Cost effectiveness of emergency ambulance services for patients that need cardiopulmonary resuscitation among government hospitals in Chonburi Province.

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A Thesis Submitted in Partial Fulfillment of the Requirements
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ต้นทุนประสิทธิผลของการบริการทางการแพทย์โดยใช้รถฉุกเฉินสำหรับผู้ป่วยที่ต้องทำการปฏิบัติการช่วยฟื้นคืนชีพของโรงพยาบาลรัฐบาลในจังหวัดชลบุรี

นายธีรวัฒน์ วงศ์สุวรรณะทัต

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
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ธีรวัฒน์ วงศ์สุวรรณะทัต : ต้นทุนประสิทธิผลของการบริการทางการแพทย์โดยใช้รถฉุกเฉินสำหรับผู้ป่วยที่ต้องทำการปฏิบัติการช่วยฟื้นคืนชีพของโรงพยาบาลรัฐบาลในจังหวัดชลบุรี (Cost effectiveness of emergency ambulance services for patients that need cardiopulmonary resuscitation among government hospitals in Chonburi Province.) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ดร.นพพล วิทย์วรพงศ์, 72 หน้า.

งานวิจัยนี้มีจุดประสงค์เพื่อหาต้นทุนประสิทธิผลการบริการทางการแพทย์สำหรับผู้ป่วยที่ต้องปฏิบัติการช่วยฟื้นคืนชีพโดยใช้รถฉุกเฉินของโรงพยาบาลสังกัดกระทรวงสาธารณสุขในจังหวัดชลบุรี สำหรับการคิดต้นทุนต่อหน่วยของชุดปฏิบัติการเปรียบเทียบแต่ละโรงพยาบาล งานวิจัยนี้ใช้แบบสำรวจข้อมูลต้นทุนที่เกี่ยวข้องในรถปฏิบัติการการแพทย์ฉุกเฉิน และใช้การคำนวณต้นทุนที่แตกต่างกัน 3 รูปแบบ ในส่วนของประสิทธิผล งานวิจัยนี้ใช้ผลลัพธ์ของชุดปฏิบัติการฉุกเฉินระดับสูงจากฐานข้อมูลในศูนย์ข้อมูลของจังหวัด 4 ประการ ประกอบด้วย ระยะเวลาที่ใช้หลังได้รับคำสั่งปฏิบัติการจนถึงจุดเกิดเหตุ, อัตราการฟื้นคืนชีพในผู้ป่วยภาวะหัวใจหยุดเต้นนอกโรงพยาบาล, การให้สารน้ำในการกู้ชีพผู้ป่วยภาวะหัวใจหยุดเต้น และผลลัพธ์ 30 วันหลังได้รับการรักษาในโรงพยาบาล ข้อมูลทั้งหมดนำมาคำนวณต้นทุนประสิทธิผลและทำการเปรียบเทียบระหว่างโรงพยาบาลที่มีศักยภาพใกล้เคียงกันแต่มีความแตกต่างของสมรรถนะบุคลากร เช่น การเปรียบเทียบระหว่างโรงพยาบาลที่มีแพทย์ หรือพยาบาลที่ผ่านการอบรมหลักสูตรพยาบาลเฉพาะทางฉุกเฉิน หลักสูตร 4 เดือนร่วมออกปฏิบัติการ กับโรงพยาบาลที่ไม่มีบุคลการดังกล่าวร่วมออกปฏิบัติการ. *ผลการวิจัยพบว่า* ต้นทุนต่อหน่วยของแต่ละโรงพยาบาลที่คิดด้วยวิธีการที่แตกต่างกันให้ค่าที่แตกต่างกันมาก โดยความแตกต่างมีค่าถึงประมาณร้อยละ 18.56 ในช่วงระยะเวลาที่ศึกษา มีการปฏิบัติการฉุกเฉินระดับสูงเกิดขึ้น 1,266 ครั้ง มีจำนวนผู้ป่วยที่หัวใจหยุดเต้นและต้องทำการฟื้นคืนชีพนอกโรงพยาบาลจำนวน 195 ราย อัตราการฟื้นคืนชีพในผู้ป่วยภาวะหัวใจหยุดเต้นนอกโรงพยาบาลสำเร็จร้อยละ 88.2 ระยะเวลาตอบสนองต่อคำสั่งปฏิบัติการจนถึงจุดเกิดเหตุ 13.67± 7.61 นาที ความสำเร็จในการให้สารน้ำเพื่อการกู้ชีพผู้ป่วยภาวะหัวใจหยุดเต้นร้อยละ 99.8 จำนวนผู้ป่วยที่ได้รับการกู้ชีพเสียชีวิตหลังรับตัวในโรงพยาบาลใน 30 วัน ร้อยละ 13.37 และพบว่า เมื่อเปรียบเทียบโรงพยาบาลที่มีและไม่มีพยาบาลเฉพาะทางฉุกเฉิน และที่มีและไม่มีแพทย์ร่วมออกปฏิบัติการ อัตราส่วนต้นทุนประสิทธิผลส่วนเพิ่มในการช่วยฟื้นคืนชีพผู้ป่วยของบุคลากรที่ออกปฏิบัติงานมีความใกล้เคียงกัน ผลการศึกษานี้ชี้ให้เห็นถึงช่องว่างของการบริหารต้นทุน และโอกาสในการเพิ่มประสิทธิผลด้วยการจัดสรรบุคลากรที่มีหน้าที่และวิชาชีพเหมาะสมกับต้นทุนการปฏิบัติงานให้ดียิ่งขึ้นในอนาคต

สาขาวิชา เศรษฐศาสตร์สาธารณสุขและการจัดการบริการสุขภาพ ลายมือชื่อนิสิต .....

ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

ปีการศึกษา 2559

5985570629 : MAJOR HEALTH ECONOMICS AND HEALTH CARE MANAGEMENT
KEYWORDS: AMBULANCE SERVICE / ADVANCED LIFE SUPPORT / COST EFFECTIVENESS ,ALS / COST / OUT-HOSPITAL-CARDIAC-ARREST / RESPONSE TIME

TEERAWAT WONGSUWANNATAT: Cost effectiveness of emergency ambulance services for patients that need cardiopulmonary resuscitation among government hospitals in Chonburi Province.. ADVISOR: ASST. PROF. NOPPHOL WITVORAPONG, Ph.D., 72 pp.

This study aimed to find the cost effectiveness ratio of Advanced Life Support (ALS) ambulance units for patients that needed cardiopulmonary resuscitation (CPR) provided by government hospitals in Chonburi province. Based on a direct survey and secondary data from the province-level ALS database, unit costs were calculated in three ways, using three sets of assumptions. Four measures of effectiveness of ALS ambulance operations were used. The data were used to finally calculate the cost-effectiveness ratio, comparing hospitals with the same level of competency but with some practice variation, e.g. comparing hospitals that included a medical doctor and a nurse with a 4-month emergency specialty training as part of the ALS unit with those that did not. *Results showed* the calculation of unit costs was sensitive to the methodology, and the difference of unit cost values from different methodologies may be as high as 18.56%. The total number ALS operations during the study period were 1,266 times. Among them, there were 195 CPR cases. The success rate of cardiopulmonary resuscitation was 88.2%, the average response time was 13.67± 7.61 minutes, the success rate of intravenous fluid was 99.8% and the ratio of deaths within 30 days after the admission was 13.37%. Through incremental cost effectiveness ratio (ICER) analyses, the results suggested that comparing hospitals with a medical doctor in the ALS unit with those without a medical doctor, an increase of 1% in terms of the CPR success would lead to an additional (incremental) cost of 1,644.4 baht. The rates of CPR success between hospitals with a specialty emergency nurse on the ALS team or without were not different. This study highlighted some gaps in the ALS organization that could lead to further cost-saving and recommended that to increase the effectiveness of the operation, human capital management, where appropriate functions are assigned to the right personnel, would be crucial.

Field of Study: Health Economics and Health Care Management Student's Signature .....
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Chapter 1: Introduction

1.1 Problem and significance

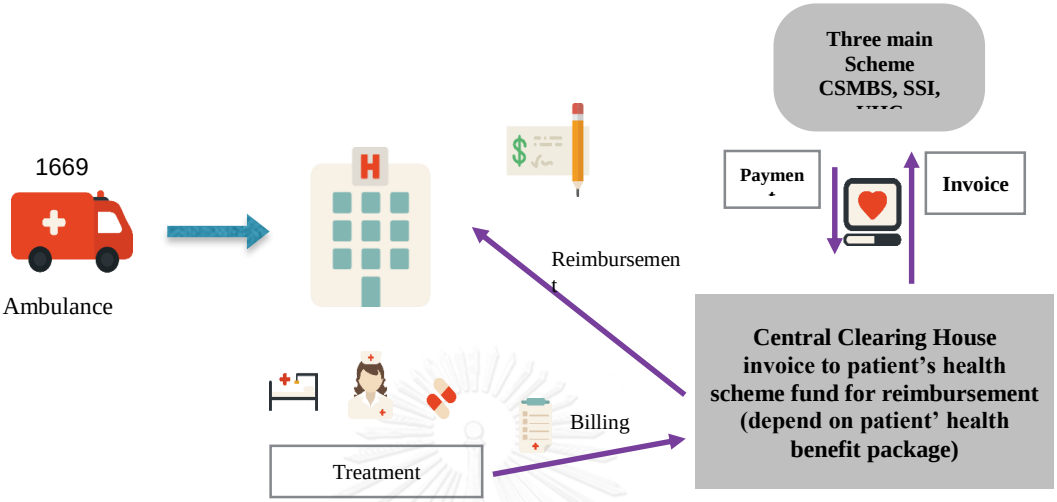
The Thai Ministry of Public Health and the National Institute of Emergency Medical Services provide a definition of Emergency medical services such that "*Emergency medical services are defined as the operations that start from realizing the patient's condition and treating them until the condition passes on from the emergency state. The services include patient evaluation, management, coordination, control, communication, transportation, diagnosis and case management in and outside hospitals*" (Pongpisut Jongudomsuk et al., 2015)

The emergency medical system (EMS) aims to increase the competency of services, decrease the cost burden for both patients and health care providers and use limited resources effectively. It includes the promotion of emergency operation call center (the 1669 Hotline), the provision of human development training, the provision of more necessary equipment, patient transportation and prehospital ambulatory care. In 2012, the Ministry of Public Health attempted to expand the availability of emergency services and to reduce the payment burden on patients through the passing of an act by the parliament about emergency services, issuing a policy of *"Free services (i.e., no payment) in whatever emergency condition"*. Here, the Ministry cooperated with all public and some volunteer private hospitals in Thailand (Pongpisut Jongudomsuk et al., 2015).

One of the more important activities of the EMS is patient transportation or prehospital ambulatory care. In the case of high severity of illness, the system requires a high-competency medical team to provide Advanced Life Support (ALS). The ALS team is comprised of life saving medical facilities, essential medications, an emergency medical physician, emergency nurses and an emergency medical technician. Most ALS ambulances are provided only by hospitals (as opposed to outpatient patients) due

to the required level of provider competency and the required adequacy of equipment and associated facilities.(Monsomboon et al., 2015)

Figure 1: Clearing House System for Emergency Medical Services



Currently, Thailand has three main schemes of public health insurance: Universal Health Coverage Schemes (UHCS or UHC), Social Security Scheme (SSS) and Civil Servant Medical Benefit Scheme (CSMBS). It has been found that there is a difference across schemes in terms of accessibility due to differences within the system, e.g. health benefits, transportation fees, the (provider) reimbursement rate and the number of visits per year. If an emergency medical condition occurs to a pre-authorized UHC patient, he/she will be able go to any government hospital or a registered private hospital without limitations on usage (Suriyawongpaisal, Tansirisithikul, Srithamrongsawat, & Sirinart, 2012). On the other hand, for SSI patients, the emergency condition is identified by the severity of illness and if the symptom is classified as mild to moderate with a stable condition, then SSI patients may receive an emergency treatment (with a limitation of the utilization of OP and IP services for 2 times per year) at their registered hospitals or may be rejected for medical services at all. However, if SSI patients have a moderate to severe medical condition then they will be able to receive all necessary treatment without having to visit their registered health affiliation (Sirinart, Orawan, & Thaworn, 2013). For CSMBS beneficiaries, if an emergency health condition occurs, then they can receive emergency treatment both OP and IP services at every government hospital, but will only covered for IP services

at private hospitals (Sirinart et al., 2013) . The Comptroller General's Department (CGD) manages the reimbursement to providers by direct payment at a standard price of the CGD's rate. For all emergency medical conditions that are not included in the health benefit criteria of the three main schemes or that are provided in private hospitals, then the patient needs to pay out-of-pocket (NIEMS, 2016) .

The three public health insurance schemes have a dissimilar reimbursement rate for emergency medical services, managed under the centralized clearing house system as shown in Figure 1.1. Under CSMBS, the Comptroller General's Department implements a direct payment system under an emergency intervention list within a regular period to the government hospitals and a direct payment system with a fixed ceiling of 4,000 baht for emergency cases with an OP treatment for private hospitals (Sirinart et al., 2013). Under SSS, if an emergency patient receives a treatment from public hospitals within the first 72 hours, then the patient's health affiliation would be responsible for all expenses and needs to transfer the patient to their own network after 72 hours, whereas for a given OP treatment at a non-affiliated private hospital, the fixed ceiling of 1,000 baht applies (Sirinart et al., 2013).

Under UHCS, when an emergency medical illness occurs, if the patient went to a facility in their registered health district area, then the National Health Security Office would pay for the charge in an out-patient case but if they visit a facility out of their registered area and need an in-patient treatment, then the UHC global budget payment and the DRG reimbursement system would be used (depending on each specific condition) (Sirinart et al., 2013). From the provider's perspective, it has been argued that the reimbursement system is inappropriate due to insufficient information and the difference between the reimbursement rate and cost of production, which might generate a financial loss to the provider.

Nowadays, knowing the actual cost of emergency medical services has become a major research topic worldwide. In the US, emergency medical departments have been referred to as "the most expensive place of all", as said by President Bill Clinton (Clinton, 1993). More than half of patients who visited an Emergency Medical Department only had a minor or non-urgent medical condition but were willing to pay twice or three times as much as normal physician visits during office hours

(Cunningham, 2011). This patient behavior generates economic losses and inefficiency as the number of patients surges every year (McCaig, 1994)(In the European Union, where people are interconnected, emergency medical services are quite complicated because of differences in the emergency health care (EHC) system across countries and regions (Beltrame, Maryni, & Orsi, 1998), which then lead to high economic losses, low accessibility of services and a mismatch of health care data in terms of health outcomes. The European Union is making an effort to implement the Worldwide Emergency Telemedicine Services (WETS) to reduce incompatibilities of health care data, to improve and optimize health care resources and to properly evaluate health care costing (Beltrame et al., 1998).

In Thailand, studies on costs of emergency medical services are scarce. In 2015, International Health Public and Policy (IHPP) and National Institute of Emergency Medicine (NIEMS) published a full report of cost emergency medical services (Chiangchaisakulthai et al., 2016), in response to the fact that the utilization rate for the emergency department is sharply increasing every year. Although the Ministry of Public Health allocates the budget for emergency medical services but the cost of emergency medical service needs to be evaluated properly in order to aid resource reallocation and improve sustainability of the health system.

In Chonburi, the health system is made up with various insurance schemes. The Universal Health Coverage Scheme is the largest health insurance scheme, covering approximately 63% of the province's population, followed by the Social Security Scheme (17%), and the Civil Servant Medical Benefit Scheme (6.1%). The rest pays out-of-pocket; this group includes foreign workers, travelers, migrant workers and individuals with an unidentified health insurance coverage (Retrieved from http://hdc2.cbo.moph.go.th, on 20 May 2016).

In this study, Chonburi province is used as the study area. It is argued that that the provision of emergency medical services in Chonburi is largely similar to the rest of Thailand and is therefore representative. In Thailand in general, almost all operation centers are situated at the provincial hospital. They function to control emergency cases, make a decision on the operation, collect emergency operation data, report the workflow and coordinate with the provincial public health office to come up with a

proper management of the emergency operation. Likewise, in Chonburi province, the emergency operation center is situated at Chonburi Provincial Hospital and it functions in accordance with the national assignment guidelines.

However, Chonburi is also a unique case in terms of its EMS management. Because of the insufficiency in human capital for the management of emergency events, the provincial public health office has attempted to implement a new workflow to improve the services while reducing the cost of operation at the same time. Chonburi has divided the network of emergency medical services into four zones by geographical areas based on the location of the main roads. Each zone is covered by a tertiary hospital. This is to decentralize the operation, make the service delivery more focused, elicit a more cooperative response within the zone, reduce cost, generate a cross-audit program (with regard to data on emergency cases) and to improve quality of services.

It should be noted that, in Thailand, there are two main ambulance services: Advanced Life Support ambulance services (ALS) which require hospital-based resources and Basic Life Support (include First Responder) ambulance services that are non-hospital based and provide only transportation and immobilization (Monsomboon et al., 2015). This study is interested in only ALS ambulance services because ALS operation provides essential care for life-threatening patients, requires as share of hospital workforces and in general imposes a higher cost on the hospital service system than the Basic Life Support.

1.2 Research question

Primary questions

- What is the cost of providing Advanced Life Support (ALS) emergency ambulance services among government hospitals in Chonburi?

- What is the level of cost effectiveness of Advanced Life Support (ALS) emergency ambulance services for patients that need cardiopulmonary resuscitation among government hospitals in Chonburi?

Secondary questions

- How does the cost effectiveness level differ between government hospitals with a high ratio of trained nurses and government hospitals with a low ratio of trained nurses?
- Do human development programs improve the cost effectiveness of Advanced Life Support (ALS) emergency ambulance services among government hospitals in Chonburi?

1.3 Research objectives

General objectives

- To identify, from the provider's perspective, the cost of Advanced Life Support (ALS) emergency ambulance services for different levels of government hospitals in Chonburi province.
- To identify, from the provider's perspective, the level of cost effectiveness of Advanced Life Support (ALS) emergency ambulance services for different levels of government hospitals in Chonburi province.

Specific objectives

- To quantity unit costs of Advanced Life Support (ALS) emergency ambulance services of government hospitals of different sizes.
- To determine the level of effectiveness of ALS emergency ambulance services in terms of successes with CPR and resuscitation in the case of Out-Hospital-Cardiac-Arrest for different types of health care providers.

- To estimate the cost effectiveness of Advanced Life Support operations for patients that need cardiopulmonary resuscitation, based on different outcomes, including the response time, the Out-Hospital-Cardiac-Arrest incidence and Intravenous fluid therapies.
- To calculate the Incremental Cost Effectiveness Ratio based on the difference in the types of health personnel involved in the Advanced Life Support operation for patients that need cardiopulmonary resuscitation, including

  (1) the comparison between an ALS unit with a medical doctor and without a medical doctor.

  (2) the comparison between an ALS unit with nurses with the four-months EMS training certificate and without.

1.4 Expected benefits

After knowing the cost of emergency medical services, particularly the cost for Advanced Life Support (ALS) emergency services provided by government hospitals in Chonburi province, it is possible to form suggestions regarding the government's budget allocation, the identification of appropriate reimbursement rates, the importance of human resource development planning, a potential reform of an emergency medical network and the improvement of the care process in order to improve efficiency within the system.

Chapter 2: Background

2.1 Background of Thailand

Thailand is in South-East Asia. The total area is around 514,000 sq. km (198,456 sq. mi) and has the border on the northwest and the west with Myanmar, on the north and the East with Laos, on the southeast with Cambodia and on the south, including the gulf of Thailand, with Malaysia. The total population in December 2015 was 67,959,000 [1]. The population density is 134 per Km^2 (346 people per mi^2) with a 0.22% year-growth rate. Approximately 7% of the population was over 65 years of age, with another 23% under 15 years of age. There were 96 males for every 100 females in the country. About 31% lived in an urban area, according to the UN [2].

2.2 Health system in Thailand

The Ministry of Public Health of Thailand (MOPH) is the national health authority responsible for formulating and implementing health policy. In 2001, after the complete establishment of the National Health Security Office, the MOPH's role has changed; several autonomous health agencies have been established through legislations. Since 2002, the universal health coverage (UHC) has been achieved; it "*means that all people and communities can use the promotive, preventive, curative, rehabilitative and palliative health services they need, of sufficient quality to be effective, while also ensuring that the use of these services does not expose the user to financial hardship*.[3]"

The Universal Health Coverage has been supported almost entirely by government tax expenditures. Since 2002, the total health expenditure (THE) relative to Gross Domestic Product (GDP) has been sharply increasing from 170,203 million baths (in 2001) to 512,338 million baths (in 2012) whereas the private expenditure as

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[1] http://www.who.int/countries/tha/en/

[2] http://data.un.org/CountryProfile.aspx?crName=THAILAND#Summary

[3] http://www.who.int/health_financing/universal_coverage_definition/en/

proportion of Total Health Expenditure has dramatically declined from 44% to 24% over the past decade. The THE as a proportion of GDP has been increasing from 3.7% to 4.5%, with public expenditure gradually increasing from 65% in 2002 to 76% in 2012. Furthermore, the THE per capita has surged from 3,211 baths per capita to 7,949 bath per capita in over a decade. Considering the health spending profile, from 2002-2012, spending on inpatient care has increased from 30.2 % to 34.3 % and health spending for outpatient care has decreased from 43.8% to 29.8%.

Table 1: Total health expenditures in Thailand in 1994-2002

Indicator	2000	2001	2002	2005	2008	2009	2010	2011	2012
Total Health Expenditure (thousand million baht)	167.1	170.2	201.6	251.6	360.2	377.2	392.3	434.2	512.3
THE as proportion of GDP	3.4%	3.3%	3.7%	3.5%	4.0%	4.2%	3.9%	4.1%	4.5%
Public expenditure proportion of GDP	56%	56%	63%	64%	76%	74%	75%	77%	76%
Private Expenditure proportion of GDP	44%	44%	37%	36%	24%	26%	25%	23%	24%
THE per capita (Baht per capita)	2,701	2,732	3,211	4,032	5,683	5,938	6,142	6,777	7,949
Exchange rate (baht per 1$)	40	44	43	40	33	34	32	30	31

Source: (Pongpisut Jongudomsuk et al., 2015)

Table 2: The health care spending profile in percentage of Total Health Expenditure

	2000	2001	2002	2005	2008	2009	2010	2011	2012
Inpatient care	30.8	32.6	30.2	33.8	36.2	31	30.4	31.9	34.3
Outpatient care	40.7	40.3	43.8	43.3	42.3	41.2	42.1	40.6	29.2
Medical goods	6.3	6.1	4.0	4.3	4.4	4.9	5.2	4.9	5.8
Prevention public health service	8.2	8.0	12.4	4.9	4.5	9.7	10.3	9.4	6.2
Health administration	7.9	7.9	4.8	8.9	6.8	7.3	7.2	5.9	12.6
Total recurrent	94.1	95	95.4	95.6	94.4	94.2	95.3	92.9	88.4
Gross capital formation	5.9	5.0	4.6	4.4	5.6	5.8	4.8	7.1	11.6
THE	100	100	100	100	100	100	100	100	100

Source: (Pongpisut Jongudomsuk et al., 2015)

Thailand has three main schemes of health insurance: Universal Health Coverage Scheme (UHCS or UHC), Social Security Scheme (SSS) and Civil Servant Medical Benefit Scheme (CSMBS). Universal Health Coverage Scheme (UHCS or UHC) covers almost 75% of all Thai population with full financial coverage from the Thai government's annual budget; almost the entire budget comes from general taxation expenditure and is managed by the National Health Security Office (NHSO). It is provided to all Thai people who are not covered under the Social Security Scheme (SSS) or the Civil Servant Medical Benefit Scheme (CSMBS). The UHC's benefit package comprises a comprehensive set of curative and rehabilitation services as well as prevention and promotion services which are managed by NHSO for all Thai citizens. The payment method is a combination of capitation for outpatient services and DRG and global budget for inpatients services (Pongpisut Jongudomsuk et al., 2015).

The second main scheme, Social Security Scheme (SSS), covers approximately 10 million people in Thailand (almost 10%). It is provided to formal sector employees but not their dependents, except for maternity benefits. The source of funding coming from three parties: employees, employers and the government with a contribution of

1.5% from each party up to a 15,000 baht ceiling (US$ 500). The SSS financial matters are managed by the Social Security Office under the Ministry of Labor. They contract with both public and private hospitals (with only over 100 beds) that are matched according to the contract requirement criteria. The main benefit package of Social Security Scheme is a comprehensive curative and rehabilitation package, without prevention and health promotion services. The provider payment method is capitation inclusive for both outpatient and inpatient services, but inpatient services are attached with an additional pay for high DRG weights hard budget (Sirinart et al., 2013).

The final scheme, the Civil Servant Medical Benefit Scheme (CSMBS), covers about 8% of the population, including Thai government officers and their families (both parents and children under 20 years old). It is financed by general taxation under the management of Comptroller General's Department (CGD), the Ministry of Finance. The CSMBS provides free health services in public hospitals and, for private hospitals, only emergency services are free. The benefit package includes comprehensive curative and rehabilitation services without prevention and health promotion services. The payment method for outpatient services is Fee-for-service with direct reimbursement to providers, and DRG for inpatient services (Sirinart et al., 2013).

2.3 Emergency medical services in Thailand

Emergency medical services in Thailand started in 1937 by the Por-Tek-Teung foundation, whose main objective was to transport patients to the hospital by means of charity. In 1993, the Ministry of Public Health (MOPH) received technical assistance from Japan International Cooperation Agency (JICA) in order to establish an Accidental Center (known also as the Trauma Center) at the Faculty of Medicine, Khon Kaen University. It also covered pre-hospital services. Later, Vajira hospital provided emergency ambulance services, called SMART (Surgico-Medical Ambulance and Rescue Team) in B.E. 2537 (1994), following the Accidental Prevention Plan of the Metropolitan of Bangkok (Retrieved from http://www.NIEMS.go.th, on 16 May 2017). The Ministry of Public Health then launched pre-hospital medical treatment at Rajavithi Hospital in B.E. 2538 (1995), called “The Rescue Narenthorn Center”. Nopparat

Rajathanee and Lerdsin Hospital were also part of the network (Retrieved from http://www.NIEMS.go.th, on 16 May 2017).

In 2004, after the Tsunami attack in many provinces in the Southern region, there were major changes in terms of the process of management for emergency care, mass casualty response and rescue team. The Ministry also created new job positions for emergency medical providers through programs such as emergency physician training, emergency nurse training short course (the four-month program) and emergency medical technician basic and intermediate level training (Retrieved from http://www.NIEMS.go.th, on 16 May 2017).

Subsequently, the Ministry of Public Health established the Office of Emergency Medical Services System under the Office of the Permanent Secretary for Public Health. It has since continuously developed the system. Finally, the Office's role expanded and it became the "National Institute for Emergency Medicine (NIEMS)" in 2008, after which it has been responsible for the administrative management and coordination between relevant agencies, both public and private sectors, including the promotion of local governments to play a role in the management of emergency medical services (Retrieved from http://www.niemsNIEMS.go.th, on 16 May 2017). This organization is considered the juristic person of the state, an entity under the supervision of the Minister of Public Health. The purpose is to have an efficient administration and policy management of medical emergencies and to implement policies of the Committee of the Emergency Medicine effectively. As a result, emergency patients have been guaranteed the right to access the emergency medical system with an equal standard of quality. Providing these rights to patients is integral to the Emergency Medical Act of B.E. 2551 (2008) (Retrieved from http://www.niemsNIEMS.go.th, on 16 May 2017).

In Thailand, there has been an interest in the comparison between costing and reimbursement in light of treatment outcomes and cost effectiveness, especially after the establishment of the National Institute of Emergency Medicine (NIEMS) in 2008 whose purposes are to develop and evaluate policy for emergency medical care, to create human resource development program, to undertake the EMS financial

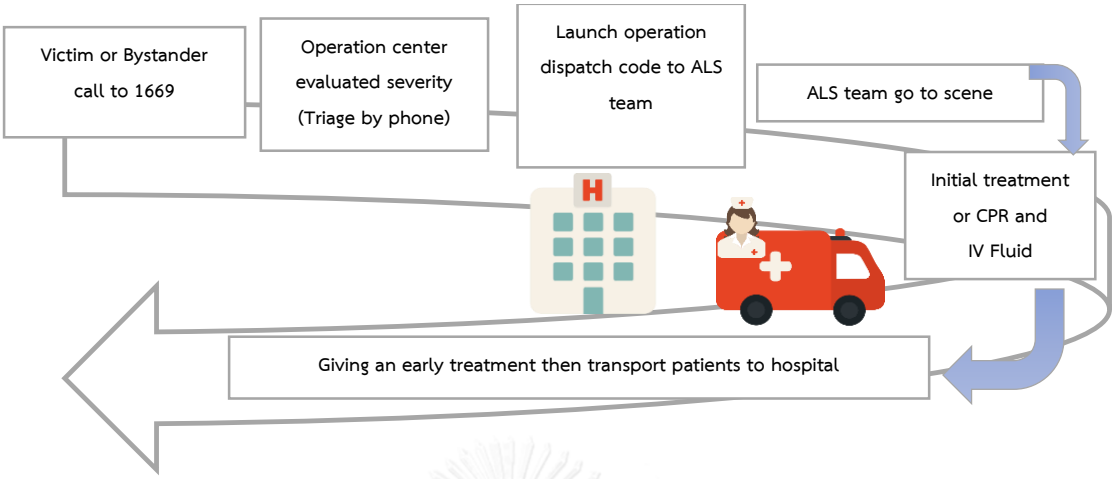
management, and to reduce inequity of emergency medical services (Retrieved from http://www.NIEMS.go.th, on 16 may 2017).

Emergency medical services are comprised of two main activities: pre-hospital care and in-hospital care at the emergency department. Focusing on pre-hospital emergency services, according to the NIEMS, there are different levels of ambulance emergency care, classified based on dimensions of health personal competency, medical equipment and vehicle performance (Sinthavalai, Memongkol, Patthanaprechawong, Viriyanantavong, & Choosuk, 2009).

Advanced Life Support (ALS) refers to sophisticated prehospital care with higher performance and competency, which uses invasive life support, a manual defibrillator (Non-AED installed), essential life-saving medications and advanced airway. The vehicle used in ALS is either a ground ambulance (GA) or a form of aeromedical transportation. It might be comprised of a medical doctor, nurses or a paramedic and an emergency medical technician (Ryynänen, Iirola, Reitala, Pälve, & Malmivaara, 2010). Basic Life Support (BLS) is composed of a nurse or an emergency medical technician, whose role is mainly to stabilize patients, evaluate and maintain vital functions until the patients have been transported to an appropriate emergency medical center. A First Responder (FR unit generally refers to local firemen, police, volunteers and registered emergency foundation memberships, responsible for carrying out emergency management efforts. The main functions of FR are scene protection, patient stabilization and general assistance following emergency events (Hughes & Palen, 2012).

In this study, the focus is on ALS emergency ambulance services. The ALS service provides hospital-based ambulance services whose costs and benefits should be evaluated to adjust and improve the efficacy, resource allocation, human capital management and cost saving. These services are used for essential care for life-threatening patients, and consume hospital resources (including, e.g., a practical nurse, emergency medical technicians and a driver).

Figure 2: Workflow of Advanced Life Support operation



2.4. Emergency medical budget in Thailand

Since 2008, after the establishment of the National Institute of Emergency Medicine (NIEMS), the annual budget for emergency medical services has been slightly increasing (Pongpisut Jongudomsuk et al., 2015). For emergency medical services which include pre-hospital acute medical care, patient transportation, and treatment at the emergency room (Sittichanbuncha, Prachanukool, & Sarathep, 2014), the NIEMS receives an annual budget from the National Health Security Office (NHSO) in order to manage the finances for the development of the EMS system, the provision of performance On-TOP payment, operation reimbursements and to provide human resource development or training program (Khrongkhan, 2015). The NIEMS's size of annual budget depends on actual operational costs from the prior year, which raises a question as to the appropriateness as the number of emergency cases rises every year. Currently the NIEMS receives an estimated 525 baht per EMS operation, which has been found to be insufficient, leading for the NIEMS to have to always ask for extra budget from other insurance funds almost every year (Khrongkhan, 2015). Further information is provided in Table 3.

Table 3 shows sources and information of emergency medical services in Thailand. It should be noted that sometimes the National Institute of Emergency Medicine receives an extra budget from the EMS Central Funding if it faces a budget shortage.

Table 3: Details of budget for EMS from the government

Year	Annual budget (million baht)	Extra budget from EMS Central Funding (million baht)	Total budget (million baht)	Targets of operation	Actual number of operation	Cost per operation	Change
2010	390.25	122.25	512.5	700,000	1,063,062	428.09	-
2011	525.0	-	525	1,000,000	1,212,875	432.86	-10.21
2012	567	12.9	579.99	1,060,000	1,473,877	393.52	-9.09
2013	773.88	168	941.88	1,212,800	1,363,438	690.81	75.55
2014	880	-	880	1,473,880	1,277,710	688.73	-0.30

Source: (Khrongkhan, 2015)

2.5 Chonburi and emergency medical services in Chonburi

Chonburi is a province that is approximately 80 kilometers away from Bangkok, located in the Eastern region of Thailand, which comprises 7 provinces (Chachengsao, Prachinburi, Sakaew, Chonburi, Rayong, Chataburi, Trat). Chonburi has an area of 4,363 sq km (0.85% of all of Thailand). This province is divided into 11 districts, 92 sub-districts and 687 villages and the Pattaya metropolitan area. The population in 2016 was 1,455,039 with 712,875 males and 742,164 females (49%: 51%), and the population density was around 333 people per sq.km. Each of the Chonburi's 11 districts has its own community hospital under the management and control of Chonburi Provincial Public Office, and they are members of the sixth regional health district. The total number of public hospitals in the province is 12 and they provide different levels of medical services, as detailed in Table 4. These hospitals are categorized in terms of the level of services provided (ChonburiProvincialPublicHealthOfficer, 2017).

Table 4: List of public (MOPH) hospitals in Chonburi

Classification of hospitals and definitions	Abbreviation	Number of beds	Level of EMS provided	Amount / Name
Advanced Level: High competency hospitals which provide services of complicated cases by sophisticated technology. Their missions include not only medical services but also services of medical education, research and act as a referral center.	A-Level	825	ALS	1 / Chonburi Provincial Hospital
Standard Level: General hospitals which provide services for complicated cases and can act as a referral center.	S-Level	250	ALS	1/ Banglamung general Hospital
Middle Level: Hospitals which comprise of major specialties (Obstetrics-Surgery-Medicine-Pediatrics-Orhtopaedics-anethesitologist and at least 3-5 family medicine doctors)	$M2^{+}$-Level	200	ALS	1/ Phanus nikom Hospital
	M2-Level	90	ALS	2/ Laem Chabang hospital (160), Banbung Hospital (120)
First Level: Hospitals which comprise only a General Practitioner or 1-3 of family medicine doctors.	F1-Level	90/60	ALS	2/ Satahep Hospital (60) and Panthong Hospital (60)
	F2-Level	60/30	ALS	4/ Bo thong hospital (60), Nongyai hospital (60), Ko Sichang Hospital (30), Wat Yanasangwanaram Hospital (30)
	F3-Level	30	ALS	1/ Ko chan Hospital
Total		1,675		

Source:http://phdb.moph.go.th/phdb/admin/files/userfiles/files/8article_20130904140619.pdf Department of Health Service Support, Ministry of Public Health, Thailand (Retrieved on 18 May 2017).

Moreover, the province also has six other government hospitals that are not under the MOPH, 14 private hospitals and 485 registered private clinics. The list of non-MOPH pubic hospitals is provided in Table 5.

Table 5: List of non-MOPH hospitals

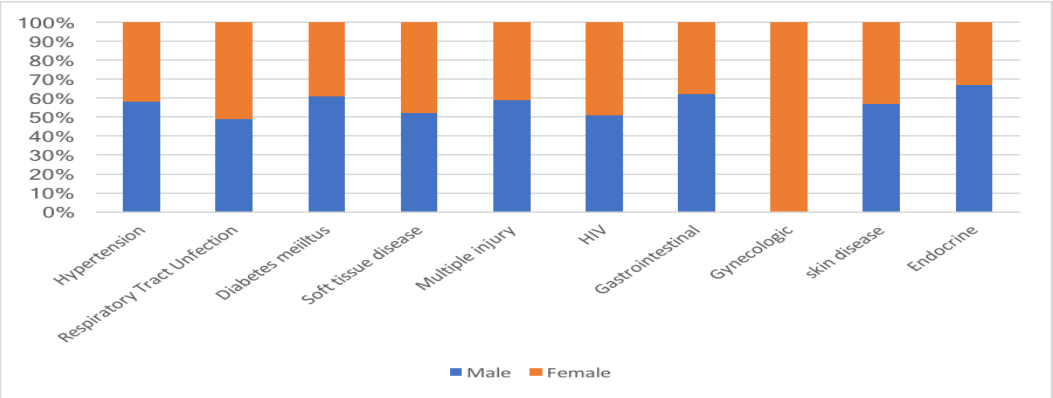
Name	Number of beds	Hospital classification	Level of EMS provided
Queen savang wattana memorial (Thai Red-Cross)	411	Tertiary Level	ALS
Queen Sirikit Naval Hospital (Royal Thai Navy's)	420	Tertiary Level	ALS
Arpakorn Kiatiwong hospital (Royal Thai Navy, based at Sattahip's district)	151	Tertiary Level	ALS
Navaminrachutit Hospital (Royal Thai Army)	30	Primary level	ALS
Burapa Hospital (Burapa University, Ministry of Education)	100	Tertiary Level	ALS
Pattaya city hospital	110	Tertiary Level	ALS

Source: (ChonburiProvincialPublicHealthOfficer, 2017)

However, the non-MOPH hospitals in Table 5 are not included in the study because of the differences in the accounting/ data recording systems and some organizational characteristics.

The population in Chonburi Province is covered by various insurance schemes. The Universal Health Coverage Scheme is the largest health insurance scheme, covering approximately 63% of the province's population, followed by the Social Security Scheme (17%), and the Civil Servant Medical Benefit Scheme (6.1%). The rest pays out-of-pocket; this group includes foreign workers, travelers, migrant workers and individuals with an unidentified health insurance coverage (ChonburiProvincialPublicHealthOfficer, 2017). In 2016, common causes of illness among the Chonburi population included hypertension, respiratory tract infection, diabetes, soft tissue infection, traumatic injury and HIV.

Figure 3: Top ten causes for outpatient visits in Chonburi Province in 2016



Source: (ChonburiProvincialPublicHealthOfficer, 2017) figure reproduce by author

The provision of emergency medical services in Thailand in general and Chonburi in particular are similar. In Thailand, almost all emergency operation centers are situated at the provincial hospital. They function to control emergency cases, decide on the operation plan, collect emergency operation data, report the workflow and coordinate with the provincial public health office for the management related to emergency operation. Likewise, in Chonburi province, the emergency operation center is situated at Chonburi Provincial Hospital. It mainly functions in accordance with the national guidelines.

However, in Chonburi, because of the insufficiency in human capital for the management of emergency events, the provincial public health office has attempted to implement a new workflow to improve the services while reducing the cost of operation at the same time. Chonburi has divided the network of emergency medical services into four zones by geographical areas based on the location of the main roads. Each zone is covered by a tertiary hospital (M-Level or above). This is to decentralize the operation, make the service delivery more focused, elicit a more cooperative response within the zone, reduce cost, generate a cross-audit program (with regard to data on emergency cases) and to improve quality of services. Details of the four emergency zones are provided in Table 6.

Table 6: Network of emergency medical services in Chonburi

Zone	Responsible hospital	Level of EMS provided	Districts area's responsibility	Road code
1	Chonburi Provincial Hospital	ALS	Ban Bung, Nongyai, Panthong	3318
2	Phanus Nikom Hospital	ALS	Phanus Nikom, Kochan, Bo thong	349
3	Queen Savang Wattana Memorial hospital	ALS	Sri Racha, Banglamung	36
4	Arpakorn Kiatiwong Hospital	ALS	Sattahep, one subdistrict of Bang lamung	332

Source: (ChonburiProvincialPublicHealthOfficer, 2017)

Based on the above information, the Chonburi Provincial Health Office creates zones for emergency services, undertakes a network management and receives cooperation from hospitals (tertiary level) that are not affiliated with the Ministry of Public Health such as the Queen savang wattana memorial hospital and the Arpakorn Kiatiwong hospital to be a host of zone 3 and zone 4 (both are not included in this study).

It can be seen that it is complicated to calculate the cost and cost-effectiveness ratio of emergency care because of the complex network of health providers and uncertainty in terms of health outcomes. Nowadays, as evidenced by the surge in total health expenditure, there seems to be a mismatch of usage of health facilities in the emergency department, which then creates a burden for patients and increases perhaps unnecessarily workload for health care providers. Costing analysis in emergency medical services must be performed correctly to find the cost of production, identify appropriate cost and cost-effectiveness measures and assist policymakers to allocate resources more proportionately in order to improve the quality of services.

Chapter 3 Literature review

This chapter discusses the concepts of costs and effectiveness related to emergency ambulance services.

3.1 Cost definitions

Cost is the value of resources used to produce something such as a specific health care service in health care perspective. The costing method involves a classification of inputs into two main categories: (1) resources/ inputs which are used up within a year and are purchased regularly (i.e. recurrent costs) and (2) inputs that last longer than one year, such as buildings, vehicles and equipment (i.e. capital costs). It may involve identifying cost centers and then calculating direct and indirect costs. Direct costs refer to the end point of the production process (Kadama, 1990). Indirect costs refer to general services, mostly in the form of overheads such as administration and transportation, while intermediate costs are from cost centers that provide diagnostic and departmental support, such as the pharmacy department, the radiology department and laboratory (and sometimes they can also be defined as direct cost depend on what is the cost center (Ojo, Foley, Renner, & Kamara, 1995).

Unit cost is derived from the calculation of the total cost divided by units of services produced (Conteh & Walker, 2004). Unit cost is the cost of a single unit of good or service. The unit cost calculation begins with identifying cost centers, followed by a unit cost analysis (Riewpaiboon, Malaroje, & Kongsawatt, 2007; Tisayaticom, Patcharanarumol, & Tangcharoensathien, 2001). The standard costing method consists of five steps: (1) organization analysis and cost center classification; (2) direct cost determination; (3) indirect cost determination; (4) full cost determination; and (5) calculating unit cost of medical services (Drummond, Sculpher, Claxton, Stoddart, & Torrance, 2015). Information regarding unit cost is important for hospital administrators or policymakers to make decisions for planning, budgeting, controlling and assessing the organization (Newbrander, Barnum, Kutzin, & Organization, 1992; Shepard, Hodgkin, & Anthony, 2000).

3.2 Costs of emergency medical services

The literature on costs and cost-effectiveness of emergency medical services are scarce. Emergency medical services are comprised of two main activities, pre-hospital care and in-hospital care at the emergency department. The focus is on pre-hospital care, which has been defined as “the care provided in the community (at home, school, work or recreation area) until the patient arrives at a formal health- care facility capable of providing definitive care” (Kobusingye et al., 2005).

Prehospital emergency medical services (EMS) systems are particularly in need of effectiveness evaluations. Most prehospital interventions are not supported by good evidence of improved patient outcomes due to the difficulty in data collection and in setting an indicator to evaluate the patient’s condition in the process (McLean, Maio, Spaite, & Garrison, 2002).

In United States, Lerner, Maio, Garrison, Spaite, & Nichol (2006) collected data of out-of-hospital Emergency Care based on relevant publications between 1966 and 2003 (Lerner, Maio, Garrison, Spaite, & Nichol, 2006). They defined “out-of-hospital emergency care” as an acute, unscheduled health care delivered outside the hospital by a system that utilizes health resources in response to calls to a public safety answering point (McLean et al., 2002). They suggested a methodology to analyze EMS costs such that it should follow guidelines for the standardization of economic analysis (Shepard et al., 2000), such as those suggested by the Panel on Cost-effectiveness in Health and Medicine (Garber & Phelps, 1997). Furthermore, the authors suggested that there is a need for a conceptual framework specific to EMS to assist EMS researchers in designing and reporting economic evaluations, realizing the complexities of the issue (Lerner, Nichol, Spaite, Garrison, & Maio, 2007).

In Thailand, in 2015, International Health Public and Policy (IHPP) published a report on emergency medical costs and reimbursement rates. The authors calculated a unit cost of emergency medical operation, collecting data from 12 provinces (10 operational centers controlled by Provincial hospitals under Provincial Public offices and two other operation centers under Provincial administrations) (Chiangchaisakulthai et al., 2016). The International Health Public and Policy (IHPP) and the National Institute

of Emergency Medical (NIEMS) calculated the average cost of production for different levels of EMS operation. The results are shown in the following table 7.

Table 7: Average costs of production for different levels of EMS operation

Level of operation	Labor cost	Fuel	Medical supply	Material cost	Communication	Capital cost	Total
ALS	219.39	101.53	225.50	148.03	9	350.32	836.72
BLS	83.5	101.53	49.5	115.60	9	148.34	556.21
FR	57	101.53	117.76	135.52	9	207.89	519.38

Source : (Chiangchaisakulthai et al., 2016)

The report recommended the adjustment of the reimbursement rates for each level of ambulatory medical services, as shown in the following table.

Table 8: Adjusted reimbursement rates from IHPP (2015)

Level of operation	Sample	Average cost		Actual reimbursement price	Adjusted reimbursement prices
		True activity cost	System setting cost		
ALS	72	1028.23	4158.69	1,000/500/350	1000
BLS	25	1457.56	1457.56	750/500/350	750
FR	88	4275.51	4275.51	500/350	500

Source: (Chiangchaisakulthai et al., 2016)

It should be noted that the actual reimbursement rate depends on the severity of the patient in each operation (Department, 2010), assessed by the operator of the 1669 emergency medical services hotline. The operator (or dispatcher) must complete asking essential questions and to classify the severity and needs of the patients (called “Phone Triage”). After recognizing that the patient meets the criteria for having a life-

threatening condition, the operator will triage the patient's case using the color-coded scheme, where "red" indicates the need for the best resources for pre-hospital care, transportation and equipment, and the dispatcher will then demand an ALS unit for the case.

After the completion of pre-hospital care and transportation to the hospital, the ALS operation unit will receive a full reimbursement for the operation (which is equal 1,000 baht per operation, as shown in the above table) but if the patient's condition in fact is less severe based on the actual data recorded at the time the ALS unit arrives at the scene, then the patient's operation code would classified into Yellow or Green color signs instead and the ALS unit will receive 500 and 350 baht per operation respectively (regardless of the fact that ALS resources have been used for the operation). It should be noted that the IHPP report (Chiangchaisakulthai et al., 2016) and this thesis are similar in terms of the research question.

However, it is argued that that the IHPP report can be improved upon. First, the report suggested that the labor cost (derived from data from eleven provinces) was about 219.39 baht per one unit of ALS operation. The labor cost here seems to be too low, and might be more accurate if it comes from hospital financial departments rather than using a direct budget method like this study. Moreover, it can also be observed that the IHPP report did not address health outcomes, which are the main function of pre-hospital ambulance emergency services especially in Advanced Life Support's operation unit. Cost effectiveness ratios were also not calculated and there was no discussion on human resources usage or human development program. This thesis attempts to fill the gap.

3.3 Effectiveness: Emergency Medical Service Outcome Measurement

Providing efficient and effective service is a primary goal of EMS agencies, there are many outcomes that can indicate success in Emergency Medical Services or pre-hospital care. Overall, the success of an EMS system has been described in terms of economic efficiency, clinical performance and response time reliability (Kuehl, 1994).

First, survival from out-of-hospital cardiac arrest has been used as an indicator of the success of clinical performance of EMS (Kuehl, 1994). This is an ambulance strategy, especially in urban areas (Persse, Key, Bradley, Miller, & Dhingra, 2003).

Cardiac arrest is defined as the moment when the heart's electrical system malfunctions and the heart suddenly stops beating (AmericanHeartAssociation, 2015). A number of deaths due to sudden cardiac arrest are preventable and an effective EMS system could reduce them significantly at a low cost (MOSS, 1993).

In Thailand, the demand for Emergency Medical Services was around 125,447 times per month in 2016. Moreover, 10 % of the total cases required resuscitation with advanced medical equipment and a high competency level of care provision from an Advanced Life Support Unit. The number of non-traumatic out-hospital-cardiac-arrest cases was around 2,142 cases in 2016. In Chonburi alone, in 2016, the rate of Advanced Life Support EMS utilization was around 232 cases per month and the average number of Out-Hospital-Cardiac-Arrest cases was 582 cases (Retrieved from http://www.ws.niemsNIEMS.go.th/items_front/index.aspx, on 16 May 2017).

Another outcome that has been used to measure the effectiveness of emergency ambulance services is the response time, defined as the time interval since the receipt of the emergency call until arrival at the scene (Blackwell & Kaufman, 2002). To minimize ambulance response time is to increase medical effectiveness. It has been shown that in cases with non-traumatic cardiac arrest, a better health outcome could be achieved if Basic Life Support (BLS) care by cardiopulmonary resuscitation (CPR) is initiated within the first 4 minutes of the onset and there would be even greater health benefits if Advanced Life Support (ALS) care (primarily, defibrillation) is provided within the first 8 minutes (Pons & Markovchick, 2002). However, among traumatic patients, it has been found that health outcomes are influenced by not only the response time required to get to the scene but also the total amount of time spent at the scene as well as the level of medical treatment provided at scene (which would be counted as part of the total amount of time); nevertheless, due to the complexity of the data collection process, the response time to the scene is usually used (Pons & Markovchick, 2002).

Finally, the probability of survival score (PS score) is also used as a benchmark for effectiveness levels of ALS services, especially in traumatic patients. The PS score was adapted from Trauma and injury severity score (TRISS), which is a combination index based on revised trauma score (RTS), injury severity score (ISS) and patient's age. TRISS method can predict the outcome in trauma cases. is calculated based on multiple factors associated with probability to survive (such as the Glasgow coma scale, systolic blood pressure, patient age, respiratory rate, mechanism of injury, body region affected and the abbreviated injury scale).(Singh, Gupta, Garg, & Gupta, 2011) The probability ranges from 0-0.25, which indicates a poor prognosis, 0.26-0.74, which indicates a fair prognosis, and 0.75-1, which indicates a good prognosis. The PS score has been used to evaluate the Advanced Life Support operation outcome (BOYD, TOLSON, & COPES, 1987).

Economic evaluation in emergency medical services is quite complicated. In Thailand there is a study about how the response time is related to the probability of patient survival from EMS operation but the study does not classify the operation levels (NIEMS, 2011).

Chapter 4 Methodology

This study has two main objectives: (1) to identify, the cost of Advanced Life Support (ALS) emergency ambulance services for different levels of government hospitals in Chonburi province and (2) to identify the level of cost effectiveness of Advanced Life Support (ALS) emergency ambulance services for different levels of government hospitals in Chonburi province. Costing is done from the provider's perspective. This chapter describes the methodology used to answer the objectives.

4.1 Data collection

Study population

The population here is health care providers that have been involved with the provision of Advanced Life Support emergency ambulance services in Chonburi.

Exclusion criteria

- Any ALS operation that is provided by hospitals that are not affiliated with the Ministry of Public Health (MOPH), including private hospitals, Thai's military hospitals and The Thai red cross hospitals
- Cases whereby patients self-transport;
- Cases whereby patients are transported to the hospital without an emergency dispatch code from the emergency operation center.

Data collection

The data in this study were obtained from 12 emergency departments of MOPH hospitals in Chonburi in the first half of the fiscal year 2017. The data collection process took several steps.

Step 1: Fill in the application form and design a questionnaire to collect data on costs of ALS ambulance medical services provided by the twelve government hospitals in Chonburi.

Step 2: Collect data on health outcomes associated with the ALS performance (namely, out-of-hospital cardiac arrest and response time) from all hospitals in the sample, using a mixture of a direct survey and data from the health data center (at the national and provincial level).

4.2 Costing method

The cost of ALS emergency ambulance services is calculated for each hospital in the sample. For each hospital, the total cost (TC) is the summation of labor cost (LC), capital cost (CC) and material cost (MC).

$$(TC = LC + CC + MC.)$$

The following costing assumptions are made.

For each capital item, in order to calculate the depreciation cost, the straight-line depreciation method is used. Guidelines set by the Comptroller General's Department (CGD) are adopted This means the life years assumption here is from the CGD and the salvage value of 1 baht is assumed for all items. For each capital item, three values of useful life years are used: the maximum and minimum determined by the CGD and the life years obtained by interviews with the hospitals.

Table 8: Total ALS cases in the period of study

Month	MOPH, ALS operation (%)	Non-MOPH ALS operation (%)	Total
October	196 (15.4)	102 (17.9)	298
November	209 (16.5)	90 (15.8)	299
December	220 (17.3)	101 (17.7)	318
January	247 (19.51)	89 (15.6)	336
February	187 (14.77)	93 (16.37)	280
March	207 (16.3)	93 (16.37)	303
Total cases	1,266	568	1,834

4.3 Outcomes of ALS services (effectiveness measures)

Consistent with the literature, the three main effectiveness measures of ALS services include the number of out-hospital-cardiac-arrest (OHCA) the number of cases that receive CPR (the success rate in life-saving activities, death at scene and survived from transportation with admission status after 30 days of admission in hospital) the response time used by the ALS operation and the success of intravenous fluid given.

4.4 Cost-effectiveness of ALS services

The following formula are used.

(1) Total cost = labor cost + material cost + capital cost + indirect cost

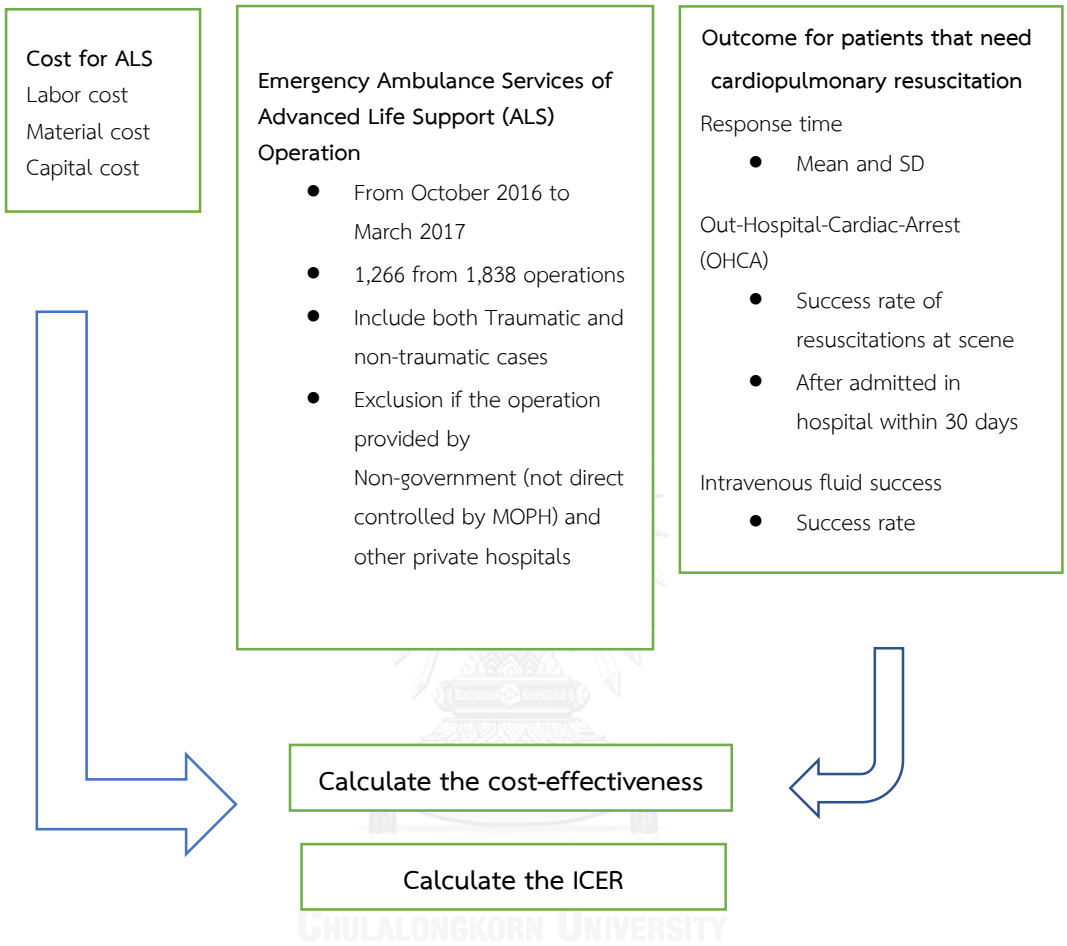
(2) Unit cost = (total cost) / (total number of ALS operation)

(3) Cost effectiveness = unit cost / effectiveness

Table 9: Cost identification and direct cost determination

Cost component	Type of data	Instruments	Cost determination	Unit
Labor cost **- Salary** **- Wages** **- Welfare** **- Extra payment**	Primary data	Financial department record	Time worked	Baht/min
Capital cost **- resources used over a year or more than 5,000 baht**	Secondary	Record form (medical equipment and vehicle data)	Time used or distance used	Baht/year or Baht/km
Material cost **- resources used less than a year or value less than 5,000 baht**	Secondary	Record form (Medical emergency bag)	Time used	Baht/unit

4.5 conceptual framework



Chapter 5: Results

This chapter discusses the data and the results.

5.1 Data description

The sample consisted of 12 emergency departments of MOPH hospitals in Chonburi. The data covered the first half of the fiscal year 2017 (from 1 October 2016 to 31 March 2017) and were retrieved from the provincial data center of emergency medical services, located at the health provincial office.

5.1.1 Sample description based on month of operation

Details of the data are provided in Table 8. In total, from 1 October 2016 to 31 March 2017, there were 1,838 cases of Advanced Life Support (ALS) operation in Chonburi. According to Table 8, it can be seen that the highest number of ALS cases occurred in January and December respectively. It was because January and December covered a period of a long weekend for the New Year celebration. Among the total ALS cases, 790 cases (43%) were self-reported, through the 1669 emergency hotline number; 73 cases (3.9 %) were reported through the 1669 number from a secondary source, e.g. police, firemen, the Thai army, etc. The rest of the cases (975 cases, i.e. 53%) were reported through a radio frequency by first responders or authorized staff. Some of the ALS cases were serviced by non-MOPH hospitals, including as hospitals affiliated with the Thai Red-Cross, university hospitals, military hospitals and private hospitals. After excluding the 568 cases treated by non-MOPH ALS operation units and 4 cases on which incomplete records were found, the final sample consists of 1,266 cases.

5.1.2 Sample description based on patient assessment by the dispatcher

For a given emergency medical service operation, the dispatcher at the emergency operation center completes the triage by phone or radio frequency,

evaluates the Emergency Severity Index (ESI) and assigns the main Criteria Based Dispatch (CBD) code. In the 6 months covered in this study, there were 16,148 emergency cases but only 1,266 of which were ALS cases performed by the MOPH hospitals.

Patient assessment is undertaken systematically. The patient`s emergency status is classified using Version 4 of the Emergency Severity Index (ESI). The ESI has 5 levels, with ESI level 1 representing the most severity which calls for an immediate life-saving intervention and most advanced medical resources, i.e. the ALS unit. ESI levels 2-5 mean that the severity of the patient doesn't meet the requirement of a high competency level operation then the utilization of the Advanced Life Support unit operation might be improper. The assignment of the ESI level by the dispatcher aims to get the right patient to the right kind of resources at the right place and the right time (Gilboy, Tanabe, Travers, & Rosenau, 2012).

The ESI is then combined within an emergency medical dispatch triage program known as the Criteria Based Dispatch (CBD). As shown in Table 10, there are 25 CBD codes, each indicating the patient's signs and symptoms (and causes of emergency care); Code 11 was removed (except code 11 which is not available in the NIEMS' CBD guidelines) (NIEMS, 2013)

Table 10: Criteria Based Dispatch

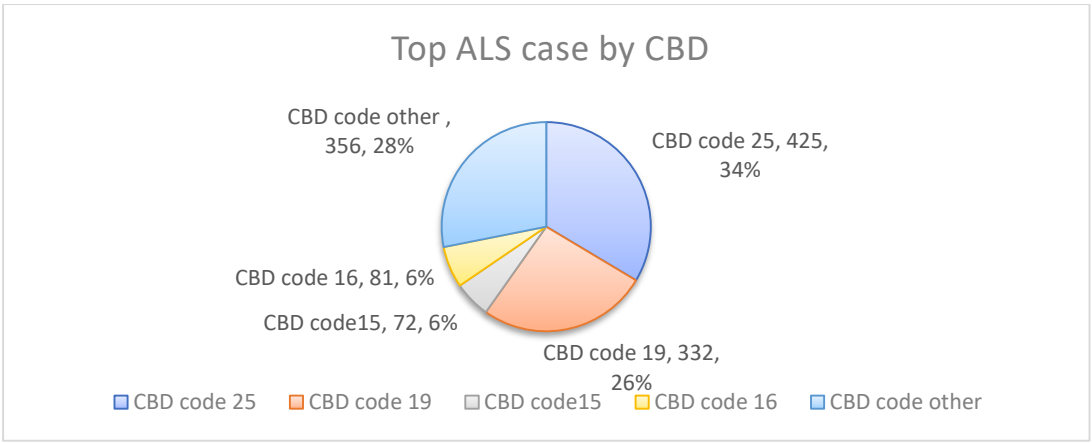
Code	Definition
0	Unidentified cause
1	Abdominal pain and other abdominal related
2	condition
3	Anaphylaxis or allergies to other substances
4	Animal bite and sting
5	Bleeding
6	Shortness of breath or dyspnea
7	Cardiac arrest
8	Chest discomfort or chest pain
9	Choking or airway obstruction
10	Diabetes related condition

Code	Definition
12	Environmental hazard
13	Headache or Ear, Nose, Throat problems
14	Psychiatric problem
15	Toxin or drugs overdose
16	Pregnancy or gynecologic related condition
17	Seizure
18	Sickness, fatigue, hemiparalysis
19	Complete paralysis
20	Unconsciousness, fainting, syncope
21	Pediatric problems
22	Body assaults
23	Fire burn, chemical burn, electrics injury
24	Drowning, near drowning, aquatic related injury
25	Falling, accidents, pain Traffic accident

Source: CBD Guidelines (NIEMS, 2013)

In this study, to save space and maintain anonymity, each of the 12 hospitals in the sample is assigned an alphabet. Hospitals A and B refer to the high advanced and excellent hospitals. Hospitals C, D and E refer to high competency hospitals with at least one medical doctor in major specialties. Lastly, hospitals E, F, G, H, I, J, K, and L are community hospitals.

Figure 4 ALS case by CBD



According to Tables 11 and figure 4, for all of the 1,266 ALS cases in the period of study, the mean age of the patients was 41.71 years (SD± 21.75). About 61.5% of the cases were male patients. The CBD code with the highest frequency was code 25 (traffic accidents), with 425 cases (33.5%). Hospital A unsurprisingly had the highest number of ALS cases, totaling 279 ALS cases (22.03% of the sample). For Hospital A, there were 94 cases of CBD code 25, followed by 74 cases of CBD code 19 (unconsciousness).

Traumatic injury refers to physical injuries of sudden onset and severity which require immediate medical attention and may require immediate resuscitation and interventions to save life and limb. Traumatic injuries are the result of a wide variety of blunt, penetrating and burn mechanisms. They include motor vehicle collisions, sports injuries, falls, natural disasters and a multitude of other physical injuries which can occur at home, on the street, or while at work and require immediate care. (retrieve from https://ufhealth.org/traumatic-injury on 29 May 2017)

Table 11: General data of ALS operation

Hospital	Number of cases	%of male	Age (min, max)	% of Traumatic cases
A	279	62.4%	49.31±22.54 (2,99)	38.7% (108/279)
B	265	62.3%	49.2±20.94 (7,99)	28.3% (75/265)
C	56	62.2%	57.82±23.78 (6,94)	31.5% (18/57)
D	154	61.2%	42.84± 20.13 (3,97)	35.48% (54/155)
E	170	63.5%	49.52±19.67(13,89)	35.29% (60/170)
F	79	69.6%	36.44±17.7 (13,78)	62.02%(49/79)
G	16	62.5%	52.53±22.85 (16,84)	43.75% (7/16)
H	11	45.5%	41.23±23.14 (2,79)	45.45% (5/11)
I	101	65.3%	48.69±22.11 (1,42)	56.43% (57/101)
J	37	54.1%	48.24±24.69 (13,92)	48.64%(18/37)
K	63	61.9%	43.32±23.0 (3,87)	41.26%(26/63)
L	35	40%	48.29±22.91(3,85)	37.1% (13/35)
Overall	1,266	61.5%	41.71±21.75 (1,99)	40.44% (512/1266)

Interestingly Hospital I, which is a community hospital, shows the highest number of cases compare within the group whereas hospital H, which is also a community hospital, shows the lowest number of ALS cases.

5.1.3 Practice variation

In this study, all hospitals provided only Advanced Life Support (ALS) emergency ambulance services operation (i.e., no BLS and FR units). Table 12 shows details of practice variation of ALS units for all hospitals in the sample.

While all hospitals in the sample provided only ALS services, hospital A was the only hospital that utilized medical doctors in the ALS operation. The number of nurses with the extra four-month training varied across hospitals. All ALS service operators have to meet the minimum requirement for intra-transportation care and life-saving activity before being selected for the operation.

Table 12: Details of ALS practice variation

Hospital	Level of hospital competency	Medical doctors for ALS units	Number of ER nurses	Percentage of four months trained nurses	Number of emergency medical technician	Number of drivers
A	A	16	29	10.34 %(3/29)	10	7
B	S	-	35	8.57 %(3/35)	4	5
C	M	-	20	5 %(1/20)	4	4
D	M	-	16	12.5 %(2/16)	4	4
E	M	-	12	16.67 %(2/12)	3	4
F	F	-	12	16.67 %(2/12)	0	3
G	F	-	11	9.09 %(1/11)	0	3
H	F	-	8	0	0	3

Hospital	Level of hospital competency	Medical doctors for ALS units	Number of ER nurses	Percentage of four months trained nurses	Number of emergency medical technician	Number of drivers
I	F	-	8	0	1	3
J	F	-	9	0	0	2
K	F	-	8	0	0	2
L	F	-	5	20 %(1/20)	0	3

5.2 Cost of ALS

The cost of ALS operations can be broken down into three components: capital cost, material cost and labor cost. Results for each component and the total cost are shown below.

5.2.1 Capital cost

Capital for an ALS operation refers to resources that are used for longer than a year or cost more than 5,000 baht. The method used to calculate the capital cost is a straight-line depreciation method with a one-baht salvage value, which can be presented formulaically as: (capital cost- salvage value) / useful life years.

In Thailand, hospitals usually purchase ALS ambulance vehicles with a set of essential medical equipment. The vehicle has to be registered with the National Institute of Emergency Medicine as an Advanced Life Support unit. The package of essential equipment in an ALS unit includes defibrillator, stretcher intravenous fluid machine(NIEMS, 2009). Since these items last longer than one year, they are considered ‘capital’ for the ALS operation.

The calculation of capital cost for ALS is based on the assumptions set forth in the methodology, which are detailed in Table 13. According to the Comptroller General's Department (CGD), the number of useful life years of each capital item differs. For a vehicle, the useful life ranges from 5 to 30 years and, for medical and scientific equipment, it ranges from 5 to 15 years. For a radio frequency machine (usually installed with the ambulance vehicle), it ranges from 5 to 10 years (CGD, 2014). The salvage value is one baht.

It can be seen that the vehicle may last longer than the equipment and therefore the equipment needs to be replaced in older vehicles. However, based on hospital interviews, all hospitals do not replace the equipment in their ALS units but instead downgrade the vehicle for other non-ALS functions. The capital cost here therefore refers only to the vehicle.

Table 13: Capital cost with depreciation

Capital Cost items	Assumption (Useful life-years form CGD)		
	Shortest useful life years = (Maximum cost after depreciation)	Average years used in this study (from survey)	Longest useful life years = Minimum cost after depreciation
Ambulance vehicle	5	10	30
Defibrillator*	5	6	15
Stretcher*	5	6	15
Infusion pump*	5	6	15
Radio frequency machine*	5	10	10

Source: (CGD, 2014)

The capital costs are shown in Table 14. They were calculated based on Table 13. Method A (for the highest capital costs) uses the shortest period of vehicle and equipment useful life years (five years). Method B is based on interviews as to the actual usage of ALS vehicle and equipment with any replacement cost to maintain the

ALS operation. Lastly, Method C is calculated from the longest useful life years by the CGD`s regulation.

Formula:

CC method A = (total vehicle cost – 1) / (5 years)

CC method B = (total vehicle cost – 1) / (7 years) +
(the equipment replacement cost-1) / (4 years)

CC method C = (total vehicle cost – 1) / (30 years)
+ (the equipment replacement cost-1) / (15 years)

Table 14: Hospital capital cost

	Vehicle cost – salvage value	**CC method A (Shortest useful life-years)**	**CC method B (Useful life years from hospital interviews)**	**CC method C (Longest useful life-years)**
A	2,209,899	883,959.60	325,489.90	101,529.97
B	2,006,799	802,719.60	313,179.90	96,893.30
C	1,476,899	590,759.60	239,589.90	73,736.63
D	1,805,899	722,359.60	289,839.90	89,329.97
E	1,713,299	685,319.60	288,829.90	88,443.30
F	1,610,499	644,199.60	276,549.90	84,483.30
G	1,997,199	798,879.60	307,219.90	95,239.97
H	1,709,999	683,999.60	273,499.90	84,333.30
I	1,592,899	637,159.60	276,789.90	84,429.97
J	1,684,899	673,959.60	270,989.90	83,496.63
K	1,868,899	747,559.60	289,389.90	89,629.97
L	1,806,399	722,559.60	283,139.90	87,546.63

Note: * = Reference for price from the price list of the Bureau of Health Administration (BureauOfHealthAdministration, 2017)

5.2.2 Material cost

For material costs, this study includes all vehicle-related costs, the cost of fuel used over the period of the study, and the maintenance cost based on the data sheet from the vehicle service department within the period (which include insurance fees based on the purchase of the 1st-level insurance coverage with an extra rate for ambulances which cover all accident types to all patients and passengers in the vehicle, and road traffic legislation fees). Fuel consumption is also included. The fuel consumption rate (baht per one kilometer) comes from the vehicle department's record (calculated by the total fuel expense divided by the total distance within the period of study). It is then multiplied with the total distance only in ALS operation.

Another group of material cost in this study comprises the emergency medication box. The medical emergency box contains some medication used during the treatment at the scene and medical essential drugs used in life-threatening events, when CPR is performed at the scene. The average dose used to transport patients back to the hospital is 4.3 ampule of adrenaline (at 5 baht per ampule) with a bag of normal saline 1,000 ml (at 35 baht per bag) then the total medication cost if CPR is performed is about 56.5 baht per case. Furthermore, if the ALS staff uses the Automated External Defibrillator (AED) then the cost for the chest disposable paddle is approximately 2,500 baht per usage. However, there is no record that AED has been used.

Table 15 shows the material cost in this study. It shows that the material cost is mainly driven by fuel consumption and vehicle-associated costs. There is no record about medical usage in the ALS operation during the study period.

Table 15: Hospital material cost

	Fuel cost (payment*consumption rate)	**Insurance half-year cost**	**Maintenance half-year cost**	**Medication Bag**	**Total half-year cost**
A	11,195.94	13,249	11,240	1,890	37,575
B	9,111.3	15,000	15,726	1,650	41,487

	Fuel cost (payment*consumption rate)	Insurance half-year cost	Maintenance half-year cost	Medication Bag	Total half-year cost
C	24,72.54	11,914	12,140	1,458	27,985
D	9,729.5	12,965	17,105	1,260	41,060
E	8,774.48	11,914	16,000	1,188	37,876
F	3,182.3	13,249	9,445	1,622.6	27,499
G	539.34	13,605	7,775	1,169.8	23,089
H	774.9	13,605	6,270	1560.6	22,211
I	5,257.4	14,280	12,285	1,905.6	33,728
J	1,495.64	13,485	6,105	1,226.4	22,312
K	3,457.32	13,730	6,710	1,396.2	25,294
L	267.3	13,990	5,840	1,283	21,380

5.2.3 Labor cost

Calculating the labor cost is the most difficult part of costing an Advanced Life Support operation. This study uses a direct survey to collect information about activity, salary, wages, fringe benefits and all expenses associated with the labor cost in ALS services, and convert the information into a monetary unit using a time-work framework. For an emergency registered nurse, the method to determine their labor cost is to first find the number of working hours that were covered by the monthly salary payment and to find the number of working hours that were covered by OT payment. The former is derived from the number of official days in a month for and the latter from holidays (OT days). An emergency nurse would be assigned the load of a full-time equivalence of 24 hours.

In the case of emergency physicians who work with ALS (which is true only for one hospital in this study), the office time (covered by their salary and wages) includes 8 hours of duty shift about 08.00-16.00 and the OT time (covered by OT payment) includes 16.01-00.00 and 00.01- 07.59.

The study uses data on labor cost calculated from the total amount of direct and indirect payment to emergency staff related to ALS and convert them into wages per minute and multiplies them with the total time spent on ALS activities.

Table 16 shows total labor costs retrieved from different calculation methods. For Method A, the total expense (salary, wages, fringe benefit and etc.) to all health care staff who participated in ALS activities in the 6-month period of study (determine at 180 days), including medical doctors, nurses, EMTs and drivers, as reported by each hospital, was used. The total amount was then divided into wage (labor cost) per minute and multiplied with the total amount of time spent on ALS activities. The calculation of LC, based on method B, is more detailed. The total salary and fixed payment to all personal who worked during the official hours (totally 124 days) and the total extra payment given for non-official hours (totally 58 days) was turned into wage per minute and multiplied with the ALS time duration. Finally, the midpoint labor cost came from the average between LC method A and LC method B.

Table 16: ALS labor cost

Hospital	Minute in ALS	LC method A	LC method B	Midpoint
A with separate MD			85,115.52	
A	5,427.88	225,132.12	18,662.86	164,455.25
B	4,737.61	146,448.08	16,923.57	81,685.83
C	1,220.68	25,228.47	3,372.63	14,300.55
D	4,031.05	88,256.59	17,590.02	52,923.31
E	4,983.68	81,282.82	29,290.56	55,286.69
F	1,587.03	27,210.53	8,964.93	18,087.73
G	3,13.01	4,589.03	1,512.14	3,050.58
H	262	2,613.66	1,291.73	1,952.70
I	2,079.03	19,215.62	9,733.02	14,474.32
J	594	5,022.19	2,127.16	3,574.67
K	1,590.2	21,226.10	15,748.33	18,487.21
L	354.01	3,958.77	1,955.90	2,957.34

Formula:

LC method A = (total labor cost payment 6 month) / (total number of workers) *180*24*60

LC method B = (total LC payment in Official hours) / (sum of workers in each duty*8) *(124*60) + (total LC payment in Non-official hours) / (sum of workers in each duty*8) *(54*60)

Midpoint = (LC method A+LC method B) /2

5.2.4 Total and unit cost calculation

Table 17 shows the total ALS cost of each hospital in Chonburi province based on different costing methods. The maximum total cost is the summation of the CC method A, calculated from the shortest period of useful life years, the material cost and the LC method A. The minimum total cost is the summation of the CC method C based on the longest useful life years possible, the material cost and the LC method B. The average total cost, which is the preferred estimate, is the summation of the LC midpoint, the material cost, and CC method B, derived from useful life years obtained through hospital interviews. (summary in table 33)

Table 17: Total ALS cost

Hospital	Details	Maximum	Minimum	Average
A	Capital Cost	883,959.60	101,529.97	325,489.90
	Material Cost	37,575.00	37,575.00	37,575.00
	Labor Cost	225,132.12	103,778.38	164,455.25
	total	1,146,666.66	242,883.29	527,520.09
B	Capital Cost	802,719.60	96,893.30	313,179.90
	Material Cost	41,487.00	41,487.00	41,487.00
	Labor Cost	146,448.08	16,923.57	81,685.83
	Total	990,654.98	155,304.17	436,353.03
C	Capital Cost	590,759.60	73,736.63	239,589.90
	Material Cost	27,985.00	27,985.00	27,985.00

Hospital	Details	Maximum	Minimum	Average
	Labor Cost	25,228.47	3,372.63	14,300.55
	Total	643,972.61	105,093.80	281,874.99
D	Capital Cost	722,359.60	89,329.97	289,839.90
	Material Cost	41,060.00	41,060.00	41,060.00
	Labor Cost	88,256.59	17,590.02	52,923.31
	Total	851,675.69	147,979.49	383,822.71
E	Capital Cost	685,319.60	88,443.30	288,829.90
	Material Cost	37,876.00	37,876.00	37,876.00
	Labor Cost	81,282.82	29,290.56	55,286.69
	Total	804,478.90	155,610.34	381,993.07
F	Capital Cost	644,199.60	84,483.30	276,549.90
	Material Cost	27,499.00	27,499.00	27,499.00
	Labor Cost	27,210.53	8,964.93	18,087.73
	Total	698,909.03	120,947.13	322,136.53
G	Capital Cost	798,879.60	95,239.97	307,219.90
	Material Cost	23,089.00	23,089.00	23,089.00
	Labor Cost	4,589.03	1,512.14	3,050.58
	Total	826,557.77	119,841.24	333,359.62
H	Capital Cost	683,999.60	84,333.30	273,499.90
	Material Cost	22,211.00	22,211.00	22,211.00
	Labor Cost	2,613.66	1,291.73	1,952.70
	Total	708,823.76	107,835.53	297,663.10
I	Capital Cost	637,159.60	84,429.97	276,789.90
	Material Cost	33,728.00	33,728.00	33,728.00
	Labor Cost	19,215.62	9,733.02	14,474.32
	Total	690,103.22	127,890.98	324,992.22
J	Capital Cost	673,959.60	83,496.63	270,989.90
	Material Cost	22,312.00	22,312.00	22,312.00
	Labor Cost	5,022.19	2,127.16	3,574.67

Hospital	Details	Maximum	Minimum	Average
	Total	701,293.83	107,935.83	296,876.61
K	Capital Cost	747,559.60	89,629.97	289,389.90
	Material Cost	25,294.00	25,294.00	25,294.00
	Labor Cost	21,226.10	15,748.33	18,487.21
	Total	794,079.22	130,671.81	333,170.63
L	Capital Cost	722,559.60	87,546.63	283,139.90
	Material Cost	21,380.00	21,380.00	21,380.00
	Labor Cost	3,958.77	1,955.90	2,957.34
	Total	747,898.67	110,882.83	307,477.54

Results in Table 17 are divided by the total number of Advanced Life Support operations to obtain the unit cost as shown in Table 18. The unit cost can be less than 1,000 baht per operation, the minimum cost method is used. The table also shows that hospitals that provided ALS operation for more than 150 cases had a much lower cost than hospitals that provided ALS for less than 100 times within the 6 months. In the total cost structure, the effect from the capital cost and the labor cost mostly influence the unit cost.

Table 18 :ALS unit cost

	Total operation	Maximum unit cost	Minimum unit cost	Average unit cost
A	279	4,109.92	870.55	1,890.75
B	265	3,738.32	586.05	904.11
C	56	11,499.51	1,876.68	5,033.48
D	154	5,530.36	960.91	2,492.36
E	170	4,732.23	915.35	2,247.02
F	79	8,846.95	1,530.98	4,077.68
G	16	51,659.86	7,490.08	20,834.98
H	11	64,438.52	9,803.23	27,060.28
I	101	6,832.71	1,266.25	3,217.74

	Total operation	Maximum unit cost	Minimum unit cost	Average unit cost
J	37	18,953.89	2,917.18	8,023.69
K	63	12,604.43	2,074.16	5,288.42
L	35	21,368.53	3,168.08	8,785.07
Overall	1,266	17,859.60	2,788.29	7,487.97

5.3 Effectiveness of ALS operations

The treatment outcome in the study is separated into two parts. Firstly, the pre-hospital care by Advanced Life Support operation before transport to the Emergency Room and the outcome of treatment within 30 days of admission.

5.3.1 Pre-hospital (at-the-scene) outcomes

(1) Response time

The response time is defined as a time interval since the operational team received a command from the dispatcher until the arrival at the scene (Blackwell & Kaufman, 2002). The National Institute of Emergency Medical Services specifies that the response time must be within 8 minutes. Furthermore, the NIEMS determines that the operation distance should be less than or equal to 10 kilometers, consistent with the 8-minute response time.

Table 18 shows information on response time. The data show that there were only 301 cases (23.7%) that achieved the goal of 8 minutes set by the National Institute of Emergency Medical Services. The highest percentage of successful response time for ALS operation was found in hospital L with a 68.5% success rate in response time; this is probably because hospital L is located in a very small area so the average distance to the scene is quite shorter than the other hospitals and there is also no traffic light or main junction in the hospital's responsibility area. On the other hand, the overall data in the study show that ALS cases that did not meet the standard response time of the NIEMS may be from road traffic conditions, the fact that the

average distance to the scene was far or from the availability of emergency medical personnel.

Table 19: Response time

Hospital	Number of cases	Response time (minutes) (Min, max)	Total cases with response time ≤ 8 minutes	Total distance in kilometer (Min, max)
A	279	12.13 ± 5.55 (2,35)	70/279 (25%)	12.46 ± 8.53 (1,62)
B	265	15.8±8.14 (1,67)	38/217 (17.5%)	16.3±9.97 (1,63)
C	56	12.71±9.08 (2,40)	24/56 (42.8%)	15.01±18.30 (1,52)
D	154	18.47±9.93 (4,55)	34/154 (22.07%)	19.92±13.87 (1,68)
E	170	13.7±7.02 (3,68)	19/170 (11.17%)	20.8±14.01 (0,66)
F	79	10.6±4.63 (2,25)	25/79 (31.6%)	15.3±7.22 (2,31)
G	16	11.43±6.20 (2,23)	6/16 (36.5%)	12.62±10.81(2,30)
H	11	13.63±9.43 (3,36)	2/11 (18.18%)	22.36±18.36 (2,60)
I	101	11.88±5.65 (3,28)	32/101 (31.68%)	19.2±10.18 (1,42)
J	37	9.65±6.71 (2,37)	22/37 (59.45%)	14.54±8.96 (2,38)
K	63	13.6±4.95 (4,27)	23/63 (36.5%)	19.46±7.92 (3,39)
L	35	6.85±5.11 (1,30)	24/35 (68.5%)	2.64±2.08 (0,10)
Overall	1,266	13.67± 7.61 (1,68)	301/1,266 (23.7%)	16.38±11.41 (0,68)

(2) The Out-Hospital-Cardiac-Arrest

This study investigates all cases of Out-Hospital-Cardiac-Arrest confirmed by emergency registered staff. As shown in Table 19, from the total 1,266 ALS operations, 195 cases (with 113 from 195 being traumatic injuries cases) received cardiopulmonary resuscitation by the ALS team at the scene; only 12 from 113 of traumatic patients had a non-response to life-saving activities and died at the scene while 101 cases were survived. Furthermore, the percentage of CPR success was 88.2% (172 cases) and they were all completely transported to the hospital for the essential life-saving treatment. It should be noted that although the total number of cases and CPR success rate had a nearly complete record in their activity details but there is incomplete information

about the total amount of essential emergency medications, details of use of defibrillator equipment or automated external defibrillator (AED) in CPR cases.

Table 20: The Out-Hospital-Cardiac-Arrest

Hospital	Total ALS cases	CPR performed (OHCA of total cases)	% Survived after CPR
A	279	16.2% (45/279)	86% (39/45)
B	265	18.11% (48/265)	85.42%(41/48)
C	56	12.22% (7/56)	85.76% (6/7)
D	154	7.14% (11/154)	71.4% (5/7)
E	170	12.3%(21/170)	80.06%(17/21)
F	79	13.9%(11/79)	81.81% (9/11)
G	16	18.75% (3/16)	100% (3/3)
H	11	9%(1/11)	100% (1/1)
I	101	15.8%(16/101)	100% (16/16)
J	37	10.82%(4/37)	100% (4/4)
K	63	11.11% (7/63)	71.4%(5/7)
L	35	14.28% (5/35)	100% (5/5)
Overall	1,266	15.41% (195/1266)	88.2% (172/195)

(3) Intravenous fluid success

The intravenous fluid is an important caring process to EMS patients. Based on Table 20, for all 195 cases of cardiopulmonary resuscitation, the success of intravenous fluid given can increase chance of survival. It can be seen that 194/195 cases (99.4%) had a complete intravenous fluid and there was only one incomplete case from hospital D due to no data record found.

Table 21:The intravenous fluid

Hospital	Total ALS cases	Intravenous fluid success in ALS and CPR cases
A	279	279/279
B	265	265/265
C	56	57/57
D	154	153/154
E	170	170/170
F	79	79/79
G	16	16/16
H	11	11/11
I	101	101/101
J	37	37/37
K	63	63/63
L	35	35/35
Overall	1,266	194/195

5.3.2 In-hospital and post-hospital outcomes

Health outcomes after 30 days admission

Based on Table 22, from all 1,266 cases, after excluding 128 of death cases (23 cases were non-response to CPR and the other 101 cases were death without CPR, death before arrival or missing data without life-saving activity from the data sheet), the data show that 1,138 cases were transported to the emergency room for further investigation, treatment, ward admission or referred to a higher level of hospital for proper treatment. About 73 of the 1,138 cases in the database had invalid or missing data in the thirty days' admission record form. Also, data in the ALS record form (the ITMES database) seem to be largely missing; some data were lost and some cases had no record of the hospital transfer process, especially in the case of death within 30 days after the admission. Furthermore, in traumatic patients, there is no information on the probability of survival score in the data record sheet, which

might lead to an improper evaluation of the progression of traumatic cases after the Advanced Life Support unit.

Table 22: After the ALS scene management

Hospital	Total ALS cases	Cases transported to ER	Number of deaths within 30 days of admission	Number of Post CPR patients that survived within 30 days of ward admission
A	279	237	76/237	(28/39)
B	265	208	43/208	(35/41)
C	56	53	6/53	(6/6)
D	154	143	32/143	(2/5)
E	170	150	20/150	(10/17)
F	79	73	18/73	(3/9)
G	16	13	3/16	(0/3)
H	11	11	0	(1/1)
I	101	95	19/95	(16/16)
J	37	37	3/37	N/A
K	63	62	12/62	(2/5)
L	35	35	5/30	(2/5)
Overall	1,266	1,138	237/1104	104/147

Table 23 summarizes the overall effectiveness of ALS operation with specific details for each hospital, already discussed above. Furthermore, the table also includes the survival rate associated with patients that received CPR within the 8-minute response time requirement.

Table 23: The effectiveness of ALS operation

	Percentage of CPR performed	Percentage of Post-CPR survivals	Percentage of post CPR survivals with response time within 8 min	Percentage of intravenous fluid success cases	Percentage of survivals after 30 days admission
A	16.2% (45/279)	86% (39/45)	17% (8/45)	100% (279/279)	71.1%(28/39)
B	18.11%(48/265)	85.42%(41/48)	9.7% (4/41)	100% (265/265)	85.3%(35/41)
C	12.22% (7/57)	85.76% (6/7)	66% (4/6)	100% (57/57)	83.3% (5/6)
D	7.14% (11/154)	71.4% (5/7)	20% (1/5)	99.3% (153/154)	40% (2/5)
E	12.3%(21/170)	80.06%(17/21)	17.6% (3/17)	100% (170/170)	58.8%(10/17)
F	13.9%(11/79)	81.81% (9/11)	11.1% (1/9)	100% (79/79)	33.3 %(3/9)
G	18.75% (3/16)	100% (3/3)	33.3% (1/3)	100% (16/16)	0 (0/3)
H	9%(1/11)	100% (1/1)	0	100% (11/11)	100% (1/1)
I	15.8%(16/101)	100% (16/16)	31.2% (5/16)	100% (101/101)	100%(16/16)
J	10.82%(4/37)	100% (4/4)	25% (1/4)	100% (37/37)	N/A
K	11.11% (7/63)	71.4%(5/7)	0% (0/5)	100% (63/63)	40%(2/5)
L	14.28% (5/35)	100% (5/5)	80% (4/5)	100% (35/35)	40%(2/5)
Total	15.41% (195/1266)	88.2% (172/195)	29% (50/172)	99.4% (194/195)	70.7% (104/147)

5.4 Cost effectiveness of ALS operations

There are two sets of cost-effectiveness values: one for pre-hospital outcomes and the other for post-hospital outcomes. To calculate cost effectiveness values, the ALS unit cost is divided by the relevant outcome.

5.4.1 Cost effectiveness based on pre-hospital (at-the-scene) outcomes

The cost effectiveness ratio is calculated from the unit cost of ALS operation divided by the percentage of success in the ALS operation measured by (1) percentage of CPR success, (2) percentage of CPR success within 8 minutes of the response time and (3) percentage of success of intravenous fluid given.

Table 24 shows that some cost effectiveness values for hospital H and K are zero; this is because there were no survived cases from CPR within the 8-minute response time.

Table 24: Cost effectiveness levels

	Items	**Maximum Cost**	**Minimum Cost**	**Average Cost**
A	Cost effectiveness CPR	4,778.97	1,012.27	2,198.55
	Cost effectiveness CPR 8 min	24,175.98	5,120.88	11,122.08
	Cost effectiveness for Intravenous fluid success	4,109.92	870.55	1,890.75
B	Cost effectiveness CPR	4,377.42	686.25	1,058.68
	Cost effectiveness CPR 8 min	38,539.39	6,041.79	9,320.75
	Cost effectiveness for Intravenous fluid success	3,738.32	586.05	904.11
C	Cost effectiveness CPR	13,418.33	2,189.82	5,873.37
	Cost effectiveness CPR 8 min	17,423.50	2,843.45	7,626.49
	Cost effectiveness for Intravenous fluid success	11,499.51	1,876.68	5,033.48
D	Cost effectiveness CPR	7,745.60	1,345.81	3,490.69
	Cost effectiveness CPR 8 min	27,651.81	4,804.53	12,461.78
	Cost effectiveness for Intravenous fluid success	5,643.23	980.52	2,543.22
E	Cost effectiveness CPR	5,842.26	1,130.07	2,774.10
	Cost effectiveness CPR 8 min	26,887.66	5,200.88	12,767.15
	Cost effectiveness for Intravenous fluid success	4,732.23	915.35	2,247.02
F	Cost effectiveness CPR	10,815.34	1,871.61	4,984.94
	Cost effectiveness CPR 8 min	80,426.82	3,917.97	37,069.80
	Cost effectiveness for Intravenous fluid success	8,846.95	1,530.98	4,077.68
G	Cost effectiveness CPR	51,659.86	7,490.08	20,834.98
	Cost effectiveness CPR 8 min	156,545.03	22,697.20	63,136.29
	Cost effectiveness for Intravenous fluid success	51,659.86	7,490.08	20,834.98

	Items	Maximum Cost	Minimum Cost	Average Cost
H	Cost effectiveness CPR	64,438.52	9,803.23	27,060.28
	Cost effectiveness CPR 8 min	N/A	N/A	N/A
	Cost effectiveness for Intravenous fluid success	64,438.52	9,803.23	27,060.28
I	Cost effectiveness CPR	6,832.71	1,266.25	3,217.74
	Cost effectiveness CPR 8 min	21,285.69	3,944.70	10,024.13
	Cost effectiveness for Intravenous fluid success	6,832.71	1,266.25	3,217.74
J	Cost effectiveness CPR	18,953.89	2,917.18	8,023.69
	Cost effectiveness CPR 8 min	75,815.55	11,668.74	32,094.77
	Cost effectiveness for Intravenous fluid success	18,953.89	2,917.18	8,023.69
K	Cost effectiveness CPR	17,653.27	2,904.98	7,406.75
	Cost effectiveness CPR 8 min	N/A	N/A	N/A
	Cost effectiveness for Intravenous fluid success	12,604.43	2,074.16	5,288.42
L	Cost effectiveness CPR	21,368.53	3,168.08	8,785.07
	Cost effectiveness CPR 8 min	26,710.67	3,960.10	10,981.34
	Cost effectiveness for Intravenous fluid success	21,368.53	3,168.08	8,785.07
Total	Cost effectiveness CPR	20,248.98	3,161.33	8,489.76
	Cost effectiveness CPR 8 min	61,584.84	9,614.80	25,820.57
	Cost effectiveness for Intravenous fluid success	17,967.41	2,805.12	7,533.16

5.4.2 Cost effectiveness based on In-hospital and post-hospital outcomes

Here, data on the 30-day follow-up after admission are used to represent post-hospital outcomes in this study. Table 25 shows the cost effectiveness ratios based on patients who survived after CPR within 30 days of admission. Some data are missing, not existing in the data record form. The total number of cases within an indicator of the final status within 30 days of admission is not equal to the number of cases transported to the hospital.

Table 25: Cost-effectiveness for 30 days after admission

	Maximum	Minimum	Average
A	5,788.61	1,226.13	2,663.03
B	4,382.56	687.05	1,059.92
C	13,804.94	2,252.91	6,042.60
D	13,825.90	2,402.26	6,230.89
E	8,048.01	1,556.73	3,821.46
F	26,808.94	4,639.32	12,356.60
G	N/A	N/A	N/A
H	64,438.52	9,803.23	27,060.28
I	6,832.71	1,266.25	3,217.74
J	N/A	N/A	N/A
K	31,511.08	5,185.39	13,221.06
L	53,421.33	7,920.20	21,962.68
Total	19,011.88	3,078.29	8,136.35

5.5 Incremental cost effectiveness ratio (ICER)

To calculate Incremental cost effectiveness ratios, the following formula is used**:** **(unit cost hospital A – unit cost of hospital B)**

(Effectiveness of hospital A – Effectiveness of hospital B)

ICER can be obtained by dividing the difference in costs with the difference in outcomes. Here, two ICER ratios are presented.

5.5.1 ICER based on the presence of a medical doctor in the ALS team versus

To compare the CER of an ALS team with a medical doctor and that without, this study calculates ICER. Hospital A is the only hospital that sends a medical doctor in the ALS operation. Hospital B is the reference hospital as it is similar in competency but it does not send out a medical doctor available in its ALS operation. The average costs and effectiveness measures are used to calculate the ICER.

The incremental cost effectiveness ratios are shown in Table 26. They show that if hospital A needs to increase 1% of effectiveness in CPR, they have to increase the cost by 1,644 baht. Conversely, for survival after 30 days of admission, if the hospital needs to increase 1 % of the effectiveness, they might not increase the cost (as there is no difference in the effectiveness of 30 days admission between the ALS unit with a medical doctor and that without).

Table 26: Incremental cost effectiveness ratios: the case of medical doctors

Items	Hospital A	Hospital B
Unit Cost (average)	1,890.75	904.11
Effectiveness in CPR	86%	85.4%
Effectiveness in CPR by response time within 8 min	17%	9.7%
Effectiveness for Intravenous fluid success	100%	100%
Effectiveness after 30 days admission	71.1%	85.3%
ICER for CPR	1,644.4	
ICER for post CPR with response time within 8 min	135.1561644	
ICER for 30 days admission	-69.48169014	

5.5.2 ICER based on training of EMS nurses

Another set of ICERs in this study is related to nurse competency distinguished by the receipt of training in the Program of Nursing Specialty in Emergency Nurse Practitioner (a four-month training program). Table 27 shows the percentage of emergency practical nurses with a qualification from the four-month nursing specialty program for emergency medical services. There were 15 nurses with the qualification compared with the total of 173 nurses in Chonburi Province and they mostly worked in high-level hospitals (hospitals A to G). The objective here is to find the rationale to train general practical nurses into an emergency practical nurse and evaluate whether such training increases the effectiveness of the service.

Table 27: Number of emergency practical nurses

	Total nurses	Number of four-months trained nurses	Percentage of nurses with the 4-month training
A	29	3	10.34%
B	35	3	8.57%
C	20	1	5.00%
D	16	2	12.50%
E	12	2	16.67%
F	12	2	16.67%
G	11	1	9.09%
H	8	0	0.00%
I	8	0	0.00%
J	9	0	0.00%
K	8	0	0.00%
L	5	1	20.00%
Overall	173	15	8.6%

The 4-month training is known as Program of Nursing Specialty in Emergency Nurse Practitioner. This course was established for the purpose of turning practical nurses into nurses with a specialty in emergency services. The aim of the training was to improve competency for the management of emergency situations, to assist in special emergency conditions such as cardiovascular cases, pediatric cases, cerebrovascular (STROKE) fast tract systems, disaster management and advanced health assessment and to allow emergency nurses to be able to make effective clinical judgment. Candidates have to pass both of the MCQ and an oral examination before being able to participate in the four-month program.

Table 28 shows the differences between hospitals with emergency practical nurses and those without. It shows that if the latter wishes to improve 1% of CPR effectiveness and 1% for patient survival within 30 days of admission, then they have

to increase the cost by 789.25 and 179.05 baht respectively. Alternatively, there is no additional cost for an increase of 1% of CPR success within 8 minutes of response time

Table 28: Incremental cost effectiveness ratios for trained versus untrained nurses

Items	Hospitals with nurses with 4-month training (8/12 hospitals)	Hospital without nurses with 4-month training (4/12 hospitals)
Unit cost (average)	5,783.18	10,897.53
Effectiveness CPR	86.37%	92.85%
Effectiveness CPR by response time within 8 min	31.8%	14.05%
Effectiveness for Intravenous fluid success	99.625%	100%
Effectiveness after 30 days admission	51.4375%	80%
ICER for CPR	789.25	
ICER for post CPR by response time within 8 min	-288.13	
ICER for 30 days admission	179.05	

Table 29 shows differences between hospitals with 3 nurses with the 4-month training and hospitals with 1 or 2 nurses with the 4-month training. To increase the effectiveness of CPR within the 8-minute response time by 1%, the cost needs to increase by 7,263.52 baht. It seems to be high because the unit costs of hospitals C, D, E, F, G and L are much higher than the units cost of hospital A and B, lacking the economies of scale.

Table 29: the incremental cost effectiveness ratio of nurses trained

Items	Hospital with 3 nurses of four months trained (2)	Hospital with only 1,2 nurses of four month trained (6)
Unit cost (average)	1,397.43	21,735.295
Effectiveness CPR	85.72	86.58
Effectiveness CPR with response time within 8 min	26.7	29.5

Items	Hospital with 3 nurses of four months trained (2)	Hospital with only 1,2 nurses of four month trained (6)
Effectiveness after 30 days admission	156.4	42.57
ICER for CPR	-156,445.07	
ICER for post CPR by response time within 8 min	7,263.52	
ICER for 30 days admission	-570.80	

5.6 Summary of results

Table 30 shows important results of the study, the overall data from twelve public hospital in Chonburi province. The maximum unit cost was 17,859.60 baht, the minimum unit cost 7,487.97 baht and the average unit cost 2,788.29 baht. For effectiveness, there was 88.2% success rate in life-saving CPR, 29% success rate within the 8-minute response time, 99.5% of intravenous fluid success rate, and 65% success rate for the post CPR cases within 30 days of admission.

Table 30: Summary of results

Items	Maximum	Minimum	Average
Unit cost	17,859.60	2,788.29	7,487.97
Effectiveness for CPR	88.2%		
Effectiveness for CPR by response time within 8 minutes	29%		
Effectiveness of IV fluid success	99.4%		
Effectiveness of survival after 30 days admission	65%		
Cost effectiveness of CPR	202.49	31.61	84.90
Cost effectiveness of CPR by 8 minutes of response time	615.85	96.15	258.21
Cost effectiveness of intravenous fluid success	179.67	28.05	75.33
Cost effectiveness of survival after 30 days admission	274.76	42.90	115.20

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APPENDIX

โครงการวิจัย: การศึกษาต้นทุนและต้นทุนประสิทธิผลของการบริการทางการแพทย์โดยใช้รถพยาบาลฉุกเฉินของโรงพยาบาลในจังหวัดชลบุรี

(Cost and cost-effectiveness of emergency ambulance services among government hospital in Chonburi Province)

แบบสอบถามเพื่อหาต้นทุนการบริการทางการแพทย์โดยใช้รถฉุกเฉินของโรงพยาบาล

คำอธิบาย

แบบสอบถามหนึ่งชุดต่อหนึ่งบุคลากรของแผนกฉุกเฉิน ที่เกี่ยวข้องกับระบบบริการด้วยรถฉุกเฉินของโรงพยาบาลเท่านั้น

กรอกข้อมูลตามความเป็นจริง หากไม่ทราบกรุณาใส่ 0 หรือขีด –

สามารถทำแบบสอบถามได้สองช่องทาง

ทางแบบสอบถาม

ทาง Online ได้ที่ https://goo.gl/forms/Yt0SUnP7ScYhDl83 หรือสแกน QR

สามารถใช้กับ QR scan จากหน้าเมนูเพิ่มเพื่อนด้วย QR code ของโปรแกรม Line

ข้อมูลจะถูกใช้เพื่องานวิจัยการประเมินต้นทุนการบริการทางการแพทย์ด้วยรถฉุกเฉินของโรงพยาบาลเท่านั้น ไม่ส่งผลต่อการเบิกจ่ายค่าตอบแทน ไม่มีการเปิดเผยหรือระบุตัวตนของผู้ให้ข้อมูล

ด้วยความเคารพ.

ผู้ทำวิจัย

ส่วนที่ 1: ข้อมูลทั่วไป

1.1 โรงพยาบาลที่ท่านปฏิบัติงาน	☐ รพศชลบุรี. ☐ รพ.บางละมุง ☐ รพ พนัส ☐ รพ.บ้านบึง ☐ รพ.แหลมฉบัง ☐ รพ.พานทอง ☐ รพ.สัตหีบ กม.10 ☐ รพ.บ่อทอง ☐ รพ.หนองใหญ่ ☐ รพ.เกาะจันทร์ ☐ รพ.วัดญาณสังวราราม ☐ รพ.เกาะสีชัง
อายุ	ปี.....
1.3 เพศ	☐ชาย ☐หญิง ☐ อื่นๆ
1.4 ตำแหน่ง	☐ แพทย์ ☐ พยาบาลวิชาชีพ ☐ เวชกิจฉุกเฉิน ☐ ผู้ช่วยเหลือคนไข้ ☐ พนักงานขับรถ ☐ พนักงานทั่วไป ☐ อื่นๆ .....(โปรดระบุ)
อัตราเงินเดือนในปีงบประมาณ 2560	
บรรจุเข้าทำงานเมื่อปีพ.ศ.	
เริ่มปฏิบัติหน้าที่ออก EMSเมื่อปีพ.ศ.	

ส่วนที่ 2: ข้อมูลด้านค่าตอบแทนและสวัสดิการ (โปรดระบุตัวเลขที่ชัดเจน)

2.1 ค่าเวรนอกเวลา (OT) ต่อ 8 ชั่วโมง	
2.2 ค่าตอบแทนรายครั้งของการปฏิบัติการ (On-call)	
2.3 ค่าตอบแทนอื่น ๆที่ได้รับ เช่น เงิน พตส.	
2.4 ค่าประกันอุบัติเหตุที่ชำระเองและมีความคุ้มครองครอบคลุมถึงการปฏิบัติงานด้วยรถฉุกเฉินของโรงพยาบาล	
2.5 ค่ารักษาพยาบาล	
2.6 ค่าเครื่องแบบ	
2.7 ค่าการศึกษาบุตร	

ส่วนที่ 3: ความสามารถและการพัฒนาบุคลากร

3.1 ในปีงบประมาณ 2559-2560 ท่านได้รับการอบรมเพื่อพัฒนาศักยภาพในการบริการทางการแพทย์ที่เกี่ยวกับระบบEMS หรือไม่ ถ้าได้รับโปรดระบุ หากเข้าอบรมมากกว่าหนึ่งรายการ โปรดระบุ) จำนวนรายการในช่องหลักสูตรและโปรดระบุค่าใช้จ่ายรวมของทุกรายการในช่องงบประมาณ (ที่ใช้)	☐ หลักสูตร..... ☐ ระยะเวลาที่อบรม (วัน)..... ☐ งบประมาณที่ใช้(บาท)..... ☐ ค่าที่พัก(บาท)..... ☐ เบี้ยเลี้ยง (บาท)..... ☐ ค่าใช้จ่ายอื่นๆที่ได้รับการสนับสนุน (บาท).....
ข้อ 3.2-3.8 เฉพาะพยาบาลวิชาชีพ 3.2 ท่านได้ผ่านการอบรมหลักสูตรการพยาบาลเฉพาะทาง สาขาการพยาบาลเวชปฏิบัติฉุกเฉิน หรือไม่	☐ ยังไม่ผ่านการอบรม ☐ ผ่านการอบรม (โปรดระบุรายละเอียด) ☐สถานที่อบรม..... ☐ งบประมาณที่ใช้(บาท)..... ☐ ค่าที่พัก(บาท)..... ☐ เบี้ยเลี้ยง (บาท)..... ☐ ค่าใช้จ่ายอื่นๆที่ได้รับการสนับสนุน(บาท).....
3.3 ท่านผ่านหลักสูตรอบรม Pre-hospital care 2 อาทิตย์หรือไม่	☐ ผ่านการอบรม ☐ ยังไม่ผ่านการอบรม
3.4 ท่านผ่านหลักสูตรการกู้ชีพเบื้องต้น (Basic Life Support) ที่ได้รับการรับรอง หรือไม่	☐ ผ่านการอบรม ☐ ยังไม่ผ่านการอบรม
3.5 ท่านผ่านหลักสูตรการกู้ชีพเบื้องต้น (Advanced Life Support) ที่ได้รับการรับรองแล้ว หรือไม่	☐ ผ่านการอบรม ☐ ได้รับบัตรรับรอง ALS Certificated ☐ ไม่ได้รับบัตรรับรอง ALS Certificated ☐ ยังไม่ผ่านการอบรม
3.6 ท่านต้องการเข้ารับการอบรมในหลักสูตรข้อ 3.3-3.5 อีกครั้งหรือไม่ โปรดระบุหลักสูตรที่อยากอบรมซ้ำ และระยะเวลา	☐ ต้องการอบรมในหลักสูตร ☐ 3.3 ☐ 3.4 ☐ 3.5 ☐ ในระยะเวลาทุกๆ .....☐ (ปี / เดือน) ☐ ไม่ต้องการอบรมซ้ำ
3.7 เดือนที่ผ่านมาท่านปฏิบัติหน้าที่โดยเฉลี่ย	☐เวรต่อเดือน .....(ในวันทำการ) ☐เวรต่อเดือน ..... (นอกวันทำการ)

3.8 ท่านคิดว่าหลักสูตรการพยาบาลเฉพาะทางสาขาการพยาบาลเวชปฏิบัติฉุกเฉินสามารถพัฒนาศักยภาพการทำงานของท่านได้หรือไม่	☐ ได้ ☐ ไม่ได้
4. ความถี่ในการปฏิบัติหน้าที่ออกรับเหตุ EMS และพบเหตุที่ต้องทำการ CPR นอกสถานที่ในปีงบประมาณ 2560	ครั้ง ภายในปี.....2560
5. ระยะเวลาในการปฏิบัติหน้าที่ในการออก EMS โดยเฉลี่ย	☐นาทีต่อครั้ง .....

Table 31: Details of labor cost

หมวด	รายการ (ประเภท แพทย์, พยาบาล, เจ้าหน้าที่เวชกิจฉุกเฉิน, คนขับรถ)	เดือน	รวม
เงินเดือน	เงินเดือนข้าราชการ(บริการ)		
เงินเดือน	ค่าจ้างชั่วคราว(บริการ)		
เงินเดือน	ค่าจ้างพนักงานกระทรวงสาธารณสุข (บริการ)		
เงินประจำตำแหน่ง	เงินประจำตำแหน่งวิชาชีพเฉพาะ(บริการ)		
ค่าตอบแทนนอกเวลา	ค่าตอบแทนในการปฏิบัติงานเวรหรือผลัดบ่ายและหรือผลัดดึกของพยาบาล		
ค่าตอบแทนนอกเวลา	ค่าตอบแทนในการปฏิบัติงานของเจ้าหน้าที่ (บริการ) - แพทย์		
ค่าตอบแทนนอกเวลา	ค่าตอบแทนในการปฏิบัติงานของเจ้าหน้าที่ (บริการ) - พยาบาล		
ค่าตอบแทนนอกเวลา	ค่าตอบแทนในการปฏิบัติงานของเจ้าหน้าที่ (บริการ) - เจ้าหน้าที่เวชกิจฉุกเฉิน		
ค่าตอบแทนนอกเวลา	ค่าตอบแทนในการปฏิบัติงานของเจ้าหน้าที่ (บริการ) - คนขับรถ		
พตส.	ค่าตอบแทนเพิ่มพิเศษสำหรับผู้ปฏิบัติงานด้านสาธารณสุข (พตส.-เงินงบประมาณ)		
คชจ.บุคลากรอื่น	เงินสมทบกองทุนประกันสังคมส่วนของนายจ้าง		
คชจ.บุคลากรอื่น	เงินสมทบกองทุนสำรองเลี้ยงชีพพนักงานและเจ้าหน้าที่รัฐ		
ค่าตอบแทน ฉ.11	ค่าตอบแทนการปฏิบัติงานในลักษณะค่าเบี้ยเลี้ยงเหมาจ่าย (บริการ)		
รวม			

โครงการวิจัย: การศึกษาต้นทุนและต้นทุนประสิทธิผลของการบริการทางการแพทย์โดยใช้รถพยาบาลฉุกเฉินของโรงพยาบาลในจังหวัดชลบุรี

(Cost and cost-effectiveness of emergency ambulance services among government hospital in Chonburi Province)

ต้นทุนอุปกรณ์ (Capital Cost)

กรุณาระบุข้อมูลของอุปกรณ์ที่ใช้ในรถพยาบาลฉุกเฉินของโรงพยาบาลที่ยังมีการใช้งานอยู่จนถึงปัจจุบัน

ข้อมูลของโรงพยาบาล.....

	ราคา	**ปีที่จัดซื้อ**	**รวมจำนวนที่มีใช้อยู่จริง**
เครื่องกระตุกไฟฟ้าหัวใจชนิดไบเฟสิกแบบมีมาตรวัดระดับออกซิเจน (Defibrillator)			
เครื่องกระตุกไฟฟ้าหัวใจชนิดไบเฟสิกแบบมีมาตรวัดระดับคาร์บอนไดออกไซด์ (Defibrillator with End- tidal CO2 monitor)			
รถเข็นผู้ป่วยแบบนอนชนิดพับเคลื่อนที่ได้ (Stretcher)			
เครื่องวัดความดันและวัดสัญญาณชีพอัตโนมัติ (BP-Monitor)			
เครื่องวัดระดับออกซิเจนในเลือด (O2 monitor)			
Automatic External Defibrillator (AED)			
เครื่องควบคุมการให้สารน้ำทางหลอดเลือดดำ (Infusion pump)			
กระดานรองหลัง (Spinal board)			
ปลอกดามคอชนิดแข็ง (Hard collar)			

Table 32: Details of total cost

	Maximum	**Minimum**	**Average**
Capital cost	CC method A	CC method B	CC method C
Materia cost	Actual material cost within 6 months		
Labor cost	LC method A	LC method B	Midpoint
Total cost	Maximum total cost	Minimum total cost	Average total cost

Costing method for capital cost: by using present value and annuity factor Formula:

Current value at year 2016 = (purchase value in year t) * $(1+r)^{2016-t}$

When r = discount rate, t = year of bought

And using the annuity capital cost by annuity factor methods

Annual capital cost = current value / annualizing factor

While annualizing factor = (1-discount factor)/ (r)

: Discount factor = $(1)/(1+r)^{t}$

When r = discount rate, t = lifetime year

Determine: Vehicle life year used for 5 years, medical equipment life year used for 7 years

Then the annualizing capital cost in the table 32

Table 33: The annualizing capital cost

	Complete ambulance price	Year bought	Current value	Annualizing capital cost	CC method A (Shortest useful life-years)	CC method B (from hospital interviews)	CC method C (Longest useful life-years)
A	2,209,899	2015	2,266,000	453,643.01	883,959.60	325,489.90	101,529.97
B	2,006,799	2015	2,094,750	419,359.53	802,719.60	313,179.90	96,893.30
C	1,476,899	2014	1,464,700	293,226.35	590,759.60	239,589.90	73,736.63
D	1,805,899	2015	1,796,500	359,651.22	722,359.60	289,839.90	89,329.97
E	1,713,299	2007	1,699,000	340,132.16	685,319.60	288,829.90	88,443.30
F	1,610,499	2015	1,598,000	319,912.41	644,199.60	276,549.90	84,483.30
G	1,997,199	2013	1,649,000	330,122.39	798,879.60	307,219.90	95,239.97
H	1,709,999	2013	1,699,000	340,132.16	683,999.60	273,499.90	84,333.30
I	1,592,899	2010	1,583,000	316,909.48	637,159.60	276,789.90	84,429.97
J	1,684,899	2011	1,675,000	335,327.47	673,959.60	270,989.90	83,496.63
K	1,868,899	2013	1,800,000	360,351.91	747,559.60	289,389.90	89,629.97
L	1,806,399	2011	1,796,500	359,651.22	722,559.60	283,139.90	87,546.63

VITA

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Primary to secondary school - Prasanmitr Demonstration School

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