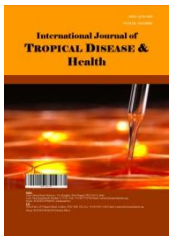

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Study about Tuberculosis in Thailand: An approach to Treatment, GIS and Sichon Model

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In this study, we seek to identify geographical areas where ongoing tuberculosis epidemiological characteristics is occurring by linking Geographic Information Systems (GIS) technology in Thailand. In addition, we seek to assess how the directly observed treatment short-course (DOTS) program improved new tuberculosis diagnosis and treatment successes in Sichon District, Nakhon Si Thammarat province, Thailand from 2014 to 2016. The assessment program included seven indicators, and the results revealed that 73 new cases of tuberculosis were admitted for treatment on average every year, with rates of risk group screening findings of 4.28, 5.23, and 6.04 %, respectively. Patients who come to the hospital for diagnosis make up most of the demographic. However, only a minor proportion of patients are identified through community-based primary screening. In the years 2013-2016, the mortality rate of TB cases is expected to rise by 10.25 %, 4.25 %, and 5.56 %, respectively. The elderly and HIV-positive patients comprise most of the TB mortality population. When completing the DOTS program at a hospital, however, the rate of success has fallen short of the targets. Furthermore, the screening technique excludes the target group. As a result, people suffering tuberculosis are reported to be slower and more susceptible to symptoms. As a result, researchers advise that the DOTS program be supported by enhancing treatment follow-up to improve the effectiveness of TB treatment and collaboration with health care worker (HCW).

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1. INTRODUCTION

Tuberculosis (TB) is a major air-born disease and a worldwide problem concern. It's being the top cause of population death in the world [1]. The mortality caused by TB in 2019 reported by WHO is more than 1.4 million people per year around the world [2]. The cause of TB is bacterial infection by *Mycobacterium tuberculosis*. The bacteria are carried in small droplets of a person with active TB and transmitted to another person via inhalation [3]. *M. tuberculosis* mostly affects the lungs due to the bacterial infection entry through the respiratory tract. Moreover, the infection can spread by lymphatic and hematogenous to other parts of the body. Approximately 15% of infected patients are extrapulmonary infections [4]. This may or may not be accompanied by pulmonary infections. The symptoms of TB can be classified into two stages. The first is the latent TB infection, which does not evince disease symptoms. The second is active TB which presents with cough lasting longer than a few weeks, bloody sputum and other classic symptoms as fever, chills, weakness, unintentional weight loss, and night sweat [5].

According to epidemiological data, most tuberculosis cases occur in Southeast Asia, Africa, and the Western Pacific [6], while TB incidence and case numbers have decreased in recent years. However, the following advancements may not be enough to reach the World Health Organization's "Ending the Tuberculosis Strategy" goal of 2020. In Thailand's rural districts, community hospitals are the front lines in the fight against tuberculosis. These community hospitals are government-run institutions that provide primary and secondary health care [7]. However, Patient awareness and understanding as well as low socioeconomic status is a fundamental problem in treating tuberculosis in this scenario [8]. As a result of these factors, there is a scarcity of accurate epidemiological data. This begs we can identify people with tuberculosis in a specific geographic area [9]. If that's the case, screening and treatment based on geography could be a nice method for Tuberculosis control programs to identify high-risk groups. As a result, using Geographic Information System (GIS) technology in combination with TB screening in community hospitals could be a viable treatment management guideline in future [10].

Directly observed treatment short courses (DOTS), an internationally recognized approach for tuberculosis treatment recommended by the WHO, is widely accepted in many countries [2]. The benefits of this therapy approach are still being discussed [11]. DOTS has been reported to have no advantage over patient self-treatment in some studies [12]. Another factor for inadequate therapy in patients is failure to diagnose, treat, and follow up TB, as well as poor procedures [13]. Thailand is a low-middle-income country with the world highest tuberculosis burden [14]. Despite implementing the official WHO Tuberculosis Control Strategy in 1997, TB rates have not reduced. This is most likely due to the widespread HIV epidemic and low treatment success rates. Patients in Thailand are treated in both the public and private sectors. DOT has been implemented using a variety of ways, including no DOT approach. Previous studies in Thailand [15], however, revealed that using a two-mouth DOT treatment program was related with lower rates of treatment default. When compared to family members, treatment outcomes were better with a DOT program administered by a health care worker (HCW). As a result, the goal of this study was to look at the implications of a six-month trial of the DOTS program in collaboration with HCW to assess long-term outcomes, as well as the use of GIS data to characterize the epidemiological characteristics of tuberculosis in Sichon model, Thailand.

2. MATERIALS AND METHODS

2.1 Study Setting

This study was conducted at Sichon Hospital in Sichon district, Nakhon Si Thammarat province with 255 tuberculosis cases from 2013 to 2016 that is 69 cases in 2013, 60 cases in 2014, 89 cases in 2015 and 37 cases in 2016. From January 1, 2013, until June 30, 2016, pulmonary tuberculosis patients were treated at an outpatient department (OPD) of a district hospital in Sichon District, Nakhon Si Thammarat Province, Thailand. Patients were monitored from the start of treatment through the end of the six-month period. Only adult patients (age 18 or older at the time of TB therapy) were included in this study, and individuals with extrapulmonary TB without pulmonary TB were excluded. The hospital under investigation was an M1 grade, which is described by the Health Administration

Division as a large-sized community hospital with 250 beds and general practitioner or family physicians as well as specialists from at least one major specialty.

2.2 Data Collection and Analysis

The Annual Tuberculosis Report 2020-2021 of the Ministry of Public Health's Division of Tuberculosis provides information on the epidemiology of tuberculosis cases in Thailand. In 13 participatory health regions, detailed data is divided into TB cases. The prevalence of tuberculosis in Thailand was performed by ArcGIS software for the prevalence of tuberculosis mapping and clustering. In addition, a portion of the data in the case study area was also obtained through the collection of TB treatment cards and the use of online registration platforms by health care worker (HCW). The patient's OPD card and chest radiograph were used to register data, which included baseline characteristics (gender, age, occupation, incarceration, and TB history), medical history, HIV infection history, previous TB infection history, history of Bacillus Calmette–Guérin (BCG) vaccination, tuberculosis treatment course, initial chest radiograph, patient status, and outcome. The rate of risk group screening, rate of CPG using hospital diagnosis and caring, rate of success, rate of medications default, rate of mortality, rate of substantial effect, and rate of a home visit were all used to examine the follow-up and treatment outcomes in this study. Descriptive statistics are used to analyze all the data.

3. RESULTS

3.1 The Prevalence of TB in Thailand

Tuberculosis (TB) is a contagious disease caused by bacteria. Tuberculosis can occur in any organ of the body, most often in the lungs. Figure 1 and Figure 2 shows the prevalence of tuberculosis in each public health region in Thailand using a GIS system. The results indicated that the prevalence rate of TB (1 October 2020 - 28 February 2021) was found in all regions of Thailand with a rate more than 30 per ten-thousand population in each public health region. Mainly most found in the Central, Northeast, and North public health region.

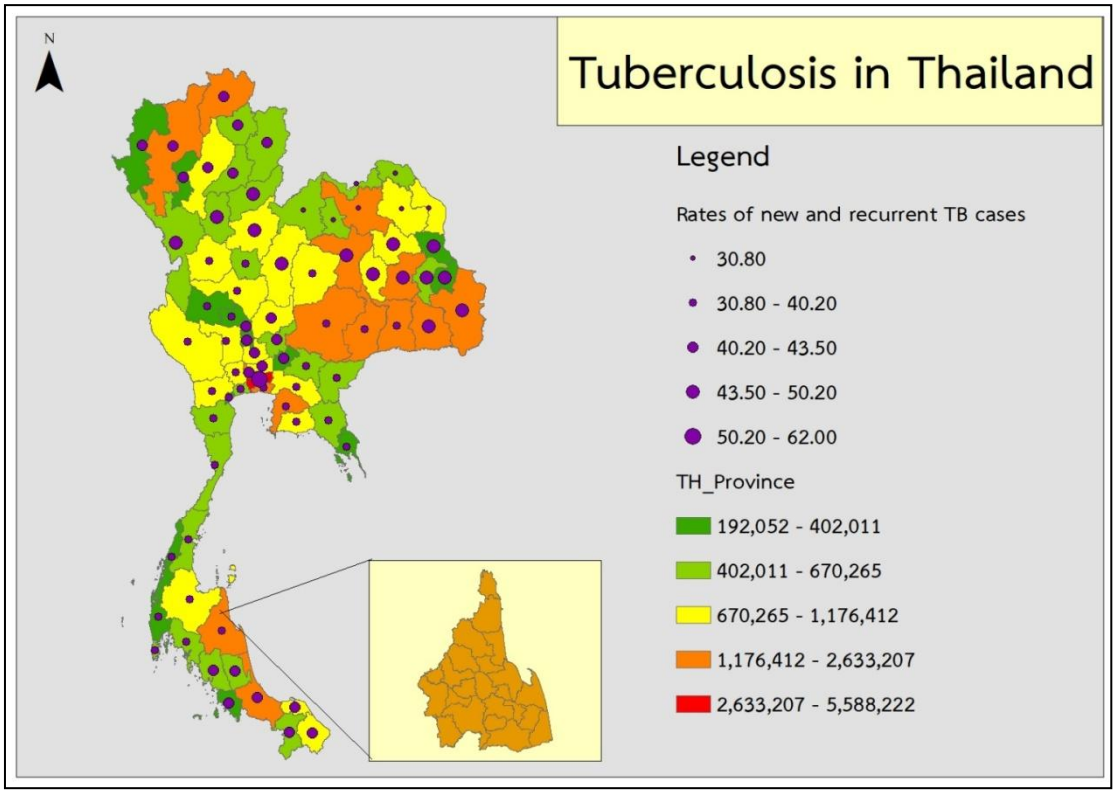

Fig. 1. The prevalence of TB in each public health region in Thailand by using a GIS system (Division of Tuberculosis, 2021)

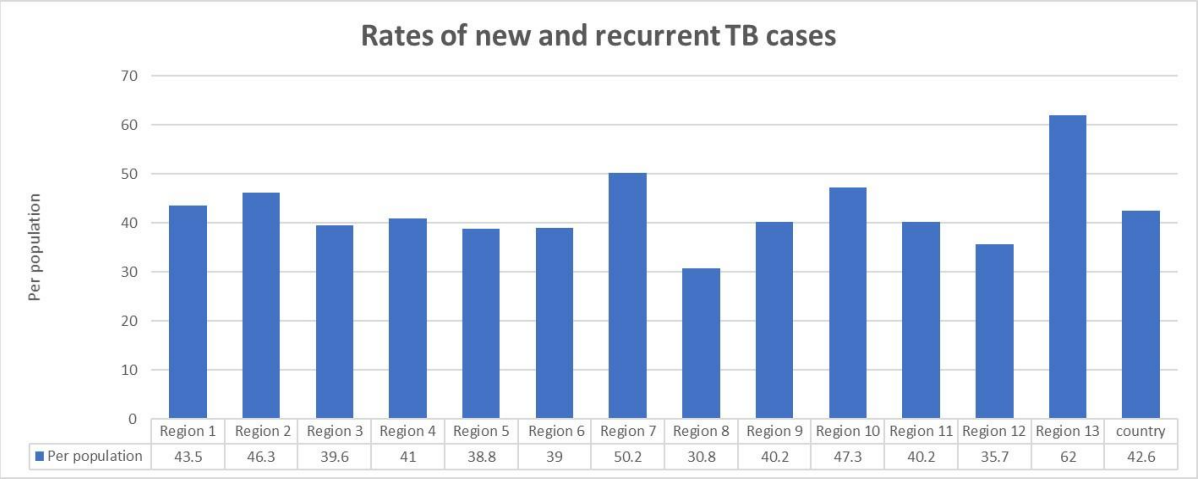

Fig. 2. Rate of new and recurrent TB cases in 13 participatory health regions in Thailand (Division of Tuberculosis, 2021)

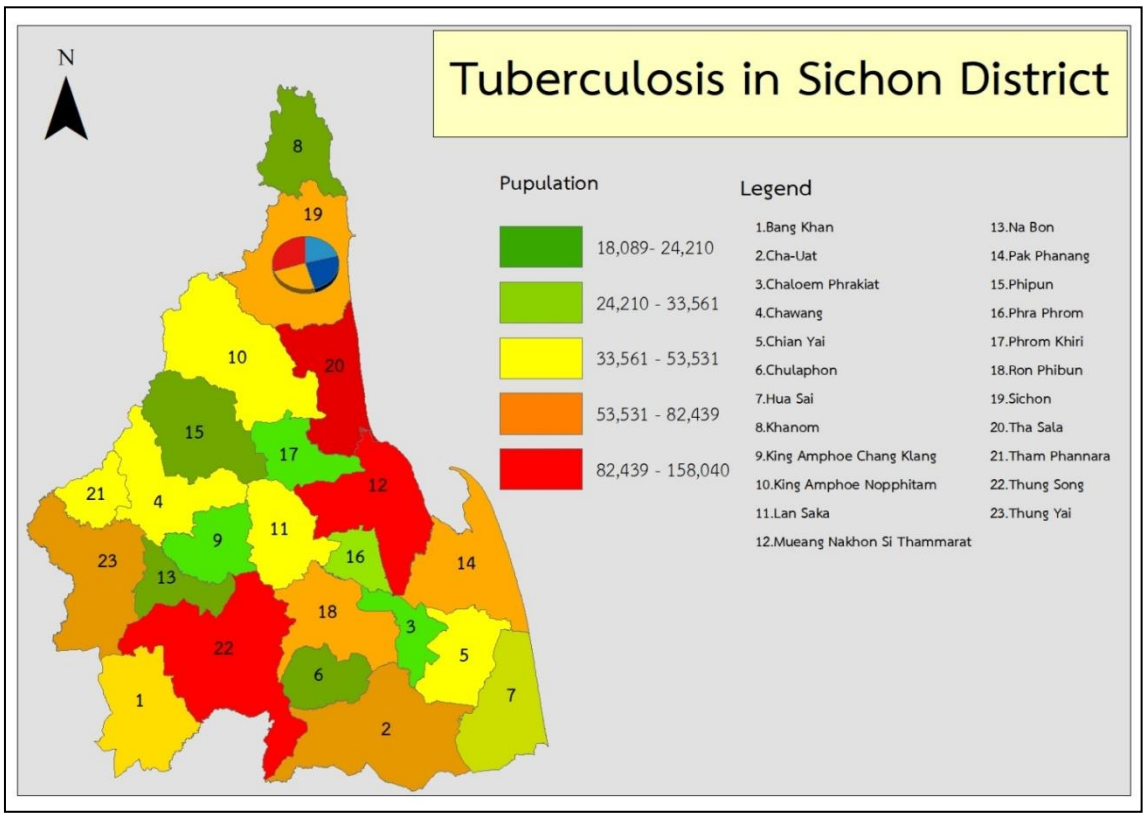

Fig. 3. The map and population density in each district of Nakhon Si Thammarat province by GIS system

The descriptive data reveal that the rate of new and recurrent of tuberculosis in 13 participatory health regions in Thailand (1 October 2020 - 28 February 2021). The highest rates were found in health region 13 with 62.0 per ten-thousand population and health region 7 with 50.2 per ten thousand population. The participatory health region with rates in the range of approximately 40.0 were 47.3, 46.3, 43.5, 41.0, and 40.2 per ten thousand population in health region 10, 2, 1, 4, 9 and 11 respectively. The participatory health region with rates in the range of approximately 30 were 39.6, 39.0, 38.8, 35.7, and 30.8 per ten thousand population in health region 3, 6, 5, 12,

and 8 respectively. Thus, the rate of new and recurrent tuberculosis cases in Thailand was 42.6 per ten-thousand population. Move this section to discussion.

3.2 The Prevalence of TB in Sichon District

The target research is Nakhon Si Thammarat Province with consists of 23 districts. Fig. 4 shows map and population density in each district of Nakhon Si Thammarat province by GIS system. The target district is number 19, Sichon district with a population density 53,531-82,439 people. The research of the health caring process in TB patients was observed and analyzed by the GIS system.

From the research in Figs. 3 and 4, the performance of the public health system related to tuberculosis were observed. Then, the results were analyzed and plotted by the GIS system. The results of research from 2013 to 2016, the rate of home visit was more than 60% in every year. The major effect less than 5% in 2013-1015, and in 2016 was 12.50%. The mortality rate was not found in 2013 and increased to 10.25% in 2014. In 2015-2016, the mortality rate was decreased to 4.25% and 5.56%, respectively. Drug treatment defaults cases were not found in 2013-2016. The success rate was more than 90% in 2013 and 2015 and more than 85% in 2014 and 2016. The percent of CPG was 100% in 2013-2016. The screening risk groups in 2013 and 2014 were 42% and 46% and increased to 50% and 58% in 2015 and 2016. The system of tuberculosis disease in Sichon hospital research, the main of research was set indicators. Then reviews learned and evaluated these indicators. The context of this research was TB cases in Sichon Hospital; The TB cases increased in 2016-2018. The purpose of the system about the factors related to TB was evaluated as the rate of success does not less than 85%, rate of mortality does not exceed 5%, rate of drug default does not exceed 5% and rate of new case report does not less than 82%. Then the process of TB cases was entry and access, continuity of care, effectiveness, and empowerment of TB patients. After that, the performance of factors in purpose was evaluated. The improvement of the process guideline was an admission of patients one to two weeks before referring to the local hospital for treatment and adjusting treatment attitudes for patients and their relatives.

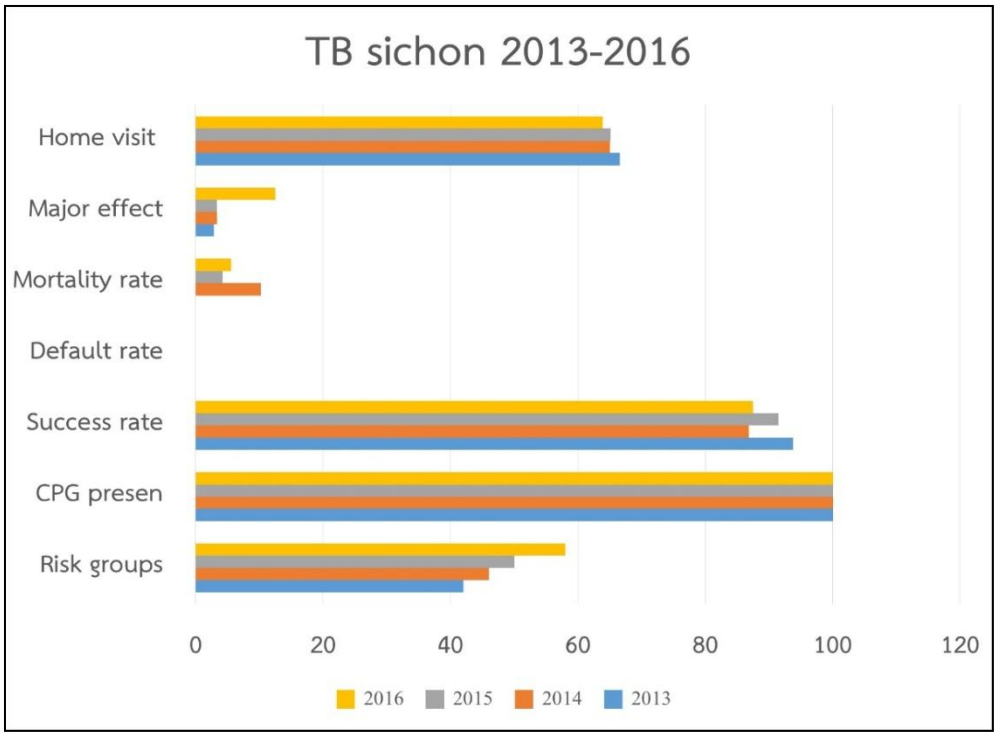

Fig. 4. Percentage of performance related caring for TB patient process in Sichon district

Table 1. The data show descriptive assessment analysis data of DOTS program in TB patient between project operation time (2013-2016)

Indicators	Percentage of expectation	Practicable level			
		2013	2014	2015	2016
1.The rate of risk group screening	> 80%	42%	46%	50%	58%
2.The rate of CPG using in patients diagnosis and caring	100%	100%	100%	100%	100%
3.The rate of success	≥ 90%	93.75%	86.84%	91.48%	87.50%
4.The rate of drugs default	< 1%	0%	0%	0%	0%
5.The rate of mortality	< 5%	0%	10.25%	4.25%	5.56%
6. The rate of major effect	< 5%	2.89%	3.33%	3.37%	12.50%
7.The rate of home visit	> 80 %	66.67%	65%	65.16%	63.89%

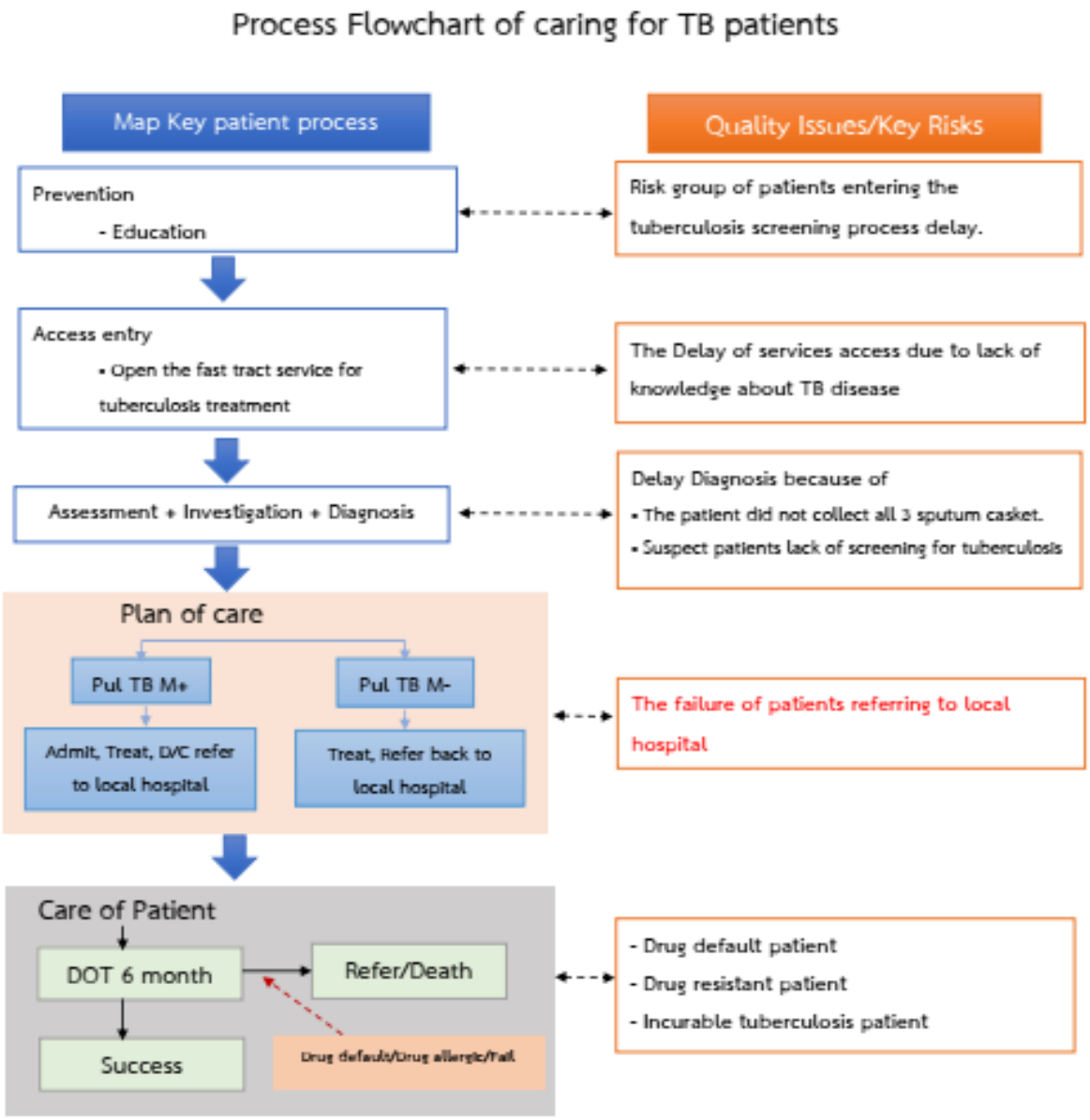

Fig. 5. The flow chart of caring for tuberculosis patients in Sichon district hospital

The plan after improvement, the model of TB care was invented. Besides, the system was co-operation with the system design to answer the objective indicated that a medical volunteer team of the community hospital to provide care and service to TB patients, improve the guidelines for caring for TB patients and empower the community, which is further explained in Figure 5 that is the purpose TB treatment. There are composed of four primary drivers and many secondary drivers to be complete process follow the purpose. The first is the topic of prevention, information, and screening of risk group is the key important. The topic of access and entry, the secondary driver, is the improvement of the patient service, including setup screening point and using of fast-track service. Third, the topic in assessment and investigation, Chest X-ray (CXR) diagnosis and Acid-Fast Bacillus (AFB) test in risk group is a secondary driver that resulting in good assessment and investigation. The last primary driver is the care of patients, which refers to the good quality of the treatment system; referring and follow-up, which is the secondary driver.

Process flowchart of caring for TB patients was indicated in Figure 5, which reference from purpose was map key patient process. In the prevention topic, the quality issue is the risk group of patients entering the tuberculosis screening process delay. The quality issue of entry access is a delay of services access due to lack of knowledge about TB disease. Moreover, the delay of a diagnosis due to not complete sputum collected and lack of suspected TB patient screening are impacts to a diagnosis of TB. The key process of patients's care was related to the diagnosis of pulmonary TB positive or negative. The pulmonary TB is positive, a patient needs to admit to the hospital before referring to local hospital. The caring of TB patient, the directly observed treatment (DOT) doing for six months and then the symptom was evaluated. In case of a patient with drug defaults, allergic and treatment fail, patient need back to DOT process again.

4. DISCUSSION

TB is a disease of global concern due to this disease serve illness and death. Thailand is also known as high-burden country list for TB by World Health Organization (WHO). The prevalence of TB is found in all regions of Thailand. This may result from labor migration between Thailand and the countries with higher TB incidence than Thailand, such as Cambodia, Myanmar, and Indonesia [2] or even the migration of labor within the country resulting in TB outbreaks to be found in each region of Thailand. The preliminary analysis of the data suggested that tuberculosis has a significant tendency to spread in border areas near neighboring countries due to its epidemiological characteristics. This has issues with patients in those locations having access to basic health care systems that aren't currently comprehensive. The findings of this study agree with those of Charoensakulchai *et al* [7], who found that geographic blockades were a major barrier to health care workers (HCW), making it unable to offer comprehensive care for TB patients and resulting in widespread TB outbreaks. Besides, the easily of transmission, the patient with TB infection can be spread through droplets to another person resulting in the rate of spread higher than non-respiratory droplets.

For the public health system, Direct observed treatment is process that WHO recommended to treat the patient with TB positive to solve a drug default problem of TB patient. The DOT was effective for this study. From the result of this study, there was no occurrence of drug defaults patient in correspond with another research of the implementation fidelity of DOT model in Bhutan using the conceptual framework for implementation fidelity. From the research, 48.9% of patients took medicine at home and the rest and 5.8% of patients took medicine at hospital. More than 90% of patient received accurate dosage and standard regimen of anti-TB drugs according to the guideline and 98.6% of patients were satisfied on the quality of TB treatment service delivery. Nevertheless, 45.3% of patients decided not to continue the DOT process due to poor adherence to DOT as perceived by patients were lack of eagerness to go in daily basis because long distance, financial inconvenience, and family help [16]. The same reason was reported by DOTS in other studies, there were various motive that result in low DOTS process in the rural area such as travel costs, illiteracy, poor knowledge of TB, and frequent visits to the clinic [17,18,19,20]. In Thailand the limitation of DOT study was describe by Charoensakulchai et al. [7], the associated factors of unsuccessful pulmonary TB treatment were previously treated TB, existence of comorbid illnesses, DOTS not performed, chest radiography showing multiple lung lesions at first diagnosis, no chest radiography

improvement in the first follow-up and unknown status of chest radiography in the first follow up [7]. Moreover, the unsuccess of pulmonary TB treatment associated with comorbid illnesses condition of patients. Countries with limited resources, the existence of TB with both communicable and noncommunicable diseases is common cases. However, this effort is hard to accomplish in resource-limited countries. Moreover, noncommunicable diseases as diabetes, chronic lung disease, smoking and malnutrition increase individuals' sensitivity to TB [21]. Comorbid illnesses and poor health status of TB patients result in increased mortality rates [22]. Consequently, the providing encouragement of health workers to the patient and a high efficacy of treatment and pursuance of both TB and other comorbid illnesses are required.

Statistical data collection of the TB incidence in Thailand is important to ensure quality planning and implementation of the Ministry of Public Health's plan. According to a case example, community health worker (CHW) conducted suspected, awareness-raising, home visits, case referral, sample collection, and continuous treatment resulting in treatment outcomes, case detection increased within one year. The limitation of this study is the research was examined factors that related to TB only in Sichon district.

5. CONCLUSION

In a case study, the directly observed treatment short-course (DOTS) program in Sichon District Hospital tuberculosis patients discovered that community-based diagnostics screening was more effective than hospital-based screening. Furthermore, while looking at the rate of success, it was discovered that anti-tuberculous therapy administered by a health care worker (HCW) in conjunction with a DOTS treatment program was more effective than patients self-treating the disease. Furthermore, based on the epidemiological characteristics of tuberculosis at a national level, this study found that TB epidemics are most common in health zones near the border and where it is accessed. Geographically, it's a barrier. Migrant laborers and the area's dynamic TB population are likely to be to cause. Furthermore, residents in this area have limited access to primary health care facilities. This makes it tough to keep track of the right treatment. As a result, this study demonstrates that extensive HCW staff monitoring is an effective treatment option for optimizing TB treatment with a DOTS treatment regimen. It's only a challenge to make the personnel management system more efficient, accessible, and comprehensive.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

CONSENT

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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