Research Methodology

#### Study design

This research was a descriptive study by retrospective data collection. It was analyzed from the provider perspective by considering only the accounting cost.

#### Study area

- ARI clinic at Bangbuathong Hospital, Nonthaburi, Thailand

#### Study period

- 1 March to 31 May 2021 (3 months), which was the period that covered before and during the 3<sup>rd</sup> wave of COVID-19 epidemic in Thailand.<sup>(49)</sup>

#### Source of data

- From hospital recorded data and database of costs

#### Data collection

This research took 2 weeks to collect data. We collected data from various departments (ARI clinic, central supply unit, pharmacy, financial and administrative department) related to the ARI clinic in Microsoft Excel, details as follows;

#### Number of patients in ARI clinic

We used data recorded on the total number of patients in the ARI clinic as a case (or visit) unit, divided into 3 major groups: those with the common cold and low-risk which did not need to swab for COVID-19, those who were at high risk of COVID-19 and need to be swab and patients who must be swabbed before undergoing any procedures.

#### Labor Cost :

We collected data on name of health workers, salaries, compensation for personnel working for service units of the Ministry of Public Health (No.11), extra money for special-emerging positions of public health workers (PTS), extra compensation for working in a service unit under the Ministry of Public Health without doing personal medicine and or working in a private hospital and contingent

compensation for COVID-19 received during the research period from the financial and administrative department of hospital. We also collected data from individual working time record from ARI clinic. In this case, each person was assigned daily hours of work in ARI clinic by specifying a percentage.

#### Record form of labor cost in ARI clinic at Bangbuathong Hospital

Name	Total of salary (PTS + No.11, etc.)	March		April		May		Total LC in 3-month
		% of working hours	Total LC in a month	% of working hours	Total LC in a month	% of working hours	Total LC in a month	
<i>Doctors</i>								
- Mr.xxx	xx,xxx	xx	x,xxx	xx	x,xxx	xx	x,xxx	xx,xxx
- Ms.xxx	xx,xxx	xx	x,xxx	xx	x,xxx	xx	x,xxx	xx,xxx
<b>Total LC of Dr.</b>			<b>xx,xxx</b>		<b>xx,xxx</b>		<b>xx,xxx</b>	<b>xxx,xxx</b>
<i>Nurses</i>								
- Mr.xxx	xx,xxx	xx	x,xxx	xx	x,xxx	xx	x,xxx	xx,xxx
- Ms.xxx	xx,xxx	xx	x,xxx	xx	x,xxx	xx	x,xxx	xx,xxx
<b>Total LC of Nurses</b>			<b>xx,xxx</b>		<b>xx,xxx</b>		<b>xx,xxx</b>	<b>xxx,xxx</b>
<i>SRRT</i>								
- Mr.xxx	xx,xxx	xx	x,xxx	xx	x,xxx	xx	x,xxx	xx,xxx
- Ms.xxx	xx,xxx	xx	x,xxx	xx	x,xxx	xx	x,xxx	xx,xxx
<b>Total LC of SRRT</b>			<b>xx,xxx</b>		<b>xx,xxx</b>		<b>xx,xxx</b>	<b>xxx,xxx</b>
<b>Total of all LC</b>			<b>xxx,xxx</b>		<b>xxx,xxx</b>		<b>xxx,xxx</b>	<b>xxx,xxx</b>

Table 1: Example of record form of labor cost in ARI clinic at Bangbuathong Hospital

#### Material Cost:

Materials used in ARI clinic were collected from requisition record from both central supply unit and pharmacy. For the prices of materials were based on medical supplies procurement plan for fiscal year 2020 (October 2019 – September 2020) of Bangbuathong Hospital.





Capital cost was calculated based on depreciation. We calculated depreciation cost by using straight line or fixed installments method as equation;

$$\text{Depreciation cost} = (\text{Initial cost} - \text{salvage value}) / \text{Estimated useful life}$$

For the salvage value (the price when equipment reaches its total life), we used 1 baht fixed.

### **3. Unit Cost calculation**

This was an analysis of unit costs for ARI clinic, with details as follows;

$$\text{Unit cost of ARI clinic} = \text{Total direct cost of ARI clinic} / \text{Total visit of patients}$$

It was presented as monthly unit cost and unit costs for all of the duration of study.

### **4. Cost recovery**

Calculation of the revenue received from compensation from COVID-19 services defined by NHSO to compare with the material cost of ARI clinic as follows:

$$\text{Cost recovery of ARI Clinic} = \text{Reimbursement from NHSO} / \text{Material cost}$$

For the reimbursement from NHSO, we used accrued revenue (revenue that has been earned by providing a service from NHSO, but for which no cash has been received) based on criteria and conditions for receiving expenses of COVID-19 for health care services (in Thailand by NHSO, fiscal year 2021).<sup>(27)</sup> For ARI clinic, compensation for screening of COVID-19 infections by RT-PCR method was received, which is sampling compensation fee for laboratory examination, payable at the rate of 100 baht per service.

### **Statistical analysis**

Descriptive statistics such as percentage and mean were used primarily to summarize and describe the findings. Data were processed by personal computer with Microsoft Excel 2016.

**Ethical review**

This research was approved by Ethical Review Committee for Research Involving Human Research Subjects, Nonthaburi Provincial Public Health Office (Certificate of Approval No. 21/2564).





## Chapter IV

### Results

#### System Analysis

ARI Clinic is under the responsibility of OPD (Nursing), which is supported by other units including Medical personnel from the medical organization, primary health care, and some personnel from operating room / labor room and Material & Equipment from the Central supply unit, Pharmacy, and General administration.

For the patient service process. First of all, all patients must pass preliminary screening by ARI clinic. The staff at the screening point inquired about the initial symptoms and measured body temperature. If it meets the specified risk criteria, patients must continue to be screened and examined at the ARI Clinic. If not, patients to be able to receive services from other departments in the hospital.

After the patient passed the screening criteria to enter the ARI Clinic, they have to wear a surgical mask, rub their hands with alcohol gel and maintain a distance of at least 1 meter from other patients. Screening nurse asked symptoms and exposure history of COVID-19 / measured body temperature, blood pressure, pulse rate, O2 saturation and recorded in OPD card. After completing the history taking and physical examination process, patients are divided into 3 groups, Patient Under Investigation (PUI), Non-PUI and Swab before procedure.

For PUI, screening nurse notified Surveillance and Rapid Response Team (SRRT) for taking patients history according to the “Novelcorona-3 form” to request the SAR-CoV-2 code from the Disease Control Department, Nonthaburi Province. In case of severe symptoms, send the patient to Emergency Room. Subsequently, all patients in this group were required to undergo nasopharyngeal swab in which specimens were examined for the presence of SAR-CoV-2 by RT-PCR method (laboratory examination performed by central lab outside the hospital). After completing the swab, the patients were discharged to self-quarantine at home according to the guidelines of the Department of Disease Control to wait for the results of the COVID-19 test. Patients who had to be swab before procedure had similar procedures to the PUI, but were not discharged to self-quarantine at home. For

Non-PUI, the doctor treated according to their causes or diseases. These patients were at low risk of COVID-19. Therefore, SAR-CoV-2 was not tested like other groups.

For the medical personnel, there were approximately 4-8 persons in the clinic, consisting of 2 doctors (1 half day in the morning and 1 half day in the afternoon), 1-4 nurses depending on the number of patients and 1-2 SRRT (public health officers). Each person wears 5 PPE kits: protective gown, surgical mask, face shield, head cover and gloves.

In case of collecting SARS-CoV2 samples, personnel added leg cover, cover all and N95. Nasopharyngeal & throat swab had been collected, put both specimens in one VTM tube and sealed with parafilm.

From the study which was conducted during the period from March to May 2021 (3 months), the number of cases in the ARI Clinic over the three-month period was 1,955, an average of 34.94 cases per day.

When considering for each month. March recorded the lowest number of cases at 328. After which the number of patients increased dramatically, with April totaling 796 cases and the highest in May with 831 cases. The number of PUI also grew rapidly, from 18 cases in March to 553 and 662 cases in April and May respectively, while the non-PUI and Swab before procedure patients also tended to decline as shown in **Figure 6**.

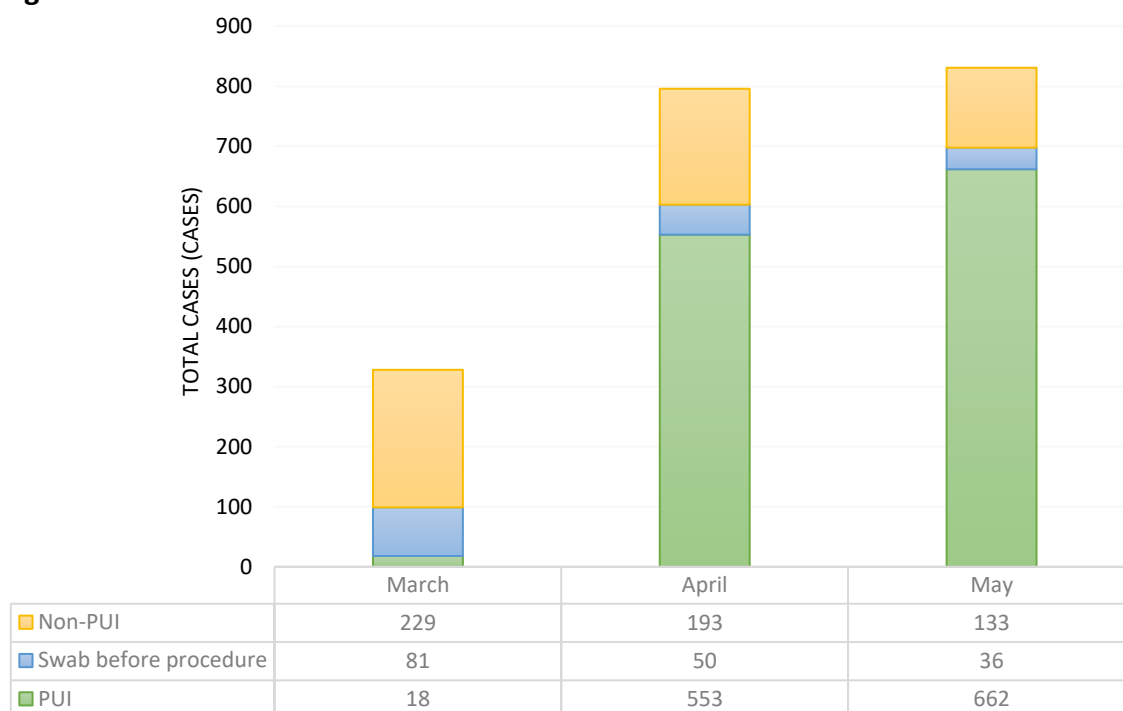
**Figure 6 : Number of cases in ARI clinic**

Figure 6: Number of cases in ARI clinic at Bangbuathong Hospital

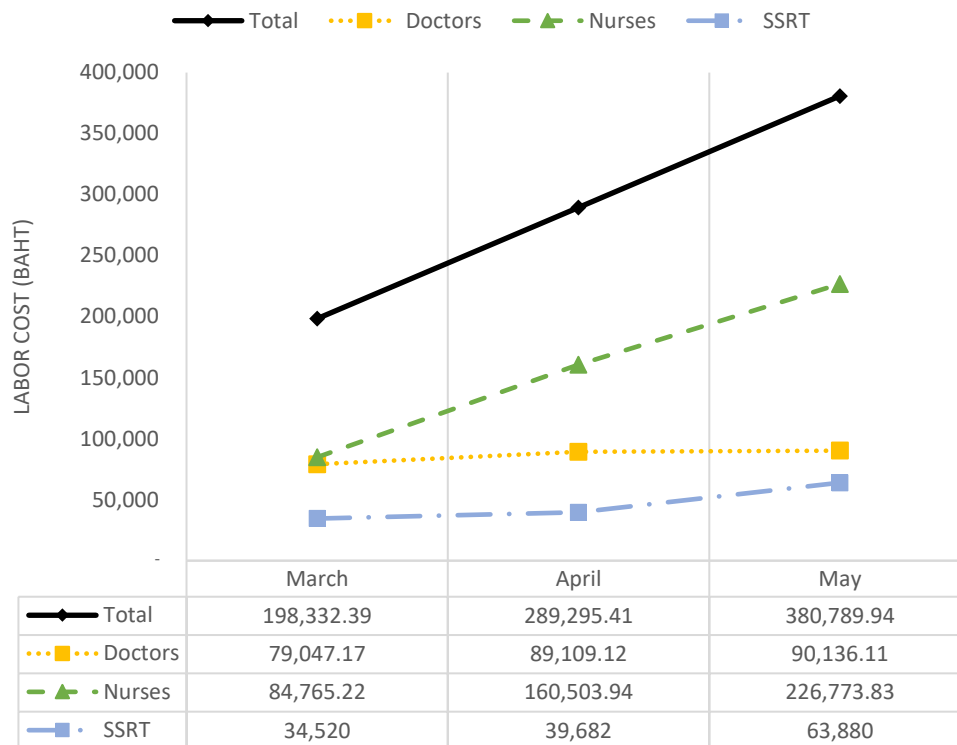
### Total cost determination

#### Labor cost

This cost depends on the number of medical personnel for each month. In March, there were 4-5 providers (2 doctors / 1-2 nurses / 1 SRRT), but April and May, with more patients, had 6-8 providers (2 doctors / 3-4 nurses / 1-2 SRRT).

Total labor cost was 868,417.75 baht. When considering monthly, it was found that Labor costs were rising. The highest month was May 380,789.94 baht, while March had the lowest labor cost. However, the monthly labor cost of doctors varied slightly as shown in **Figure 7**.

### Labor cost of ARI clinic (Thai baht)



\*SRRT = Surveillance and Rapid Response Team

Figure 7: Labor cost of ARI clinic at Bangbuathong hospital

### Material cost

Total material cost was 257,844.87 baht. The highest cost in May was 123,312.10 baht, followed by April 92,023.82 baht and March was the lowest cost at 42,508.95 baht as shown in **Table 4**.

**Material cost of ARI clinic at Bangbuathong Hospital (Thai baht)**

Material lists	Price / unit	Month						Total cost
		March (23 days)		April (17 days)		May (18 days)		
		Unit used	Cost	Unit used	Cost	Unit used	Cost	
Disposable Glove (1 box = 100 pieces)	208.65 (per box)	3	625.95	12	2,503.8	14	2,921.1	6,050.85
Disposable mask (1 box = 50 pieces)	125 (per box)	4.5	562.5	5	625	6	750	1,938
N95	50 (per piece)	92	4,600	120	5,980	184	9,200	19,780
Face shield	45 (per piece)	92	4,140	120	5,382	184	8,280	17,802
Disposable head cover	1.3 (per piece)	92	120	120	155	184	239	514.28
Cover all kit	214	92	19,688	120	25,594	184	39,376	84,658
Protective gown	17.65 (per piece)	92	1,624	120	2,111	184	3,248	6,982.34
Leg cover	20 (per piece)	184	3,680	239	4,784	368	7,360	15,824
Alcohol gel (1 bottle = 450 ml)	27.82 (per bottle)	5	139	10	278	10	278	696
Swab kit (VTM + sterile wooden swab)	70	99	6,930	603	42,210	698	48,860	98,000
Parafilm	800 (per piece)	0.5	400	3	2,400	3.5	2,800	5,600
<b>Total material cost</b>			42,508.95		92,023.82		123,312.10	<b>257,844.87</b>

Table 4: Lists of materials, unit price, amount used, and monthly material cost of ARI clinic (Thai baht)

### Capital Cost

Capital cost, calculated from the depreciation cost of equipment, over a period of 3 months totaled approximately ten thousand baht (3,447.6 baht per month). Depreciation cost of computer equipment was the highest, similar to those from automatic blood pressure monitors as shown in Table 5.

#### Capital cost of ARI clinic at Bangbuathong Hospital (Thai baht)

Lists	Number	Cost/unit	Total cost	Estimated useful life	Salvage value	Depreciation cost (per 1month)	Depreciation cost (per 3 month)
Contactless Infrared thermometer	2	1,200.00	2,400.00	5	1	39.98	119.95
Automatic blood pressure monitor	1	70,000.00	70,000.00	5	1	1,166.65	3,499.95
Weighing scale	1	20,000.00	20,000.00	5	1	333.32	999.95
Stethoscope	1	3,000.00	3,000.00	5	1	49.98	149.95
Computer	2	22,000.00	44,000.00	3	1	1,222.19	3,666.58
Printer	1	2,600.00	2,600.00	3	1	72.19	216.58
Wheelchair	2	6,900.00	13,800.00	5	1	229.98	689.95
Stretcher	1	20,000.00	20,000.00	5	1	333.32	999.95
<b>Total</b>						<b>3,447.6</b>	<b>10,342.87</b>

Table 5: Capital cost of ARI clinic at Bangbuathong hospital

### Total direct cost

The total direct cost derived from the sum of labor, material and capital cost of ARI clinic for all three months was 1,136,605.48 baht. May had the highest cost at 507,549.67 baht, while March had the lowest cost at 244,288.96 baht, as shown in **Figure 8**.

### Total direct cost of ARI clinic (Thai baht)

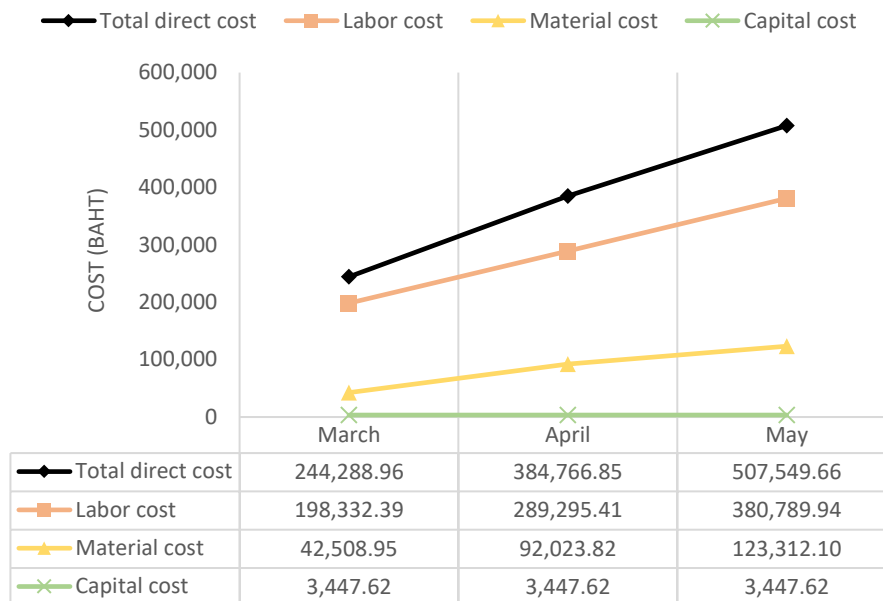


Figure 8: Total direct cost of ARI clinic at Bangbuathong hospital

### Unit cost

The total cost of services at ARI clinic per case was 581.38 baht, but when considering monthly, it was found that March had the highest cost per case at 744.78 baht, followed by May (610.77 baht) and April (483.38 baht)

### Cost recovery

The reimbursement from NHSO varied from month to month depending on the number of cases in which COVID-19 screening specimens were collected (which mean PUI and Swab before procedure groups).

From total of 3 months, compensation was 140,000 baht (from 1400 cases). In May, the highest was 69,800 baht, followed by April at 60,300 baht, while March was the lowest at only 9,900 baht.

When calculated for cost recovery (divided by material cost), this 3-month total period was 0.54. If considering at each month, the highest April was 0.66, followed by May (0.57) and March (0.23) respectively.





## Chapter IV

### Discussion

The unit cost analysis of Acute Respiratory Infection (ARI) clinic for COVID-19 screening at Bangbuathong Hospital, Nonthaburi was studied during the third wave of COVID-19 spreading period in Thailand, before the spreading was March, during the spreading was April and after 3<sup>rd</sup> wave in May. The three-month study thus provided the rough estimate of the cost data of hospitals in managing all three scenarios of COVID-19 screening at ARI clinic.

The number of patients in ARI clinics increased dramatically in April and May, especially PUI group, in line with the third wave of COVID-19 epidemic situation in Thailand.<sup>(49)</sup>

The data from the research also shows that total direct costs tend to increase with the number of patients in the ARI clinic and patient group. Especially for patients with PUI group, which is much higher in the last 2 months, this group of patients need to be screened for SARS-CoV2 and need more medical materials (e.g. disposable gloves, swab kit, parafilm and alcohol gel), thus increasing the cost as well.

Labor costs also tend to be in line with the number of patients. When the number of patients increases, it requires more personnel to provide services in the clinic, especially nurses who have to do history taking, screening, including swabs to collect specimens. Similarly, SRRT had to add personnel to investigate the disease in late April until May. However, the labor cost of doctors did not increase each month because the number of doctors in the clinic did not increase with the number of patients.

However, if considering the cost of labor for doctors, it was found to be quite high compared to the wages of nurses or SRRT. In addition to the reason that doctors receive more salary than other professions, Bangbuathong hospital provided specialized doctors such as obstetricians, surgeons, orthopedists etc. whose full-time jobs had been reduced due to the spreading of COVID-19 to help in ARI clinic.

As for the material cost, the amount of all materials used was also in line with the number of patients. As a result, the cost of materials in May was the highest, followed by April.

Taking into account the unit cost, the month with the fewest patients had the highest cost per case, as many of the medical supplies were not used by the number of patients but by the number of working days mentioned above. Moreover, March had the highest number of working days (23 days), making March's cost-per-case the highest.

As for the unit cost of COVID-19 screening at Bangbuathong hospital, which averaged 581.38 baht per case, when compared to other studies that looked at similar results, it was found to be close to *Saensunthai's* research<sup>(39)</sup>. That study examined the unit cost of Out-patient department (OPD) services and found that the unit cost was 543.97 baht per case. But compared to *Thongruk's* research<sup>(42)</sup>, it was found that the cost was higher. The unit cost of that research was 375.18 baht per case. This may be because the study considered only the operating cost (not including capital cost), hence the cost was lower than this research.

Compared to other studies, considering the characteristics of services, the unit cost of this study was higher than *Eamratsameekool's* research<sup>(43)</sup>, which study cost of cervical cancer screening, which was 170.83. baht per case. This may be due to the fact that such characteristics of screening using a smaller number of medical personnel and medical materials.

For the cost recovery, due to the reimbursement rate of ARI clinic from the NHSO, it can only be reimbursed for collecting specimens for COVID-19 testing, which is 100 baht per case. Therefore, reimbursable cases were in the both of PUI and Swab before procedures group, so March, which had fewer cases in these two groups than the other months, had the lowest cost recovery.

Although the other studies were similar, none had a cost recovery greater than 1. However, the cost of providing such medical services is usually included in the per capita expenses in the National Health Insurance system every year. This was

different from the screening service for COVID-19 which is an emerging disease and has no clear policy regarding reimbursement. Therefore, the hospital may have to adapt by using donated medical materials or using maintenance money so that the cost of such services will not be a burden on the hospital's fiscal system in the short term.

In case of better control of the epidemic, the central authority should adjust the reimbursement rate in accordance with the cost used. For example, it may be necessary to increase the payment channel for supporting equipment or PPE packages, etc.

Finally, this research may have some limitations. First, although the study analyzed data over a three-month period covering the third wave of outbreaks. However, it may be a short time to see the details of each cost structure and constrain the learning of organizational adaptation, especially resource management, in the face of different epidemic scenes. Second, the statistics used in this research were not able to tell the relationship, the degree of relationship between variables and did not consider confounding factors. Lastly, this research was an analysis of accounting costs from service provider perspective only. It did not include economic costs (did not account for opportunity costs), and analyzed only direct costs, did not take into account the indirect cost, so it can only provide preliminary cost data used in the ARI clinic.

## **Conclusion**

During the three-month period that overlapped the third wave of the COVID-19 outbreak in Thailand, unit cost and cost recovery of ARI clinic at Bangbuathong hospital was 550.37 baht per case and 0.71 consequently. When considering the monthly, May had the highest total direct costs and cost recovery, while March had the highest unit costs.

## **Recommendation**

The data obtained from this research can not only be used as the preliminary information for the director or chief financial officer (CFO) of the hospital to use in

managing the resources of the ARI clinic in various scenarios, but also to develop and optimize reimbursement models from central organization.

For future researches, in order to get a clearer and more detailed cost structure in various dimensions, longer data collection intervals should be taken into account. Other statistics should be used to tell the relationship of related variables. A full cost analysis, which includes indirect cost, should also be considered, as well as taking into account the opportunity cost in the economic cost dimension.



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