COST-EFFECTIVENESS ANALYSIS OF LAPAROSCOPIC CHOLECYSTECTOMY COMPARED WITH OPEN CHOLECYSTECTOMY AT A PRIVATE HOSPITAL IN MYANMAR

Mr. Pye Paing Heing

A Thesis Submitted in Partial Fulfillment of the Requirements

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การวิเคราะห์ต้นทุนประสิทธิผลของการผ่าตัดถุงน้ำดีทางกล้องวิดีทัศน์เปรียบเทียบกับการผ่าตัดถุงน้ำดีชนิดเปิดหน้าท้องของโรงพยาบาลเอกชนแห่งหนึ่งในสาธารณรัฐแห่งสหภาพเมียนมา

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การผ่าตัดถุงน้ำดีทางกล้องวิดีทัศน์เป็นวิธีหลักในการรักษาโรคนิ่วในถุงน้ำดีที่ไม่มีภาวะแทรกซ้อนในประเทศที่พัฒนาแล้ว เนื่องจากเวลาในการเข้าพักรักษาและเวลาในการพักฟื้นที่สั้นกว่า อย่างไรก็ตามผลการศึกษาดังกล่าวยังคงเป็นที่ถกเถียงกันอยู่ในประเทศกำลังพัฒนา การศึกษาครั้งนี้ มีจุดมุ่งหมายเพื่อทำการประเมินว่าการผ่าตัดถุงน้ำดีทางกล้องวิดีทัศน์มีต้นทุนประสิทธิผลที่ดีกว่าการผ่าตัดถุงน้ำดีโดยการผ่าตัดเปิดหน้าท้องหรือไม่ ในการรักษาโรคถุงน้ำดีในประเทศเมียนมา ข้อมูลต้นทุนและผลการรักษาที่ใช้ในการประเมินมาจากโรงพยาบาลเอกชนในเมืองย่างกุ้ง ประเทศเมียนมา ประสิทธิผลสองชนิดที่ใช้ในการศึกษานี้ คือ การไม่เกิดภาวะแทรกซ้อนจากการผ่าตัด และจำนวนการผ่าตัดที่ใช้ระยะเวลาพักรักษาตัวในโรงพยาบาลที่สั้นกว่า นอกจากนี้ การศึกษายังทำการทดสอบความอ่อนไหวของผลการศึกษา วิเคราะห์เพิ่มเติมเพื่อทดสอบ the robustness of the result โดยสรุปผลการศึกษาพบว่าการผ่าตัดถุงน้ำดีทางกล้องวิดีทัศน์มีต้นทุนประสิทธิผลที่มากกว่าการผ่าตัดถุงน้ำดีโดยการผ่าตัดเปิดหน้าท้อง โรงพยาบาลในประเทศเมียนมาจึงควรพิจารณาการใช้การผ่าตัดถุงน้ำดีทางกล้องวิดีทัศน์ในการรักษาโรคนิ่วในถุงน้ำดี เป็นอีกหนึ่งทางเลือก

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PYE PAING HEING: COST-EFFECTIVENESS ANALYSIS OF LAPAROSCOPIC CHOLECYSTECTOMY COMPARED WITH OPEN CHOLECYSTECTOMY AT A PRIVATE HOSPITAL IN MYANMAR. ADVISOR: ASST. PROF.TOUCHANUN KOMONPAISARN, Ph.D., CO-ADVISOR: PROF.SIRIPEN SUPAKANKUNTI, Ph.D., 115 pp.

Laparoscopic cholecystectomy (LC) has become the main treatment of uncomplicated gallstone diseases in developed countries due to shorter hospital stay, faster recovery time and other benefits. However, it is still controversial for developing countries. This study aims to evaluate whether laparoscopic cholecystectomy is more cost-effective than open cholecystectomy (OC) in the treatment of gallstone diseases in Myanmar. A cost-effectiveness analysis was evaluated from the provider perspective. The required cost and outcome data were obtained from a private hospital which is located in Yangon, Myanmar. Two outcomes are used as effectiveness in this study, namely cases of complications avoided and cases with shorter hospital stay. Sensitivity analysis was also performed to check the robustness of the result. In conclusion, LC is found to be more cost-effective than OC in the hospital of Myanmar. According to the result of this study, the hospitals in Myanmar should strongly consider to do further study and apply laparoscopic technique in the treatment of gallstone diseases.

Field of Study:	Health Economics and Health Care Management	Student's Signature	.....
		Advisor's Signature	.....
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ABBREVIATION

LC	Laparoscopic cholecystectomy
OC	Open cholecystectomy
CEA	Cost-effectiveness analysis
OT	Operation theatre
HR	Human Resource
M and E	Monitoring and Evaluation
S and P	Sale and Procurement

CHAPTER I
INTRODUCTION

1.1 Problems and Significance

Gallstones are solid particles formed from the digestive bile fluid which are located in the gallbladder. There are different sizes and shapes of gallstones. The smallest gallstone can be as small as sand of grain and the largest one can be as large as a golf ball. Gallstones arise when the chemical components of bile become imbalance (Njeze, 2013).

There are three types of gallstones: cholesterol stones, pigment stones and mixed stones. Although 80% of gallstone cases with gallstone diseases show asymptomatic, it has been predicted that 10-20% of cases change into symptomatic within five years. In asymptomatic patients, the risk of developing biliary complications such as acute pancreatitis and choledocholithiasis is 0.3% per year and chance of growing gallbladder cancer is 0.02% per year (Gallagher & Parks, 2014).

There are number of risk factors for formation of gallstones such as high biliary protein and lipid concentrations that can be precipitated by some predisposing factors such as obesity, diabetes mellitus, estrogen and pregnancy, hemolytic diseases and cirrhosis. Moreover, non-modifiable risk factors such as age, gender and genetic are also important in influencing gallstone diseases (Njeze, 2013).

It cannot be denied that gallstone diseases are becoming one of the most significant health problems which can lead to surgical procedures in either developed or developing countries. Nowadays, 10% to 20% of adult population is suffering from gallstone diseases. Although female to male ratio of incidence rate of gall stone diseases is 4:1 in young people, it becomes nearly equal in older population (Stinton & Shaffer, 2012).

In US alone, there are approximately 500,000 cases of cholecystectomies in every year leading to approximate 6.2 billion dollars which contain both direct and indirect costs. The cost has increased more than 20% over past three decades showing that gallstone diseases has become major health burden (Bruce D. Schirmer, Kathryne , & Edlich, 2005; Stinton & Shaffer, 2012).

There are different prevalence rate all over the world in different countries and areas especially in Asia. Figure 1 shows the world wide prevalence in females based on ultrasonographic surveys. From the figure, it can be seen that the percentages of prevalence rate of gallstone diseases for female in America are quite high and those in Asian countries are intermediate. Table 1 shows the prevalence of gallstones and gallbladder disease in sonographic and ultrasound surveys in Asian countries.

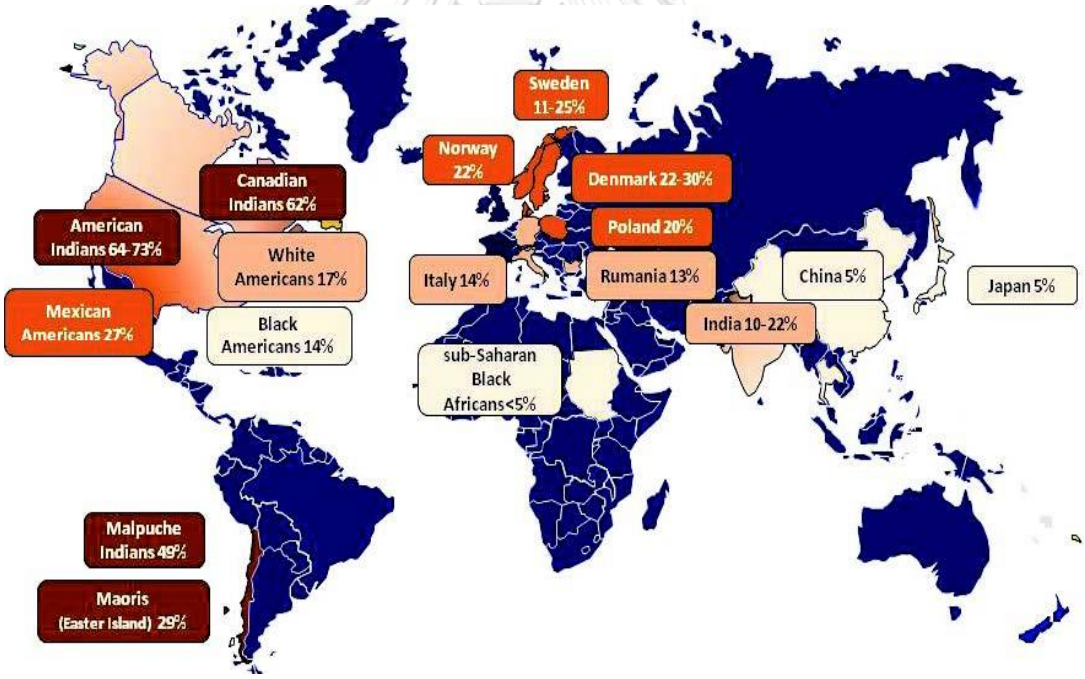

Figure 1: Worldwide Prevalence of Gallstones in Females based on Ultrasonographic Surveys

(Source: Epidemiology of Gallbladder Disease: Cholelithiasis and Cancer) (Stinton & Shaffer, 2012)

Table 1: Prevalence of Gallstones and Gallbladder Disease in Sonographic and Ultrasound surveys

Geographic Population	Prevalence (%)			Age Range (years)	Study	Number studied	Year
	Male	Female	Total				
Chandigarh, India	6.2	21.6	15.6	>15	Singh et al	248	2001
Srinagar, Kashmir (India)	3.1(0-8.1)	9.6 (2.0-29.1)	6.1	15-65	Khuroo et al	1104	1989
Taipei, Taiwan	10.7	11.5	10.7	>20	Khuroo et al	3647	1998
Chiayi (Taiwan)	4.5	4.6	4.6	30-70	Lu et al	923	1990
Jiaotong (China)	2.3	4.7	3.5	7–70	Zhao et al	15856	1990
Okinawa (Japan)	2.4	4	3.2	0–75	Nomura et al	2584	1988
Chiang Mai (Thailand)	2.5	3.7	3.1	20–70	Prathnadi et al	6146	1992

(Source: Epidemiology of Gallbladder Stone Disease) (A.Shaffer, 2006)

Although the prevalence of gallstone in Myanmar is unknown exactly, the gallstone diseases has become the significant problem within Myanmar population over the last decade. Due to changes of lifestyle of Myanmar people, gallstone related factors such as obesity, high cholesterol diet and diabetes are becoming popular resulting in rapid rise of gallstone diseases with an increasing trend.

There are three primary diagnosis methods for gallstone diseases: ultrasonography, nuclear scanning (cholescintigraphy), and oral cholecystography.

Among them, ultrasonography is widely used for diagnosis. There are two kinds of treatment methods for gallstone diseases. One is the conventional open cholecystectomy which was regarded as the gold standard procedure of all gallstone diseases until laparoscopic cholecystectomy was emerged. With the developing of modern medical technology in the whole world, minimally invasive laparoscopic procedure has become another main treatment of gallstone diseases. There are advantages and drawbacks for both open and laparoscopic cholecystectomy. For example, there is longer operating time in laparoscopic cholecystectomy while longer hospital stay in open cholecystectomy (Njeze, 2013).

Laparoscopic procedure is widely used in the clinical field for many years in some western developed countries. In Myanmar, both public and private hospitals introduced this laparoscopic technology only in the last decade. In 2010, laparoscopic method for cholecystectomy was started to use in the private sector of Myanmar and only after 2015, it has been widely accepted in both private and public hospitals in Myanmar (Thet, Tun, Win, & Tin, 2018). However, the laparoscopic method was not very popular and most of the hospitals were still using conventional surgery.

In Myanmar, the traditional method is open surgery which has been widely used for many years. In recent years, laparoscopic method for minimally invasive surgery is gradually promoted and the two procedures are becoming the main treatments for cholelithiasis and gallstone diseases in Myanmar. But there are different costs and effectiveness of these two treatments. According to many related literatures, there are many comparison studies between the two treatment methods which only focus on cost of patients related with length of hospital stay, operation time and so on. There is few research analysis of laparoscopic and open cholecystectomy from the provider perspective.

This study aims to analyze the cost-effectiveness of two treatment methods from the provider perspective. It is certain that the result of this study will be beneficial for both patients and hospitals in Myanmar. This study can provide the evidence for

decision making of providers and also deliver more reasonable policy suggestions for hospitals. This study also helps to provide basic decision making related with treating cost, payment methods and medical standards. The research result is not only for costing but also for estimating the effectiveness of the different treatment methods regarding gallstone diseases. Myanmar is now trying to develop payment mechanism of diagnosis-related group for Universal coverage so that the result of the research can support the theoretical basis of cost-effectiveness of open and laparoscopic cholecystectomy.

1.2 Research Questions

1.2.1 Primary Question

Which treatment method of laparoscopic cholecystectomy and open cholecystectomy is more cost-effective for gallstone diseases at a private hospital in Myanmar?

1.2.2 Secondary Questions

1. What are the costs of laparoscopic cholecystectomy and open cholecystectomy from the provider perspective at a private hospital in Myanmar?
2. What are the effectiveness of laparoscopic cholecystectomy and open cholecystectomy in term of two outcomes at a private hospital in Myanmar?
3. Is the cost-effectiveness result robust?

1.3 Objectives

1.3.1 General Objective

To calculate and compare the cost-effectiveness of two treatment methods which are laparoscopic cholecystectomy and open cholecystectomy at a private hospital in Myanmar?

1.3.2 Specific Objectives

1. To calculate the total costs of two treatments from the provider perspective at a private hospital in Myanmar?
2. To calculate the effectiveness of two treatments in term of two outcomes at a private hospital in Myanmar?
3. To calculate and compare the cost-effectiveness ratios of two treatments?

1.4 Scope of the Study

1. The study focused on the provider perspective in the calculation of cost-effectiveness. Provider perspective means the perspective from the hospital.
2. The study was done in a private hospital which is located in Yangon, Myanmar.
3. The data used in the study were patient medical records from the medical department and the operation theatre and medical bills from the finance department of a private hospital in Myanmar.
4. The study collected the relevant patient documents for two treatment methods within the period between December 2016 and December 2017.
5. Both laparoscopic and open cholecystectomy groups of patients had similar age period which were within 20-80 years.

1.5 Research Hypothesis

Laparoscopic cholecystectomy is more cost-effective than open cholecystectomy at a private hospital in Myanmar

1.6 Possible Benefits

This study has some possible benefits:
1. It can help to identify more effective, safe treatment method from the economic point of view through analysis.
2. It indicates which intervention provides the highest value for money and helps the decision makers choose the suitable surgical procedure.

3. It can also help to provide policy recommendations and concise suggestions for the hospitals. Based on the result of the study, the hospitals can make some technical improvement and can decide how to allocate and utilize the resources and how to establish payment criteria of treatment of gallstone diseases.

In conclusion, comparison of cost-effectiveness of two treatment methods give number of benefits not only from the clinical perspective but also from the monetary perspective. Hence, the result of this study will provide evidence and suggestions for hospital decision makers to either achieve rational resource allocation or improve utilization.

CHAPTER II
BACKGROUNG

2.1 Physiology of Gallbladder

There are two components of biliary system: extrahepatic and intrahepatic. The gallbladder is a part of extrahepatic biliary system. The gallbladder is located in a fossa that divides the right and the quadrant lobe of the liver. The gallbladder can be distinguished into three parts: fundus, body and neck. Approximately, 50ml of bile that is essential for digesting fat can be stored by the ordinary gallbladder(Ellis, 2011).

2.2 Cholelithiasis and Gallstone Diseases

Gallstones which are also known as cholelithiasis are formed within gallbladder as hardened crystalline deposits due to accumulation of bile components. There are different size and shape of gallstones. The smallest one can be as small as sand grain while the largest one can be a golf ball (Gallagher & Parks, 2014; Njeze, 2013).

Gallstones can be categorized into three main groups according to their composition and organic structure: cholesterol stones, pigment stones and mixed stones. For cholesterol stones, the color can be different from light yellow to dark green. They are radiolucent stones which are constituted with at least 80% cholesterol. For pigment stones, there are two types: brown and black pigment stones. Black pigment stones are radiopaque stones made with bilirubin, calcium salts and cholesterol which contributes for less than 20%. Brown pigment stones are common in Asia with the prevalence rate of 20% in some parts of China. Mixed stones are formed with 20%-80% cholesterol and other components such as calcium carbonate, palmitate phosphate, bilirubin and other bile pigments (Gallagher & Parks, 2014).

The following Figure 2 shows the percentage of different types of gallstones based on biochemical structure.

Classification of gallstones based on biochemical structure.	
	Gallbladder stones
Cholesterol stone (%)	58.3
Bilirubin stone	
Black-pigment stone (%)	23.7
Brown-pigment stone (%)	15.9
Others (%)	2.1

Figure 2: Classification of Gallstones based on Biochemical Structure

(Source: Epidemiology, Pathogenesis and Classification of Biliary Stones) (Tazuma, 2006)

There are many clinical presentations in gallstone diseases including acute presentation with biliary colic, acute cholecystitis and other complications such as choledocholithiasis and acute pancreatitis. The most common form of uncomplicated gallstone diseases is biliary colic in the epigastrium or right upper quadrant which is developed by obstruction of cystic duct due to gall stones in the neck of gallbladder. The pain can last from 30 minutes to 2 hours and sometimes up to 6 hours. If the gallstones in the neck of gallbladder block the cystic duct for more than 12 hours, it can lead to inflammation of gallbladder which is known as acute cholecystitis. If the treatment is delayed for acute cholecystitis, it can lead to many complications such as inflammatory infiltrates, oedema of the gallbladder wall and bacterial infection. In severe cases, necrosis of the gallbladder wall can be developed. If the gallstones from the gallbladder slip out into the common bile duct, common bile duct stones called choledocholithiasis appear. Gallstone diseases are also main factors of developing gallbladder cancer and acute pancreatitis which can lead to death (Gallagher & Parks, 2014; Noble & Johnson, 2015).

Figure 3 shows the clinical presentations of gallstone diseases.

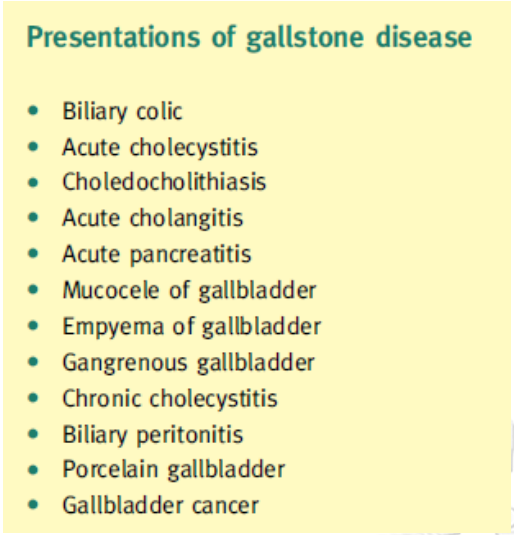

Figure 3: Clinical Presentation of Gallstone Diseases
(Source: Gallstones) (Gallagher & Parks, 2014)

There are many risk factors such as age, gender, genetic, obesity for formation of gallstones. When age increases, the risk of developing gallstones will rise up to 4 to 10 times. Gender is also important factor for gallstone diseases. Young female can suffer gallstone diseases twice than male because of pregnancy, hormonal treatment or use of hormonal contraception. However, the chance of getting gallstone diseases between male and female becomes equal when age increases. Family history and genetic can also precipitate the risk of rising gallstones. It is reported that family members can have five times increased risk of gallstone diseases if there is family history. There are also other important precipitating factors such as obesity and diabetes mellitus. Obese female have higher risk of gallstone diseases than male. Moreover, metabolic syndrome such as high blood pressure and diabetes mellitus are highly correlated with gallstone diseases. Lifestyle changes such as alcohol intake, less physical activity, high cholesterol diet and rapid weight loss can increase the risk of gallstone diseases (Njeze, 2013; Stinton & Shaffer, 2012).

There are many diagnostic tests to find presence of gallstones. Among them, ultrasonography is the most common diagnostic test which is regarded as gold

standard test for gallstones because over 90% of presence of gallstones can be shown by ultrasonography. Other tests such as computed tomography scan, magnetic resonance cholangiopancreatomography, endoscopic ultrasound, endoscopic retrograde cholangiopancreatography and biliary scintigraphy are also used according to the patient condition and types of gallstones (Njeze, 2013; Noble & Johnson, 2015).

2.3 Treatment Rationale for Gallstone Diseases

If the gallstone diseases are asymptomatic, treatment is not usually required. Prophylactic cholecystectomy is usually done in asymptomatic gallstone diseases if the gallstones are larger than 3 cm and the patients have sickle cell disease or diabetes and the patients are in certain specific groups such as children and elderly. If the symptoms of gallstone diseases are not persistent, elective cholecystectomy can be done (Njeze, 2013; Noble & Johnson, 2015).

Cholecystectomy is considered as the main treatment for symptomatic gallstone diseases. According to the theory of evidence-based medicine, there are two types of cholecystectomy which are divided based on patient condition and disease stages: open cholecystectomy and laparoscopic cholecystectomy.

Conventional open cholecystectomy was regarded as a gold standard surgical procedure for gallstone diseases before laparoscopic cholecystectomy was turned out. When the technique of surgical procedures improved, the large open cholecystectomy was replaced with minilaparotomy cholecystectomy which is also called small incision cholecystectomy. In 1998, the laparoscopic cholecystectomy was introduced and became popular due to its advantages such as shorter hospital stay, less operative pain, quick recovery and small scarring (Dijk et al., 2014; Njeze, 2013).

2.4 Healthcare System in Myanmar

Generally, there is no definite health insurance schemes as well as official insurance law in Myanmar. However, the health expenditure can be divided into four

categories: government, private household out-of-pocket, social security scheme and non-profit institutions serving households expenditure. Among them, the private household out-of-pocket led the total health care expenditure with more than 80% between 2001 and 2009. This indicates that the prepayment method such as insurance is still limited and not quite popular in Myanmar. While the government health care expenditure was increased about 9 times from $ 94 million in 2010-2011 to 850 million US$ in 2016-2017, it was still far behind the private household out-of-pocket expenditure (Sein et al., 2014).

Figure 4 shows the health expenditure of Myanmar by financing agents in 2014. While out-of-pocket expenditure was the main payment mechanism for the patients in both public and private hospitals, expenditure of government and public hospitals accounted only for 15%. Expenditure of international non-governmental organizations and social security scheme stood for 6% and 1% respectively (Sein et al., 2014).

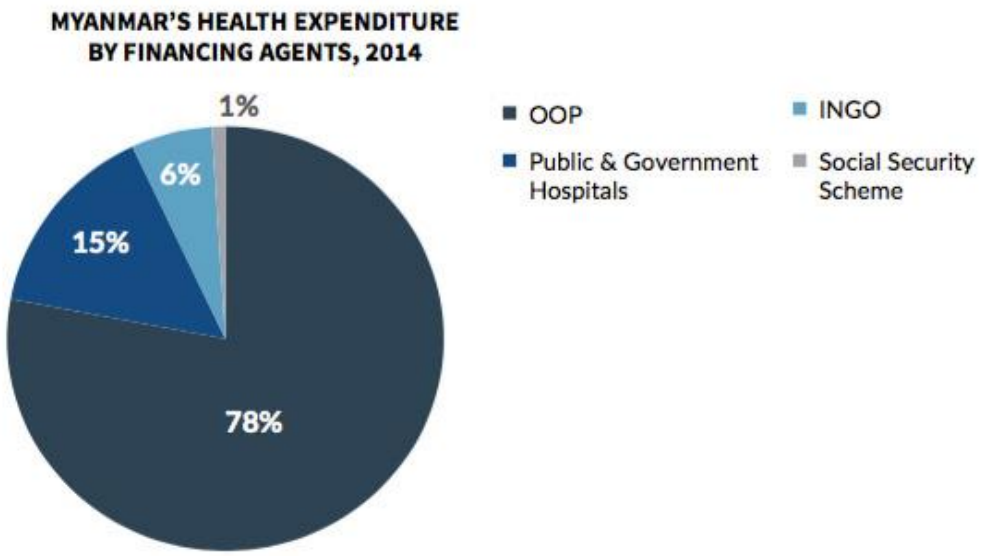

Figure 4: Health Expenditure of Myanmar by Financing Agents in 2014
(Source: The Republic of the Union of Myanmar Health System Review) (Sein et al., 2014)

2.5 General Characteristics of Public Hospitals in Myanmar

The following table shows the overview of public hospital services including outpatient and inpatient services.

Table 2: Hospital Service Indicators of Myanmar in 2013

No	Hospital service indicators	Year 2013
1	Number of public hospitals	969
2	Number of sanctioned beds	44,046
3	Number of available beds	48,035
4	Number of admission	1,793,000
5	Number of deaths	32,000
6	Number of patient days	9,878,000
7	Number of surgical operations	432,000
8	Percent of bed occupancy based on available beds	56%
9	Average number of inpatients per day	27,000
10	Average number of outpatients per day	23,000
11	Average duration of stay (in days)	5.5
12	Hospital death rate	1.8

(Source: Annual Hospital Statistics Report 2013) (Annual Hospital Statistics Report 2013, 2015)

2.6 Back Ground Information of Place for Research (Yangon, Myanmar)

According to statistics, healthcare spending of Yangon, commercial city of Myanmar, was approximately 20% of total healthcare expenditure in Myanmar in 2012. Moreover, health care expenditure per capita of Yangon was twice than that of the whole country, Myanmar. While Yangon spent 55 dollars per capita in 2012, Myanmar's healthcare expenditure per capita was only 23 dollars. The difference is prominent because most of the surgical procedures including cholecystectomy cases are performed only in the hospitals located in Yangon due to adequate facilities and

skillful specialists. Figure 5 shows the comparison of healthcare spending between Myanmar and Yangon.

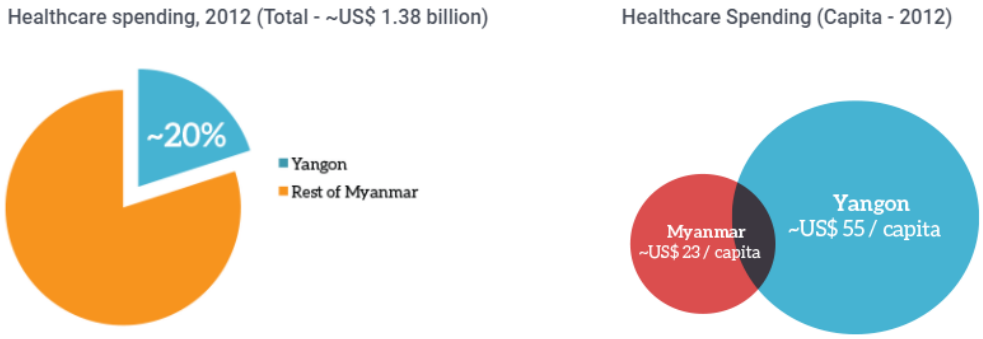

Figure 5: Comparison of Healthcare Spending between Myanmar and Yangon (Source: Asia Healthcare Market Research) ("Myanmar Healthcare Industry Insights," 2014)

In Myanmar, there are three main segments in hospital market: public sector government hospitals, private sector polyclinics and private sector hospitals. In 2012, there were 944 public hospitals under Ministry of Health, 26 public hospitals under other Ministries, 166 private hospitals and 444 private polyclinics (Sein et al., 2014).

Among total 994 public hospitals under Ministry of Health and 116 private hospitals of the whole country, Myanmar, 8% of public hospitals and 36% of private hospitals are resided in Yangon which is the former capital city of Myanmar. Private hospital market of Yangon was the largest one in Myanmar in 2012 and it is still expanding until now (Sein et al., 2014).

According to Asia Healthcare Market Research, there are total 119 public and private hospitals in 2012 in Yangon. Out of total 119 hospitals, private hospitals comprise 38% and public hospitals possess 62%.

Moreover, Yangon has higher hospital beds not only in public hospitals but also in private hospitals than other states and divisions in Myanmar. Figure 6 shows

percentage of public and private hospitals in Yangon in 2012 and comparison of hospital beds between Yangon and Myanmar.

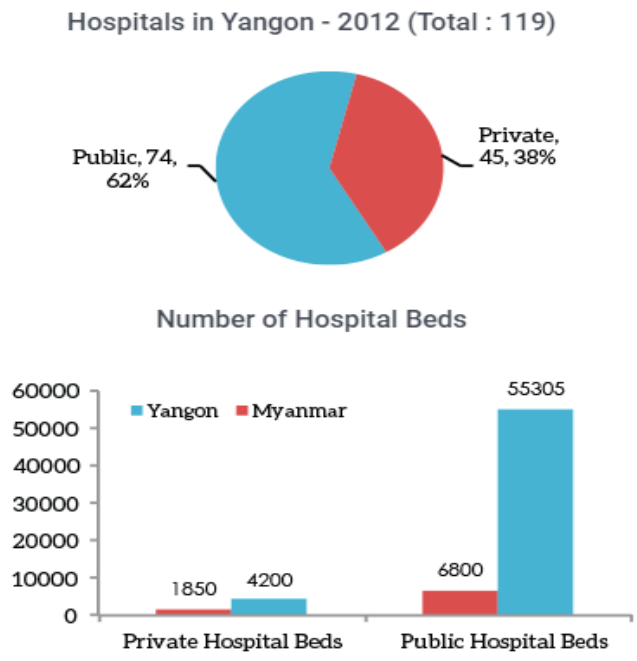

Figure 6: Hospitals in Yangon in 2012 and Comparison of Hospital Beds between Yangon and Myanmar

(Source: Asia Healthcare Market Research) ("Myanmar Healthcare Industry Insights," 2014)

2.7 Background Information of a Private Hospital in Myanmar for Research

In this study, data were collected from a private hospital which is located in Yangon, Myanmar. The private hospital which was founded in 2000 is one of the most successful private hospitals in Myanmar. It is an 11th storey twin building which have 200 beds. It provides multidisciplinary medical care services including outpatient and inpatient treatment, wide-ranging investigations and diagnosis by using modern medical equipment. It also offers prompt and effective treatment to the patients supported by well-trained residential medical doctors, nurses and expert professionals at every respective department. 160 specialists and 1200 staffs are currently working in the private hospital.

The private hospital in Yangon, Myanmar is chosen for this study because it is one of the leading private hospitals in the market of cholecystectomy. The hospital introduced the laparoscopic technology since the year of 2010. It is one of the earliest hospitals which started laparoscopic cholecystectomy among both public and private sectors. There are around 700 surgical cases per month including open and laparoscopic procedures in the private hospital. Now, there are 7 surgeons and 9 anesthetists who are currently implementing either laparoscopic or open cholecystectomy in that private hospital.

In the private hospital, the main payment mechanism of the patients for two surgical procedures is out-of-pocket payment method which accounts for more than 99% expenditure of the patients. The other payment comes from two foreign insurance companies which are directly connected with the hospital. The insurance from the foreign companies cover all cost related with laparoscopic or open cholecystectomies so that there is no limitation in both out-of-pocket and insurance when calculating the cost of two surgical procedures.

Table 3 shows the summary of general characteristic of the private hospital. The table includes founded year of the hospital, location, building and services, number of patient rooms, number of operating rooms, number of specialists, residing medical doctors, nurses and staff, average number of operations per year and bed occupancy rate.

Table 3: Summary of General Characteristic of the Private Hospital for Research

Hospital Summary	
▪ Founded Year	2000
▪ Location	Yangon, Myanmar
▪ Building	11th storey twin building
▪ Services	Outpatient + Inpatient
▪ Number of patient rooms	220
▪ Number of operating rooms	4 rooms
▪ Number of specialists	160
▪ Number of residing medical doctors	88
▪ Number of nurses	260
▪ Number of staff	1,200
▪ Average number of operations per year	>8,000 cases
▪ Bed occupancy rate	97%

(Source: Website of the Private Hospital)

This study was done in the private hospital because of time limitation of the study. The reason is that data can be accessed easily in the private hospital and it takes long time for permission to request data in the public hospital. Moreover, because of the improper data storage system of the public hospitals in Myanmar, it is quite difficult to do research regarding data requesting and accessing in the public hospitals. Hence, the study aims to do in the private hospital which is the first leading hospital of in the field of cholecystectomy in Yangon, Myanmar.

CHAPTER III

LITERATURE REVIEW

According to some related studies of the two treatment methods which are laparoscopic and open cholecystectomy, 5 types of relevant researches which should be included in the literature review of this study are found.

1. Economic evaluation in health care system and clinical fields
2. Cost-effectiveness analysis in health care field
3. Laparoscopic cholecystectomy review
4. Open cholecystectomy review
5. Past Study on comparison of laparoscopic and open cholecystectomy
6. Decision Tree Pathway for complications of laparoscopic and open cholecystectomy

Many researchers use the cost-effectiveness analysis which is one of the methods of economic evaluation tools to calculate interventions and treatment of diseases. While some researchers consider the cost analysis, some only analyze the patient outcome. Moreover, some studies draw the decision tree analysis to estimate the different clinical outcomes of the interventions.

3.1 Economic Evaluation in Health Care System and Clinical Fields

Economic evaluation is an important major tool in the health economics. It is the method of systematic identification, measurement and assessment of inputs and outcomes of two or more alternative events to succeed the best result. It helps decision makers to make decision how to allocate available resources. In the health care sector, because of health care limited resources, economic evaluation helps to compare the costs and different health care interventions to achieve the maximizing health benefits. Economic evaluation is also widely used in not only health economics but also health technology assessment. In the past few years, trend of economic

evaluation has been increased rapidly to use in the health field of Asian countries (Brazier, Deverill, & Green, 1999; Dang, Likhar, & Alok, 2016; Rezapour, Jafari, Mirmasoudi, & Talebianpour, 2017).

There are four different types of economic evaluation which are cost-minimization, cost-effectiveness analysis, cost-utility analysis and cost-benefit analysis in the health care setting. In cost-minimization analysis which is also called cost-comparative analysis, only costs of interventions are compared and measured in monetary term. Outcomes of interventions have to be the same in the cost-minimization analysis.

Cost-effectiveness analysis compares the costs of different interventions to attain a common outcome. In cost-effectiveness analysis, health outcomes are measured in natural units such as life saved from treatment so that units of costs and outcomes are not the same and cannot compare to each other. The result of cost-effectiveness analysis will be cost per unit of outcome or units of outcome per dollar spent.

Cost-utility analysis is similar to cost-effectiveness analysis on the cost side but outcome is measured by utility based measures such as disability-adjusted life years gained or quality-adjusted life years gained which is widely used in cost-utility analysis. Cost per utility gained is expressed as the result of cost-utility analysis. In cost-benefit analysis, both cost and outcome are measured in monetary term such as dollars. But in real practice, it is difficult to measure health benefits as monetary term so that there are some restrictions to use cost-benefit analysis in health care.

Among four types of economic evaluation, cot-minimization is partial evaluation and the remaining three methods are full economic evaluation. All types of economic evaluation are widely used in health care setting. Undoubtedly, economic evaluation is vital for health care system because of three reasons. Firstly, systematic analysis is needed to classify the appropriate alternatives compared with the existing

health interventions. For example, it is difficult to realize cost-effectiveness of one intervention if there is no alternative to compare. Secondly, perspective used in an analysis is essential for health system. For example, although one health care program from the patient perspective may not be important, it may become significant from the society perspective because of the inclusion of different costs. Last but not least, without measurement and comparison of inputs and outputs, it is difficult to identify value for money for health care programs. From these facts, it is clear that economic evaluation stands as a critical tool in health field.

With the development of advanced technology and numerous innovative medical procedures of diagnosis and treatment of the same disease, it becomes challenging for decision makers to choose the appropriate and reasonable interventions or treatment for the patients. To solve this problem, economic evaluation can assess the different interventions or treatment to provide the reliable result to the decision makers.

This study used cost-effectiveness analysis which is one of the methods of economic evaluation to analyze the treatment technique of gallstone diseases, to compare the new surgical procedure which is laparoscopic cholecystectomy to open cholecystectomy and to provide comparison information to the policy makers (Drummond, Sculpher, Torrance, O'Brien, & Stoddart, 2005; Palmer, Byford, & Raftery, 1999).

3.2 Cost-effectiveness Analysis in Health Care Field

Cost-effectiveness analysis is the method of economic evaluation to evaluate health and clinical interventions to know whether health benefits of that interventions are value for money. Cost-effectiveness analysis is done to assist decision makers allocate limited health resources efficiently.

Normally, cost-effectiveness analysis compares the costs and outcomes of two health interventions. Costs are expressed as dollars and health outcomes as natural units of health that can vary from short term and medium term outcomes such as hospitalization days averted to long term outcomes such as life saved from treatment, a case of cancer averted. Cost-effectiveness analysis shows the result by calculating cost-effectiveness ratio which is the ratio of dollars spent to units of health outcome obtained. Hence, the result will be dollars spent per unit of health outcome. The cost-effectiveness analysis compares same health outcomes of two health interventions so that various clinical areas which have different clinical outcomes cannot be compared.

In cost-effectiveness analysis, when one intervention is more effective but more expensive than alternative one, incremental cost-effectiveness ratio is calculated to estimate the additional costs per unit of outcome. Incremental cost-effectiveness ratio is the ratio of difference in costs divided by difference in units of health outcome of two interventions. From this formula, it can be predicted for the amount of additional costs to increase one unit of outcome of desired intervention (LL & AB, 2000; NA & HG, 1998).

The study used cost-effectiveness analysis due to two reasons. Firstly, this study collected the data of immediate outcomes which are direct index of effectiveness so that effectiveness index produced better result. Secondly, it is difficult to find effectiveness as monetary term in health care so that this study used cost-effectiveness analysis to compare and count the same outcomes.

3.3 Laparoscopic Cholecystectomy

Laparoscopic cholecystectomy is a surgical procedure of minimally invasive method in which the gallbladder is removed by using laparoscopic technique. The laparoscopic surgery has become popular since the early 1990s for the treatment of gallstone diseases related with acute and chronic cholecystitis, symptomatic

cholelithiasis, biliary dyskinesia, acalculous cholecystitis, gallstone pancreatitis, and gallbladder masses or polyps.

Laparoscopic cholecystectomy is contraindicated if the patient cannot tolerate pneumoperitoneum or general anesthesia or the patient has severe coagulopathy or metastatic diseases. There are many benefits in laparoscopic procedures including less post- operative pain due to small incisions, faster recovery, lesser days of hospital stay, early going back to work or doing household chores. Moreover, there may be less internal scarring when the procedures are performed in a minimally invasive fashion compared to standard open surgery.

The equipment needed for laparoscopic cholecystectomy are two laparoscopic monitors, one laparoscope containing camera cord and light source, carbon dioxide source and tubing for inflation, trocars, laparoscopic instruments such as Atraumatic graspers, Maryland grasper, clip applier, electrocautery and other surgical instruments such as scalpel, forceps, needle driver, and absorbable sutures. Although laparoscopic procedure is popular, it requires the skillful, experienced surgeons and nurses to perform this surgical procedure. To become a safe procedure, diagnostic tests such as ultrasound should be done. Ultrasound will shows the shape and size of gallstones, information status of gallbladder and surrounding structures such as common bile duct (Hassler & Jones, 2017; Litwin & Cahan, 2008).

The laparoscopic surgery can lead to complications including bleeding, infection, damaging to surrounding structures and accidental common bile duct or hepatic duct injury which is the most severe complication. Occurrence of common bile duct injury in laparoscopic cholecystectomy is higher than that of open cholecystectomy. It is published that six cases of laparoscopic cholecystectomy has related to common bile duct injury when 5200 laparoscopic cases are collected over 14 years. To prevent bile duct injury, it is suggested that routine cholangiography which is imaging technique of showing common bile duct should be performed instead of intraoperative cholangiography (Hassler & Jones, 2017; Litwin & Cahan, 2008).

3.4 Open Cholecystectomy

Open cholecystectomy is the procedure which removes the gall bladder by doing incision in the abdomen. Although laparoscopic cholecystectomy is regarded as the primary choice in gall bladder removal, open surgery is still used in certain conditions. The suggestions for open cholecystectomy are cirrhosis, history of upper abdominal surgery, other comorbid situations and less experienced surgeon with laparoscopic procedure. Moreover, in gallbladder-related conditions such as gallbladder cancer, gallbladder mass and cholecystobiliary fistula, open procedure is performed (McAneny, 2008; MW & JG, 2017; Visser, Parks, & Garden, 2008). The complications such as pneumoperitoneum, peritoneal abscess, surgical exploration and thermocoagulation while doing laparoscopic procedure, can also lead to change to open surgery (Genc et al., 2010).

The common complications for open surgery includes high chance of getting hernia formation, wound infection, thromboembolic or cardiopulmonary problems, urinary tract problems and hematoma due to large incision. Other complications such as bile leak and bile duct injury, bleeding, peritonitis and pancreatitis can also occur in the open cholecystectomy (McAneny, 2008). Compared with laparoscopic procedure, complication rate, hospital stay, recovery time and costs in open surgery are certainly higher (MW & JG, 2017).

3.5 Past Study on Comparison of Laparoscopic and Open Cholecystectomy

It has been a controversial issue whether which method is more effective and cost saving between laparoscopic and open cholecystectomy for a long time. Hence, many researchers tried to compare the cost and outcomes of both surgical procedures by using different methods of economic analysis.

Laparoscopic cholecystectomy became popular in the removal of gall bladder as an alternative method of open surgery since it had been introduced so that Mcintyre et al. (1992) tried to compare the outcomes and cost of these two cholecystectomy

operations. Mcintyre et al. (1992) did the research at Rose Medical Center which is university related private teaching hospital. They collected prospective data of 100 cases for laparoscopic surgery between July 1990 and June 1991 and did retrospective study of 100 cases for open surgery. In order to equivalent to two study groups, Mcintyre et al. (1992) decided to exclude the complicated and emergency cases such as acute cholecystitis or possible choledocholithiasis and only considered the elective cases of both treatments. Complications in their study were indicated as cases that were necessary for prompt treatment or delayed hospital discharge. Mcintyre et al. (1992) also considered charges for both in-patient and complication treatment, but did not take into account doctors' fees. Mcintyre et al. (1992) used the statistical method of two tailed t-test to find mean data and chi square test for percentages. As the result, Mcintyre et al. (1992) stated that the laparoscopic cholecystectomy was more effective than open cholecystectomy. Apart from average total operative time (107mins vs 72mins), other outcomes such as practice of intraoperative cholangiography (24% vs 93%), use of surgical drains (4% vs 27%), rate of complications (3% vs 4%) and average admission days (1.6days vs 4.8days) were lower in laparoscopic surgery compared to open surgery. The authors also found that the hospital charges paid by patients for laparoscopic surgery ($6,471) was also cheaper than that of open surgery ($8,896). Hence, Mcintyre et al. (1992) concluded that laparoscopic surgery was alternative method for open surgery in term of cost and effect (McINTYRE, ZOETER, WEIL, & COHEN, 1992).

There was another similar research on cost and outcomes of laparoscopic and open surgical procedures which was studied by Schirmer and Dix at the teaching hospital of University of Vrigina Health Science Center in the United States in 1992. The retrospective study included 30 cases from each surgical procedure which was done by the same surgeon. The authors excluded the patients with concomitant diseases or the cases with long admission more than one week. The authors used either one way analysis of variance or Chi square test to find mean and standard error of mean. After calculation of outcome data, authors found that although average operative time of open procedure was less than laparoscopic (92.1mins vs 117.7mins),

the latter had lower admission days (1.0 day vs 3.6 days) and faster recovery days (8.6 days vs 32.4 days) than the former procedure. For the cost calculation, cost of open procedure was lower than laparoscopic procedure in term of charges of operating theater including charges of operating room, post anesthesia care unit and anesthesia except specialist fee. However, total admission costs of laparoscopic and open procedures were $5,606 and $4,831 so that the former saved $775 more than that of open procedure per patient. Hence, authors resulted that laparoscopic procedure was more cost saving and better outcome than open procedure (Bruce D. Schirmer & Dix, 1992).

McKellar et al. (1995) believed that most of the researches only emphasized on the benefits of laparoscopic treatment so that they decided to evaluate the cost-effectiveness of laparoscopic method compared with open method. They did the retrospective study in a community hospital of the United States which was allied with the university. They collected the data of 246 laparoscopic cases which were performed during 1990 and that of 211 open cases which were implemented during 1989. They excluded the operation cases with bile duct exploration and conversion from laparoscopic to open procedure during operation. They considered other factors affecting cost such as operative time, use of cholangiogram and laser during surgery, use of endoscopic retrograde cholangiopancreatography before operation and during admission. The authors decided to use days of recovery to normal work after operation as outcome because they thought that recovery time was main contributor in the procedure of calculating cost-effectiveness. To know the details when the patients could go to work within how many days, they chose 50 random patients from each laparoscopic and open group and telephoned them to collect the data. In consideration of cost, the authors calculated the cost in term of admission charges, operation doctor fees and anesthesiologist fees obtained from the financial department and operation theatre. The authors also divided the two treatment groups into emergency and elective groups. The authors used statistical analysis by mean of variance analysis or Chi square to calculate cost and outcome. After calculation, the authors stated that the total cost of laparoscopic method ($6,695.67) was higher than

that of open method ($6,993.31). However, for the outcome, there was huge difference of recovery days between laparoscopic and open methods (29days vs 8days). The authors concluded that although cost of laparoscopic method was greater than that of open method, outcome in term of recovery days involved a great participation in considering cost-effectiveness (McKellar et al., 1995).

After showing laparoscopic being better replacement for open cholecystectomy in former years, Berggren et al. (1996) analyzed the cost of both laparoscopic and open methods from perspective of society. The authors collected the data of 211 cholecystectomy cases from Uppsala University Hospital. The evaluation method used in the article was cost minimization analysis with clinical decision tree including both direct and indirect costs and one way sensitivity analysis. Hence, the authors assumed that the outcomes of two treatments were the same. After analysis, the authors found that when they calculated only direct costs, the cost of laparoscopic surgery was higher than open surgery. However, after indirect costs were added to get final costs of both procedures, then laparoscopic surgery was more cost saving with $309 per case than open surgery if annual laparoscopic operations were done 68 cases minimally. For sensitivity analysis, the authors changed conversion rate from laparoscopic to open surgery and laparoscopic operating time separately and they found that open surgery was more money-saving if there were 19% conversion rate and laparoscopic operating time longer than 134 min. The authors finalized that although laparoscopic surgery can save more money than open surgery from society view, there was no incentive for hospitals due to high cost of investment in the laparoscopic equipment so that Berggren et al. (1996) suggested National Social Insurance Board to support the hospitals for the development of laparoscopic technique (Berggren, Zethraeus, Arvidsson, Haglund, & Jonsson, 1996).

Because of the requirement of expensive equipment and highly training skills in laparoscopic surgery, Srivastava et al. (2001) decided to examine the cost effectiveness to compare laparoscopic and mini laparotomy cholecystectomy from the view of society. The authors stated that mini laparotomy cholecystectomy was an

alternative form of open cholecystectomy. The authors conducted the prospective study during the period from July 1995 to April 1997 by choosing 100 patients randomly (59 patients for laparoscopic cholecystectomy and 41 patients for mini laparotomy cholecystectomy). However, if the patients have obstructive jaundice history or ultrasound shows there are stones in the common bile duct, the formers were excluded. The authors regarded success or failure as outcomes. Procedures with no injury of bile duct and surrounding structures, least wound pain and wound discharge within 4 weeks and return to work within 2 weeks were defined as success. The authors also assessed not only direct costs including operation cost, equipment cost, pharmacy cost, diagnosis cost, hospitalization cost but also indirect costs including transport cost of both procedures. The authors stated that 50 cases out of total 59 patients showed the successful outcomes in laparoscopic cholecystectomy while only 15 cases out of total 40 patients were successful in mini laparotomy cholecystectomy. After calculation, total costs for both laparoscopic and min laparotomy cholecystectomy were 386,769 rupees and 205,041 rupees respectively. Hence, the authors resulted that cost per case with success in laparoscopic cholecystectomy was 7,735.38 rupees which were lower than that of mini laparotomy cholecystectomy (13,669.40 rupees). Lastly, Srivastava et al. (2001) advised that because laparoscopic method could save more money than mini laparotomy method, Indian public hospitals should train to produce skilled surgeons and apply the laparoscopic technology (Srivastava et al., 2001).

In 2005, Teerawattananon and Mugford did the research to compare the cost-effectiveness of laparoscopic and open cholecystectomy for Thailand. They evaluated their study from both governmental and societal perspective at Chiang Rai Hospital which is one of the public regional hospitals. They used outcome in term of quality adjusted life years (QALYs) and collected corresponding information by carrying out the systematic review from the international and national published articles. For the cost, they performed 32 cases of retrospective (September to November 2004) and another 32 cases of prospective (October 2002 to September 2004) review of patient medical records from the hospital to calculate direct and indirect costs. For the

prospective review, they contacted to the patients and conducted the cost questionnaire by using face to face or telephone interviews. They also did the probabilistic sensitivity analysis to check the robust of result. After calculation, the authors stated that for changing from open to laparoscopic method, incremental cost per QALY was 134,000 Baht for governmental view and 89,000 Baht from societal view. However, the authors pointed that unless the minimum value of willingness to pay was 270,000 Baht per QALY for governmental view and 190,000 Baht per QALY for societal view, the probabilities of preferable from open to laparoscopic method would be less than 95%. The authors concluded that laparoscopic method would be cost-effective if threshold was three times gross domestic product per capita of Thailand (Teerawattananon & Mugford, 2005).

Silverstein et al. (2016) believed that laparoscopic method was popular in developed countries due to many benefits but not in developing countries. Hence, the authors decided to do the research to evaluate the cost-effectiveness of both laparoscopic and traditional open cholecystectomy from the view of society at 350 bedded tertiary care hospital in Rwanda, namely Rwanda Military Hospital. The authors calculated the cost and outcome by using decision tree and took the probabilities of decision tree from the other articles The authors evaluated the effectiveness measures by using quality-adjusted life years (QAYLs). To check whether the result was consistent or not, authors tested the result with one way sensitivity analysis, two way sensitivity analysis, Monte Carlo simulation and probabilistic sensitivity analysis. After calculation, the authors resulted that the costs for laparoscopic and open methods were $2,664 and $2,058 respectively and outcomes were 0.87 and 0.75 respectively. The incremental cost-effectiveness ratio changing from open to laparoscopic procedure was $4,946.18 per QALY. After doing sensitivity analysis, the authors stated that if the primary cost of laparoscope was lower than $91,979, annual operation cases were more than 65 cases and larger willingness to pay was larger than $3,975/QALY, laparoscopic method would be more cost-effective than open method. The authors concluded that the suitable method for Rwanda was open cholecystectomy because GDP per capita was lower than wiliness to pay threshold. While laparoscopic method

was expensive, authors suggested that policy makers should make decisions according to not only cost-effectiveness result but also other benefits of laparoscopic method. The authors also advised to improve other alternative ways for decreasing laparoscopic cost to overcome that obstacle (Silverstein et al., 2016).

3.5.1 Mapping of Past Study on Comparison of LC and OC

Author/Year	Questions / Objectives	Design features / Form of analysis	Findings / Argument	Conclusion
Mcintyre et al. (1992)	-To calculate and compare the cost and outcome of laparoscopic and open cholecystectomy	-Statistical analysis (Mean data by two tailed T-test and percentages by Chi square)	-Open cholecystectomy had greater use of intraoperative cholangiography and surgical drains, larger complication rate, longer average admission days and higher cost than laparoscopic method	-Authors stated that the laparoscopic cholecystectomy was not only money saving but also efficient to improve impact of health outcome

Schirmer & Dix (1992)	-To calculate and compare the cost and outcome of laparoscopic and open cholecystectomy	-Statistical analysis by using one way analysis of variance or Chi square test	-Apart from operative time, laparoscopic procedure revealed lower admission days, faster recovery days and lesser cost than open procedure	-Authors resulted that laparoscopic procedure was more cost saving and better outcome than open procedure
McKellar et al. (1995)	-To calculate and compare the cost and outcome of laparoscopic and open cholecystectomy	-Statistical analysis in term of variance analysis and chi square	-Total cost of laparoscopic method ($6,695.67) was higher than that of open method ($6993.31). But for the outcome, there was huge difference of recovery days between laparoscopic and open methods (8days vs 29days)	-The authors concluded that although cost of laparoscopic method was greater than that of open method, outcome in term of recovery days involved a great participation in considering cost-effectiveness

Berggren et al. (1996)	-To calculate and compare the cost of laparoscopic and open cholecystectomy from perspective of society	-Cost minimization analysis by mean of decision tree -One way sensitivity analysis	-Laparoscopic surgery saved more money ($309 per case) than open surgery if annual laparoscopic cases were done 68 cases minimally	-National Social Insurance Board should support the hospitals for the development of laparoscopic technique due to high cost of laparoscopic investment
Srivastava et al. (2001)	-To compare the cost-effectiveness of laparoscopic cholecystectomy and mini laparotomy cholecystectomy from perspective of society	-Cost-effectiveness analysis -Incremental cost-effectiveness ratio	-Cost per case with success in laparoscopic cholecystectomy was 7,735.38 rupees which were lower than that of mini laparotomy cholecystectomy (13,669.40 rupees)	-Authors advised that because laparoscopic method could save more money than mini laparotomy method, Indian public hospitals should train to produce skilled surgeons and apply the laparoscopic technology

Teerawattananon & Mugford (2005)	-To compare the cost-effectiveness of laparoscopic and open cholecystectomy from perspective of society and government	-Cost-utility analysis -Incremental cost-effectiveness ratio - Probabilistic sensitivity analysis	- For changing from open to laparoscopic method, incremental cost per QALY was 134,000 Baht for governmental view and 89,000 from societal view	- The authors concluded that laparoscopic method would be cost-effective if threshold was three times gross domestic product per capita of Thailand
Silverstein et al. (2016)	-To estimate whether laparoscopic cholecystectomy is cost-effective than open method from perspective of society in lower and middle income countries	-Cost effective analysis by mean of decision tree -Incremental cost-effectiveness ratio -One way and two way sensitivity analysis, probabilistic sensitivity	-Laparoscopic method would be more cost-effective than open method if the primary cost of laparoscope was lower than $91,979, annual operation cases were more than 65 cases and willingness to	-Authors suggested that policy makers should make decisions according to not only cost-effectiveness result but also other benefits of laparoscopic method -Authors suggested to improve other alternative ways for

		analysis, Monte Carlo stimulation	pay was larger than $3,975/QALY	decreasing laparoscopic cost to overcome that obstacle

3.6 Decision Tree Pathway for Complications of LC and OC

Decision tee analysis is done to show the pathway for complications of both laparoscopic and open cholecystectomy. Complications of both treatment can be divided into two parts: intraoperative complications which occur during operation and postoperative complications which occur after operation. According to research articles, major complications of both two treatments are the same. Most common intraoperative complications include injury of surrounding major retroperitoneal vessels such as aorta and vena cava, injury of common bile duct, perforation of bowel or bladder and conversion of open cholecystectomy from laparoscopic cholecystectomy during operation. For common postoperative complications, bleeding, wound infection and bile leak are involved. Hence, decision tree pathway can be drawn according to the complications obtained from articles.

Table 5 shows the percentages of complications of both laparoscopic and open cholecystectomy. These percentages are obtained from the published articles of the literature review.

Table 5: Percentages of Complications of Laparoscopic and Open cholecystectomy

Complications	Laparoscopic cholecystectomy	Open cholecystectomy
Bile leak	0.9% (Wolf, Nijsse, Sokal, & Chang, 2009)	1.5% (Wolf et al., 2009)
Wound infection	0.23% (Hannan, Imperato, Nenner, & Starr, 1999)	2.16% (Hannan et al., 1999)
Bleeding	0.59% (Hannan et al., 1999) 0.2% (Wolf et al., 2009)	1.37% (Hannan et al., 1999) 0% (Wolf et al., 2009)
Emphysema	0.82% (Hannan et al., 1999)	1.72% (Hannan et al., 1999)

Injury of major vessels	8% (Harvey R & Hartman, 1993)	
Injury of common bile duct	31% (Harvey R & Hartman, 1993)	

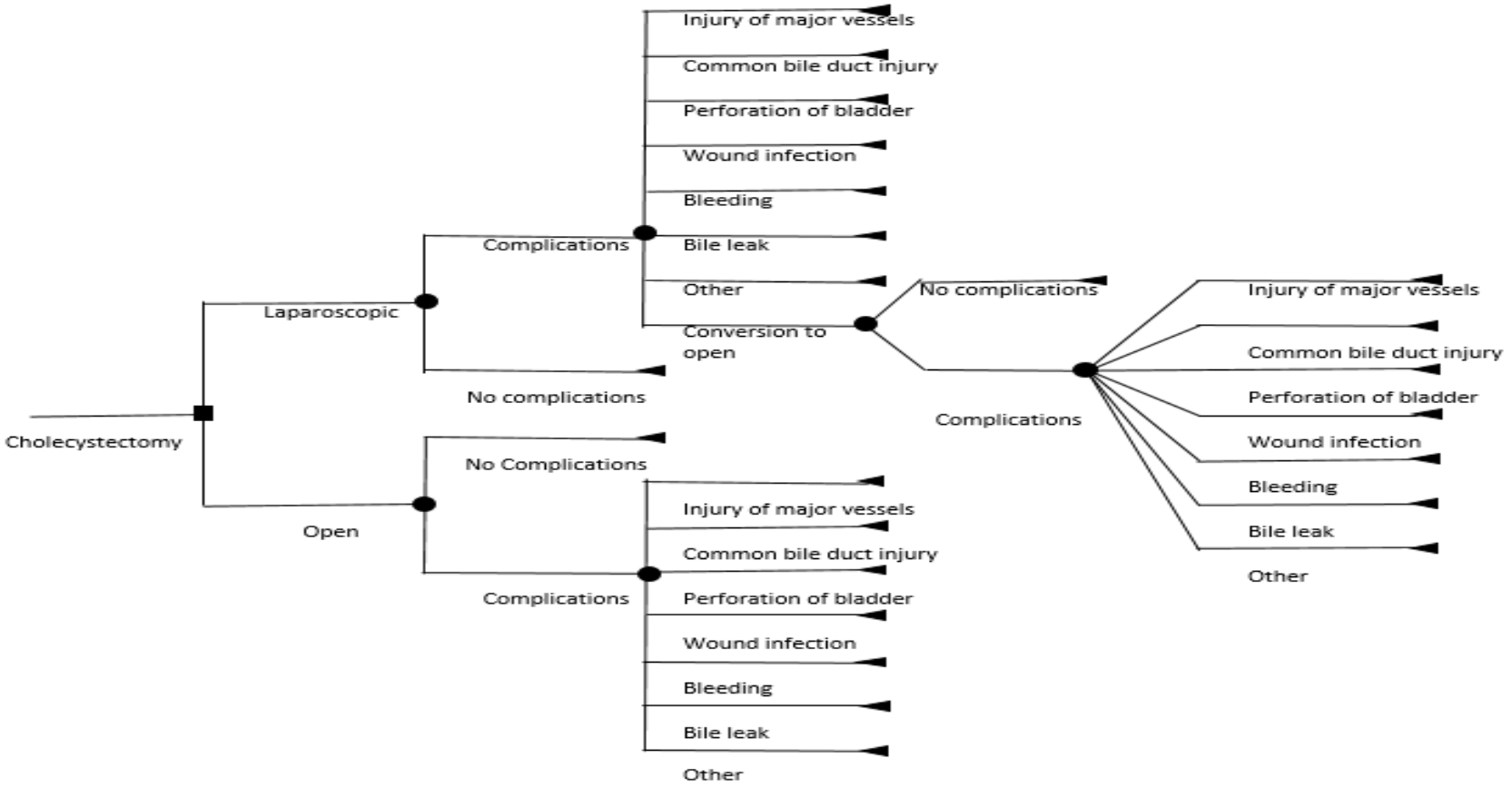

Figure 7: Decision Tree showing Complications of Laparoscopic and Open Cholecystectomy

Sources for complications: (McINTYRE, et al., 1992),(Schirmer & Dix, 1992),(McKellar, et al., 1995),(Berggren, et al., 1996), (Srivastava, et al., 2001), (Teerawattananon & Mugford, 2005), (Silverstein, et al., 2016)

3.7 Summary and Gap

There are few studies about cost-effectiveness of laparoscopic cholecystectomy compared with open cholecystectomy from the view of provider. Most researches only emphasize on societal or patient perspective. Hence, I want to do this study from the provider perspective because providers play a vital part in implementing cost-effective procedure for long run to support for the patients and hospital policymaking process.

Moreover, from the review, it is seen that most of the researches use the outcome in term of days of hospital stay, recovery days, use of intraoperative cholangiography and utility such as QALY and there are only a few studies which apply intraoperative and postoperative complications as outcome. Hence, I would like to fill this gap in this study.

Another important fact to do this study is that there is no research about the comparison of cost-effectiveness of laparoscopic and open cholecystectomy for Myanmar. As life style of Myanmar people has changed noticeably in the past years, there has been increasing non-communicable diseases such as hypertension and diabetes that are highly correlated with gallstone diseases. Although Myanmar does not have exact data about prevalence of gallstone diseases and cholecystectomy rate in both private and public hospitals, there is no doubt that gallstone diseases are becoming the main problem and cholecystectomy rate is increasing rapidly within a decade, especially in private hospitals in Myanmar. Although laparoscopic method is quite popular in developed and some developing countries, most of the private and public hospitals in Myanmar are still using conventional open method. Hence, it is important for the providers to know that which method is more cost-effective for Myanmar to adopt the cost-saving procedure.

Because laparoscopic technique requires expensive laparoscopic equipment and highly skilled surgeons, it is required to be certain that laparoscopic procedure is

more cost-effective than open procedure to adopt this technique in the hospital. Hence, I intend to do this study in a hospital of Myanmar to compare both laparoscopic and open cholecystectomy.

Moreover, from this study, not only the hospital providers but also the national policy makers can clearly see that which method is more advantageous for cholecystectomy in considering cost-effectiveness. As Myanmar is developing country, resources such as skillful health care personal, equipment and budget are limited to some extent so that it is extremely important in optimum allocation of restricted resources. From this study, it is certain that policy makers can choose more cost-effectiveness procedure for cholecystectomy and adopt the optimal surgical policy for hospitals.

Chapter IV
RESEARCH METHODOLOGY

4.1 Study Design

This study compared the cost-effectiveness of laparoscopic cholecystectomy (LC) and open cholecystectomy (OC) from the provider perspective. The research design of this study was retrospective study in which the data were taken from a private hospital in Myanmar within the period between December 2016 and December 2017.

In order to calculate the cost-effectiveness of two surgical procedures, cases of complications avoided and cases with shorter hospital stay were regarded as outcomes. Complications include intraoperative and postoperative complications before the patient is discharged from the hospital.

4.2 Data Source

The data needed for this study were secondary data taken from a private hospital which is located in Yangon, Myanmar. The data used in the study were patient medical records from the medical department and the operation theatre and medical bills from the finance department of the private hospital in Myanmar.

This study only focused on laparoscopic and open cholecystectomy so that medical records were explored according to patients who underwent either treatment among two procedures. In order to search the medical record of a patient from the medical department of the private hospital, patient admission code of surgery and patient discharge date were required. Patient admission code of surgery was obtained from the operation theatre and patient discharge date was obtained from the customer care department.

Basic information and clinical information of patients were collected from both the customer care department and the medical department. Basic information of patients included name, age, gender, admission date, discharge date and so on. Clinical information of patient included history of previous abdominal surgery, underlying diseases, length of hospitalization, length of operative time and so on.

4.3 Data Collection Process

Firstly, data of patient admission code of surgery (AD code) of both LC and OC groups were collected from the operation theatre and patient discharge date from the customer care department. With combination of these two data, patient medical records could be searched from the medical department. Data of operation treatment were collected from the operation theatre and complication treatment from the medical department again. Cost information of pharmacy, health care personnel salary and building, equipment and other costing were collected from the finance department. Figure 6 shows detail data collection process from different departments of the private hospital.

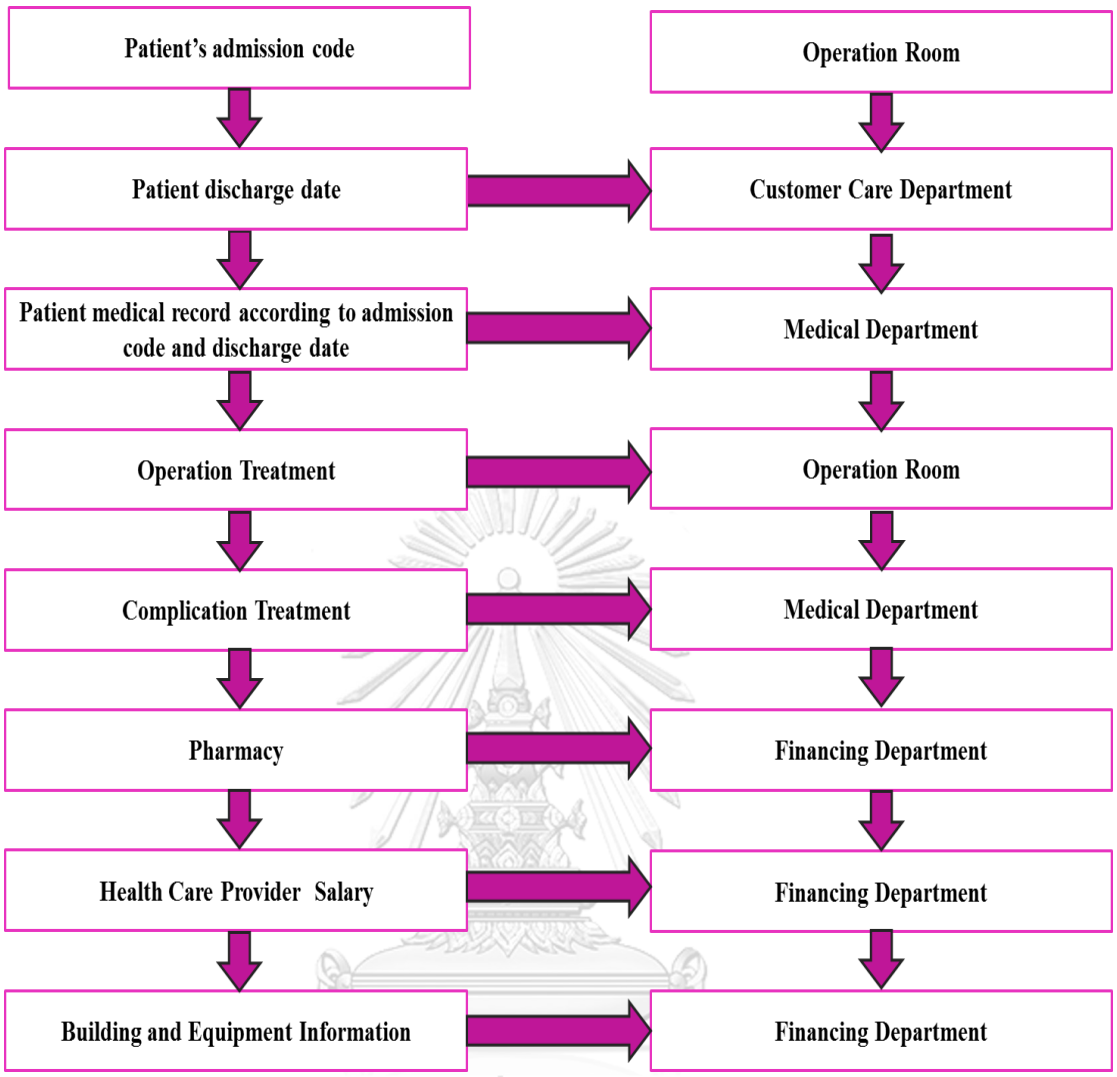

Figure 8: Data Collection Process from Different Departments of the Private Hospital

4.4 Conceptual Framework

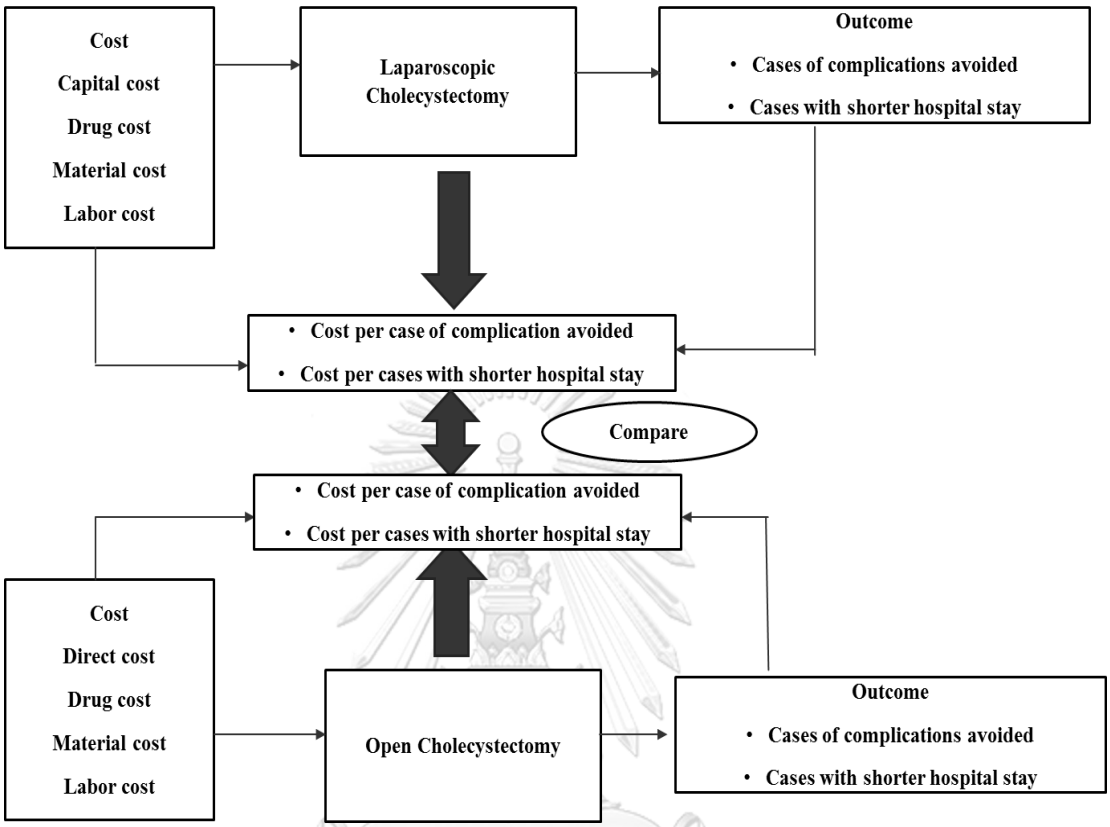

Figure 9: Conceptual Framework showing Comparison of Cost per Outcome of Two Procedures

4.5 Study Population

Study population in this study were patients with gallstone diseases who underwent either LC or OC within the period between December 2016 and December 2017. Both LC and OC groups of patients had similar age period which were within 20-80 years. Based on eligible criteria, patients were chosen for the treatment cost and effectiveness.

There are two types of cholecystectomy: total and partial cholecystectomy. This study only focused on cases with total cholecystectomy in order to make sure that level of two patient groups are the same. Although both total and partial

cholecystectomy have similar situations, total cholecystectomy is more common in Myanmar.

4.6 Inclusion and Exclusion Criteria

4.6.1 Inclusion Criteria

1. Patients with gallstone diseases who did not have concomitant diseases
2. Patients with uncomplicated gallstone diseases
3. Patients who underwent elective cholecystectomy operation by using either laparoscopic or open method

4.6.2 Exclusion criteria

1. Patients with gallstone diseases who had concomitant diseases
2. Any emergent cases of cholecystectomy for acute cholecystitis or exploration of common bile duct due to choledocholithiasis
3. Patients for whom laparoscopic cholecystectomy were not indicated

Table 6 shows the summary of inclusion and exclusion criteria for the patients undergoing LC and OC procedures.

Table 6: Summary of Inclusion and Exclusion Criteria

No	Inclusion	Exclusion
1	Those did not have concomitant diseases	Those had concomitant diseases
2	Uncomplicated gallstone diseases	Laparoscopic cholecystectomy not indicated
3	Elective cases of cholecystectomy	Emergent cases of cholecystectomy

4.7 Sample Selection

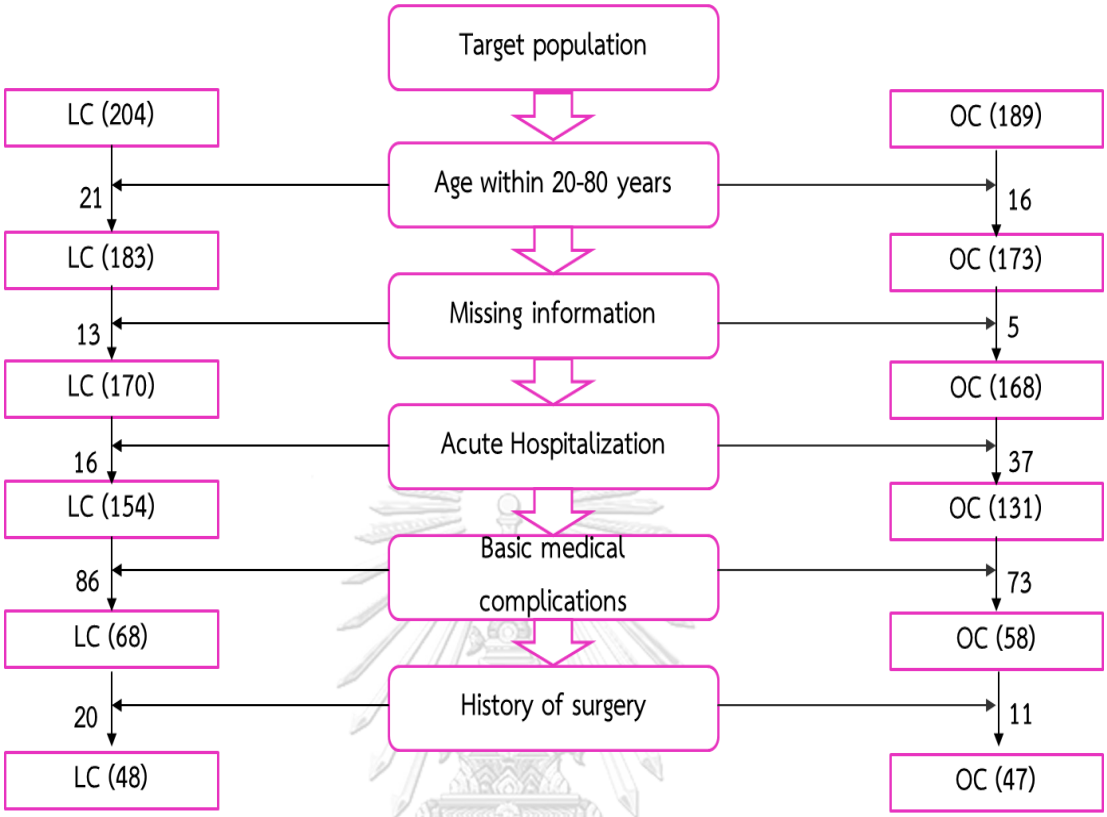

Figure 10: Sample Data Selection Process

According to the sample selection process, patients from both LC and OC groups were excluded according to out of age, missing information, acute hospitalization, basic medical complications, different age group and surgical history. Hence, there were 44 patients in each LC and OC group after selection.

When doing research, completeness and quality of patient documents was assessed carefully. If there was missing information from the patient document such as treatment, responsible doctor was asked about the patient condition and missing information. When the information could not be retrieved, the patient was excluded from the research. By this way, it was ensure that quality assessment of patient documents was completed.

4.8 Data Analysis

4.8.1 Cost Analysis

There are two parts in cost analysis:

1. direct cost and
2. indirect cost

1. Indirect cost

To calculate indirect cost, organizational structure of the hospital was needed to verify first. In the private hospital, there are three main service departments which are admin department, human resource (HR) department and monitoring and evaluation (M and E) department. For the operating departments, there are medical department and sale and procurement (S and P) department in the hospital. Above each department, there are directors for management and operations. The following figure is organizational structure of the private hospital.

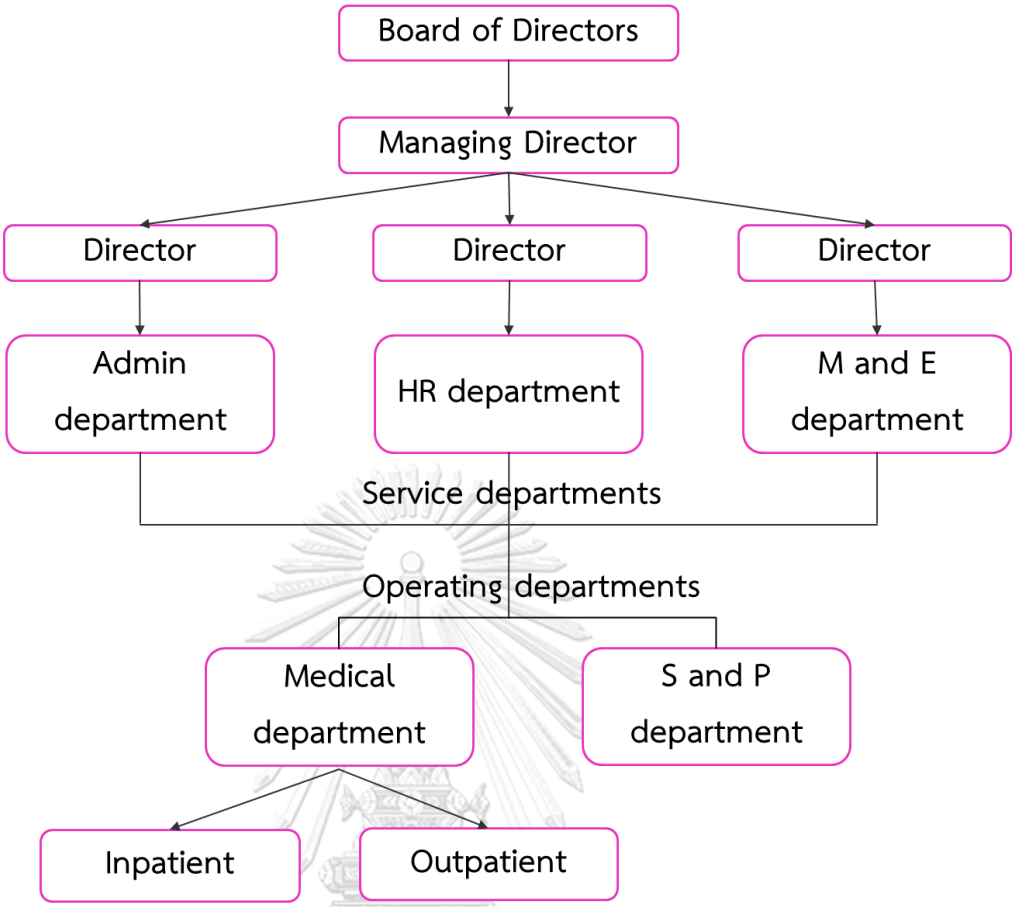

Figure 11: Organizational Structure of the Private Hospital

To calculate the indirect cost of the medical department, capital, labor and material cost of the admin department, HR department and M and E department was needed to calculate. However, the hospital only provided the total cost of service departments so that capital, labor and material cost of service departments could not be calculated and the total cost of service departments was identified.

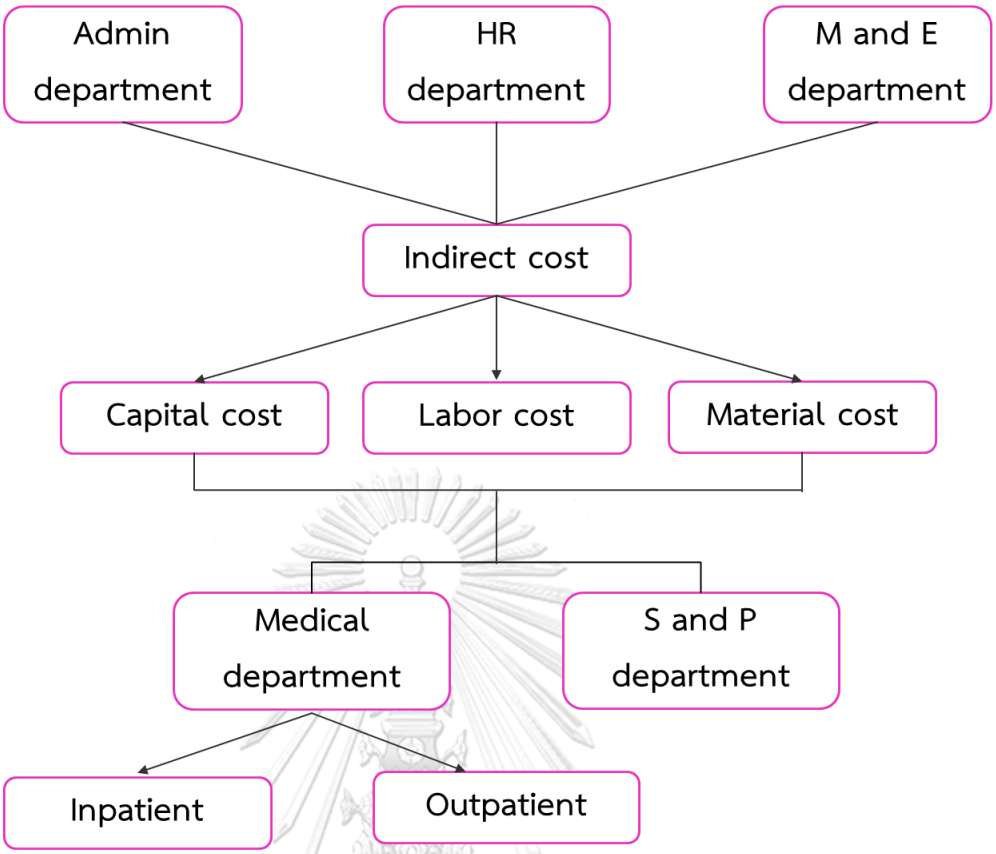

Figure 12: Indirect Cost of the Medical Department

Indirect cost is the allocation of capital, labor and material cost of service departments to operating departments. In this study, allocated cost from service departments to the medical department was only calculated. After calculating allocated cost to the medical department, service cost was calculated by summing up of allocation cost and medical departmental cost.

As there are two parts in the medical department which are inpatient and outpatient, calculated service cost was allocated to inpatient and outpatient depending on the percentage that the medical department works. According to data from the private hospital, medical department handles the office work for both outpatient and inpatient in the estimate percentage of 20% and 80%. After evaluating service cost of inpatient, service cost for LC and OC were calculated.

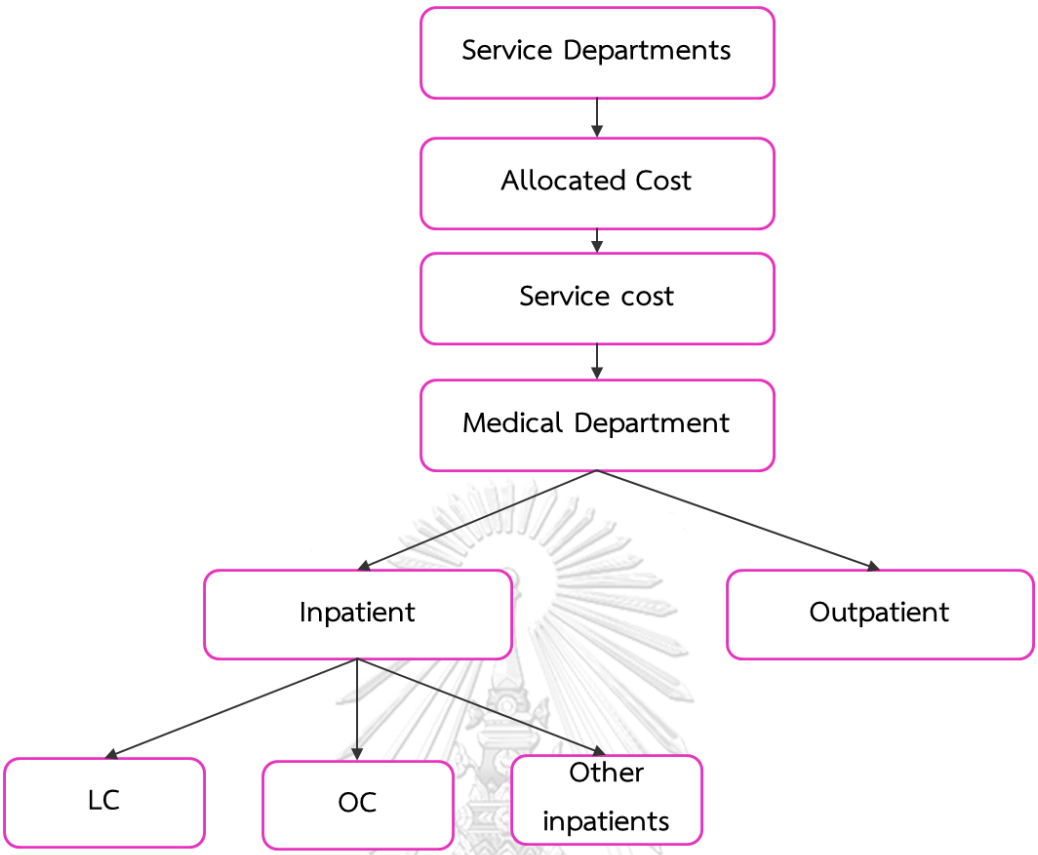

Figure 13: Indirect cost of the Medical department

This study used direct method of cost allocation from the service departments to the medical department because this method is widely used for allocation of cost from one department to another department. In this study, number of employee was used as unit of service of all service departments for cost allocation.

2. Direct cost

Direct cost of LC and OC was calculated from the direct cost of inpatient of the medical department. Direct cost of outpatient was excluded because the cost data obtained from the finance department was inpatient cost data. Direct cost was divided into ward cost and operation cost of LC and OC which in turn were divided into three groups: capital, labor and material costs.

Table 7: Direct Cost Included in Calculating Laparoscopic and Open Procedures

	Category	LC	OC
1	Capital cost	Include	Include
2	Labor cost	Include	Include
3	Material cost	Include	Include
	Total direct cost	Sum of 1,2,3	Sum of 1,2,3

Capital cost in ward and operation contains building cost, ward medical equipment cost, investigation cost, operation theatre room cost and operation theatre equipment cost. Labor cost in ward and operation contains salary cost for ward doctors, ward nurses and operation theatre nurses, specialist ward round cost and operation theatre team cost. Material cost for ward and operation contains ward drug cost and operation theatre drug cost.

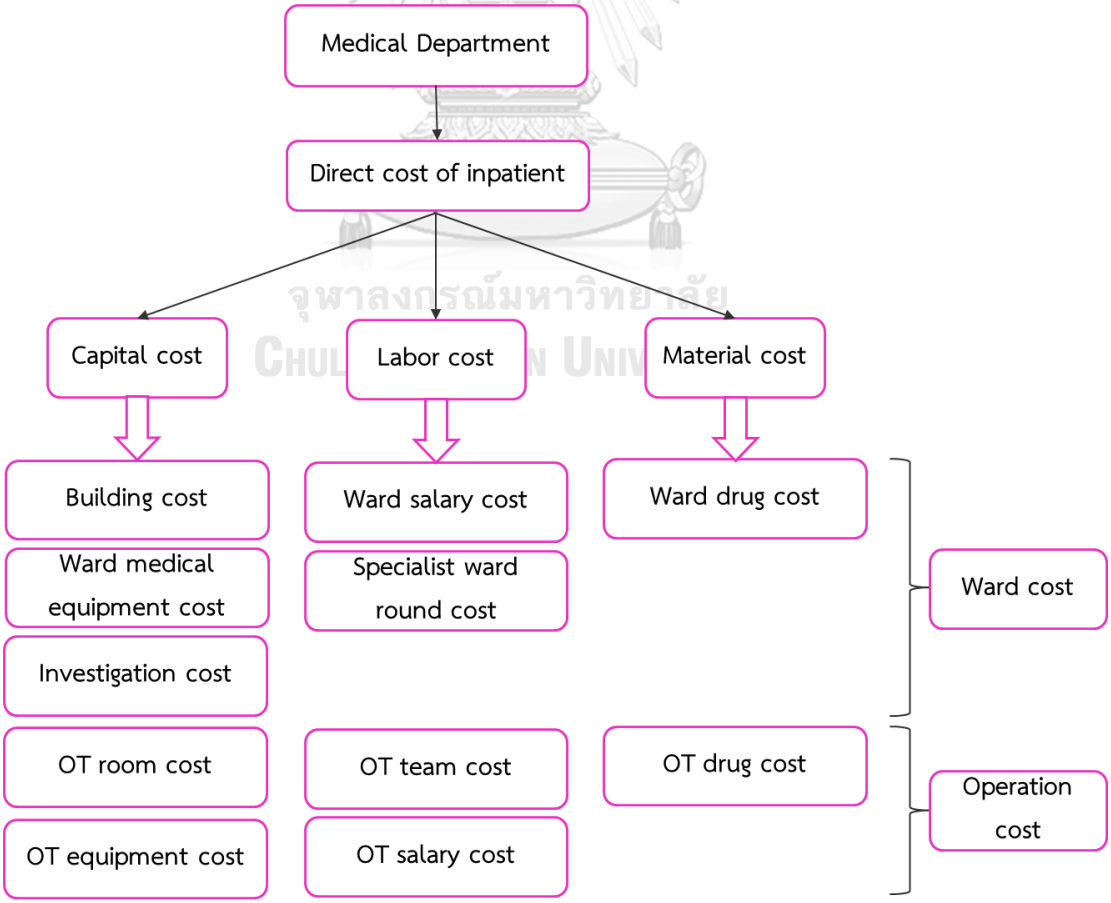

Figure 14: Framework for Direct cost of the Medical Department of the Private Hospital

Table 8: Direct cost of LC and OC groups

Medical department		
	Ward cost	Operation cost
Capital cost	Building cost	Operation theatre room cost
	Ward medical equipment cost	Operation theatre equipment cost
	Investigation cost	
Labor cost	Salary cost (ward doctors and ward nurses)	Salary cost (operation theatre nurses)
	Specialist ward round cost	Operating theatre team cost (Surgeon and anesthesiologist fee)
Material cost	Ward drug cost	Operation theatre drug cost
	Complication treatment cost	

1. Capital Cost

Capital cost included the building cost, ward medical equipment cost, investigation cost, OT room cost and OT equipment cost.

In calculating building cost and operation theatre room cost for LC and OC, straight line depreciation was used for annual cost of the building. Since ward and operation equipment were used more than 1 year, cost for these equipment were regarded as capital cost. Investigation cost was also regarded as capital cost because materials of various laboratory tests, chest X-ray, ultrasound, ECG, glucometer and so on were used more than one year in investigating the patients.

2. Labor Cost

Labor cost included ward and operation salary cost, specialist ward round cost and operating theatre team cost.

Ward salary cost contained ward doctors' and ward nurses' cost. Specialist ward round cost means daily patient round fee for the specialist who did the surgery.

In the private hospital, the specialist fee is not monthly salary but per round. There are different round fee depending on the patient conditions. Operation theatre team cost contained surgeon and anesthesiologist fee for the operation. Operation theatre team cost was different according to patient condition and surgical procedures. Operation theatre team cost did not depend on the duration of operation.

3. Material Cost

Material cost included ward drug cost, operation theatre drug cost and complication treatment cost. Pharmacy cost included the total cost of drugs which were used in ward. Because there is no National drug rule to control drug price for hospitals in Myanmar, real drug cost is difficult to know so that it was calculated in term of drug charges to the patients by the hospital.

Complication treatment cost included the total cost of intraoperative and postoperative complications of the patient during and after the surgery until the patient discharged from the hospital. Different patients could have different complications. Some may need ward doctor's action while some may need additional drugs and monitoring with medical equipment such as 24 hour ECG. Hence, complication treatment cost was not be calculated separately. It was contributed in the calculation of labor cost, material cost and capital cost of ward and operation. Hence, remaining complication costs such as blood transfusion cost and oxygen cost were only calculated as material cost in this study.

4.8.2 Effectiveness Analysis

This study evaluated the effectiveness in term of two outcomes. The first outcome was cases of complication avoided. Complications included intraoperative and postoperative complications before the patient was discharged from the hospital. Intraoperative complications could be regarded as injury of surrounding major retroperitoneal vessels such as aorta and vena cava, injury of common bile duct, perforation of bowel or bladder and conversion of open cholecystectomy from

laparoscopic cholecystectomy during operation. For common postoperative complications, bleeding, wound infection and bile leak were involved.

The second outcome was cases with shorter hospital stay. Whether to decide patients' hospital stay was shorter or longer, the cutoff point to define longer hospital stay was needed. Two types of cutoff point were used in this study which were mean hospital stay taken from the published article and medium hospital stay of LC and OC groups.

For the first type, the cutoff point was taken from the literature review of the published article and mean hospital stay from the article was regarded as cutoff point (McKellar et al., 1995). The cutoff point for LC was 3 days while that of OC was 6 days. Hence, if the length of hospitalization of a patient was greater than that point, it was regarded as longer hospital stay. The published article was chosen because the cutoff point of mean hospital stay in the article was the same with average hospital stay of both LC and OC groups of the private hospital. Hence, it was clear that the cutoff point could be used for the hospital in Myanmar.

For the second type, median hospital stay of LC and OC was used to define shorter hospital stay. Median hospital stay of LC was 2 days and that of OC was 5 days. If the hospital stay of a patient was greater than median hospital stay, it was regarded as longer hospital stay.

4.8.3 Cost-effectiveness Analysis

The cost-effectiveness analysis was evaluated to compare which procedure was more favorable. The following equation was used in calculating cost-effectiveness ratio (CE ratio).

CE ratio=Cost/Effectiveness

Hence, for the first outcome, cost-effectiveness ratio can be calculated as follow:

For laparoscopic procedure,
CE ratio=total cost/percentage of cases of complication avoided in LC

For open procedure,
CE ratio= total cost/percentage of cases of complication avoided in OC

For the second outcome, the same formula is also used as follow:
For laparoscopic procedure,
CE ratio=total cost/percentage of cases with shorter hospital stay in LC

For open procedure,
CE ratio= total cost/percentage of cases with shorter hospital stay in OC

After calculating cost-effectiveness ratios of the two treatments, cost-effectiveness analysis was evaluated and the two ratios were compared.

4.8.4 Sensitivity analysis

Sensitivity analysis determines how much the result is robust by altering the values. Because of the limited duration of the study, outcome in term of intraoperative and postoperative complications before the patient was discharged from the hospital and cost in term of direct costs could only be analyzed. Medium-term outcome such as three-year surgical sequelae and long-term outcomes such as five-year surgical sequelae, ten-year surgical sequelae and costs such as indirect costs had to be excluded. Moreover, for the outcome of cases with shorter hospital stay, mean hospital stay was only taken from one published article. If mean hospital stay was different in another articles, the result could be changed too. Furthermore, median hospital stay of LC and OC groups were also required to run sensitivity analysis. If the sample size

changed, median hospital stay of LC and OC groups would alter affecting the cost-effectiveness ratios. Hence, this study had some limitations and sensitivity analysis was needed to do.

In this study, sensitivity analysis was used to change some parameters such as drug charges, investigation charges, medical equipment charges and hospital stay cutoff point. Afterward, cost-effectiveness ratios of both two treatments were calculated again and compared the results whether the results were robust or not.

CHAPTER V
RESULTS

5.1 Basic Information of Two Patient Groups

This study analyzed the statistical data of basic information of two patient groups who underwent either laparoscopic or open cholecystectomy in the private hospital during the period of December 2016 and December 2017. Stata 13 software was used for patient data analysis. The analysis included the patient age, gender, operating time and hospital length of stay. More details are expressed in the tables.

Hypothesis test was used in this study to examine the validity of the result and therefore, p-value was used to determine for the significance of the result. In this study, null hypothesis was stated that data of two patient groups were not different while alternative hypothesis was that data of two patient groups were different.

5.1.1 Age

Table 9: Age Information Comparing both LC and OC Patient Groups (Unit: year)

	LC (n=48)	OC (n=47)	p-value
Mean	52.85417	54.78723	0.4876
Range	23-79	23-80	
Standard deviation	13.60849	13.42116	

The table shows the information of patient age at the time of admission comparing both laparoscopic and open cholecystectomy groups. The data of patient age information were obtained from the patient medical records. For laparoscopic cholecystectomy group, the age range was between 23 and 79 years while the youngest age was 23 years and the oldest one was 80 years in open cholecystectomy group. Comparison of age statistic difference of two groups were evaluated by two-sample t-test. Significance level was 95%. Since p-value was greater than 0.05, null

hypothesis could not be rejected. Hence, there was no significant age difference between laparoscopic and open cholecystectomy patient groups.

5.1.2 Gender

Table 10: Gender Information Comparing both LC and OC Patient Groups

	LC (n=48)	OC (n=47)	X^2	p-value
Male	15	18	0.0270	0.869
Female	33	29		

The table shows the information of patient gender collected at the time of admission comparing both laparoscopic and open cholecystectomy groups. The data of patient gender information were obtained from the patient medical records. According to table, it can be seen that there were 15 males and 33 females in laparoscopic cholecystectomy group while 18 males and 29 females contained in open cholecystectomy group. Comparison of gender statistic difference of two groups were evaluated by Chi-square test. Significance level was 95%. Since p-value was greater than 0.05, null hypothesis could not be rejected. Hence, there was no significant gender difference between laparoscopic and open cholecystectomy patient groups.

5.1.3 Operating Time

Table 11: Operating Time Comparing both LC and OC Patient Groups (Unit: minutes)

	LC (n=48)	OC (n=47)	p-value
Mean	55.41667	101.8085	0.0000
Range	30-120	45-275	
Standard deviation	19.86211	43.70635	

Operating time means the time duration when the patient is started to be operated till the operation is finished. The table shows the information of operating time comparing both laparoscopic and open cholecystectomy groups. The data of patient operating time were obtained from the patient operation records. For

laparoscopic cholecystectomy group, the operating time range was between 30 and 120 minutes while the minimum operating time was 45 minutes and the maximum operating time was 275 minutes in open cholecystectomy group. Comparison of operating time statistic difference of two groups were evaluated by two-sample t-test. Significance level was 95%. Since p-value was lower than 0.05, null hypothesis could be rejected. Hence, there was significant difference of operating time between laparoscopic and open cholecystectomy patient groups.

5.1.4 Hospital Length of Stay

Table 12: Hospital Length of Stay Comparing both LC and OC Patient Groups (Unit: days)

	LC (n=48)	OC (n=47)	p-value
Mean	3.291667	6.468085	0.0000
Range	2-16	4-22	
Standard deviation	2.500709	3.315648	

Hospital length of stay means the duration that the patient is admitted to the hospital till the patient is discharged. The table shows the information of hospital length of stay comparing both laparoscopic and open cholecystectomy groups. The data of patient hospital length of stay were obtained from the patient medical records. For laparoscopic cholecystectomy group, the hospitalization days ranged from 2 days to 16 days while the minimum length of stay was 4 days and the maximum length of stay was 22 days in open cholecystectomy group. Comparison of hospital length of stay statistic difference of two groups were evaluated by two-sample t-test. Significance level was 95%. Since p-value was lower than 0.05, null hypothesis could be rejected. Hence, there was significant difference of hospital length of stay between laparoscopic and open cholecystectomy patient groups.

5.1.5 Therapeutic Effect

Table 13: Therapeutic Effect Comparing both LC and OC Patient Groups (Unit: number of cases)

	LC (n=48)	OC (n=47)	X^2	p-value
Success	44	45	0.1943	0.659
Fail	4	2		

Therapeutic effect means the surgical result including intraoperative and post operative complications before the patient is discharged from the hospital. The table shows the information of therapeutic effect comparing both laparoscopic and open cholecystectomy groups. The data of therapeutic effect were obtained from the patient medical and operation records. According to table, it can be seen that there were 44 successful cases and 4 failure cases in laparoscopic cholecystectomy group while 45 successful cases and 2 failure cases contained in open cholecystectomy group. Comparison of therapeutic effect statistic difference of two groups were evaluated by Chi-square test. Significance level was 95%. Since p-value was greater than 0.05, null hypothesis could not be rejected. Hence, there was no significant difference of therapeutic effect between laparoscopic and open cholecystectomy patient groups.

5.1.6 Summary

Table 14: Summary of Basic Information of both LC and OC Patient Groups

Characteristic	Mean (SD)		p-value
	LC (n=48)	OC (n=47)	
1. Age (years)	52.85 (13.60)	54.78 (13.42)	0.4876
2. Gender Male Female	 15 33	 18 29	 0.869

3. Operating time (minutes)	55.41 (19.86)	101.80 (43.70)	0.0000
4. Hospital length of stay (days)	3.29 (2.50)	6.46 (3.31)	0.0000
5. Therapeutic effect (number of cases) Success Fail	 44 4	 45 2	 0.659

5.2 Cost Analysis

In this study, the total direct cost from the start of admission to the discharge of the patient was considered at the patient level of the private hospital. There were three types of costs which were calculated in this study: ward cost and operation cost which in turn divided into capital cost, labor cost and material cost.

Ward cost included building cost, administrative cost, ward medical equipment cost containing disposable material cost, drug cost, investigation cost and salary cost. For operation cost, these contained operating room cost, operation theatre equipment cost, drug cost and salary cost.

According to cost analysis, complication treatment cost was also considered. Complication treatment costs such as complication related drug cost, medical equipment cost, disposable material cost and salary cost were not calculated separately because they were included in both ward cost and operation cost. However, remaining complication costs such as blood cost and gas supplies cost (O2) were separately calculated.

5.2.1. Indirect cost

1. Service Cost

Service cost of the medical department was considered in this study because there is office work related with inpatient wards such as input and output of medical records. Service cost included not only operating cost of the medical department (salary of employee of the medical department) but also indirect cost from other service departments.

To calculate the service cost of the medical department, cost allocation of the service departments to the operating departments was needed to evaluate first. This study used direct method of cost allocation because this method is widely used for allocation of cost from one department to another department. In this study, number of employee was used as unit of service of all service departments for cost allocation. The following data in the table was provided by the human resource department and the finance department.

Table 15: Total Costs per Month and Number of Employee of Departments

		Number of employee	Department cost per month (kyats)
Service departments	HR department	-	5,000,000
	M and E department	-	19,000,000
	Admin department	-	44,000,000
Operating departments	Medical department	12	9,000,000
	S and P department	23	-

After collecting data of all department cost, unit of service in term of cost per employee was calculated as follow:

Unit of service in term of cost per employee

=Service department cost per month/total number of employee of operating departments

Table 16: Service Departments Allocation Rate to Operating Departments (Unit: Kyats)

	Calculation	Allocation cost per month (cost per employee)
HR department	5,000,000/(12+23)	142,857
M and E department	19000000/(12+23)	542,857
S and P department	44000000/(12+23)	1,257,143
Total		1,942,857

From the above table, the result was allocation cost per employee from the service departments to both medical and sale and procurement departments per month. To get the total service departments allocation cost to the medical department alone, the total result was multiplied by the number of employee of the medical department.

Service department allocation cost to the medical department per month
=Allocation cost per employee per month x number of employee of the medical department
=1,942,857 x 12
= 23,314,286 kyats per month

After calculating service department allocation cost to the medical department, service cost of the medical department was calculated as follow:

Service cost of the medical department per month
=Department cost of the medical department per month + Service department allocation cost to the medical department per month
= 23,314,286 + 9,000,000
= 32,314,286 kyats per month

Medical department handles the office work for both outpatient and inpatient in the estimate percentage of 20% and 80%. Hence, the service cost of the medical department for inpatient can be calculated as follow:

Inpatient service cost of the medical department per month

= 32,314,286 x 0.8

= 25,851,429 kyats

It was assumed that inpatient service cost was the same for all inpatients regardless of diseases. The only difference was inpatient days. The longer the inpatient days, the higher the service cost. There are total number of 220 beds in the private hospital. Because bed occupancy rate was 97%, average number of inpatients in the private hospital were 213 patients per day. The following table is data required for calculating service cost of LC and OC groups.

Table 17: Data Required for Calculating Service Cost of LC and OC Groups

Working days of the medical department per month= 22 days
Average number of hospital inpatients per day= 213 patients
Total inpatient days of LC group= 158 days
Total inpatient days of OC group= 304 days

Hence, service cost for laparoscopic cholecystectomy and open cholecystectomy groups could be calculated as follow:

Table 18: Steps of Calculating Service Cost of both LC and OC Patient Groups (Unit: kyats)

1. Inpatient service cost per day
=inpatient service cost per month/working days of the medical department per month
=25,851,429/22
=1,175,065

2. Inpatient service cost per day per patient = inpatient service cost per day/average number of hospital inpatients per day =1,175,065/213 =5,517
Service cost for LC group = inpatient service cost per day per patient x total inpatient days of LC group =5,517 x 158 =871,644
Service cost for OC group = inpatient service cost per day per patient x total inpatient days of OC group =5,517 x 304 =1,677,088

The following table shows the summary of service cost of both LC and OC groups.

Table 19: Service Cost of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)
Service cost	871,644	1,677,088

5.2.2 Direct cost

5.2.2.1 Ward cost

1. Capital Cost

1.1 Building Cost

Because building cost is the capital cost, several allocation methods from the economic evaluation can be used. In this study, straight line depreciation was used for calculating building cost because this method has many benefits and is commonly used in health care field. Straight line depreciation is simple and easy to calculate by subtracting the salvage value from the purchase value of the asset and dividing by the total productive years or useful life of the asset. Hence, depreciation cost is regarded as annual building cost through its life time. The formula for depreciation cost can be written as follow:

D=1/n x (purchase value-salvage value)

Where D=depreciation cost

n=useful life of asset

The private hospital has two buildings which are connected with a bridge to each other. The buildings were constructed separately in different years so that the cost of two buildings have to be calculated one by one and sum up together to get the total building cost. According to the data, building 1 of the private hospital was built in 2010 and building 2 in 2007. According to the hospital asset book, the lifetime of the building is 30 years and there is no salvage value. The original cost for building 1 was 535,190,665 kyats and that for building 2 was 2,821,796,597 kyats. Hence, according to the formula, the finance department of the private hospital calculated the annual building cost as follow:

Annual building cost (depreciation cost) for building 1 =1/30 x (535,190,665-0)

=17,839,688 kyats

Annual building cost (depreciation cost) for building 2 =1/30 x (2,821,796,597-0)
=94,059,886 kyats

Total annual building cost of the private hospital =building 1 cost + building 2 cost
=(17,839,688 + 94,059,886)kyats
=111,899,574 kyats

To calculate the building cost for LC and OC groups, percentage of occupied space of inpatient wards in the hospital was needed to evaluate first. There are 10 levels in each building 1 and building 2 of the private hospital respectively and inpatient wards occupied 11 levels out of total 20 floors. Hence, it could be known that 55% of total building cost was concerned with inpatient wards.

Table 20: Percentage of Occupied Space of Inpatient Wards

Building 1 + Building 2	Percentage space occupied
Inpatient wards	55%
Outpatient	15%
Operation theatre and laboratory	15%
Office and other	15%

Hence, annual building cost of inpatient wards could be calculated as follows:

Annual building cost of inpatient wards =111,899,574 * 55%
=61,544,766 kyats

In the private hospital, there is no separate surgical ward for the patients who undergo surgery. There are 11 wards with average 20 number of beds in each ward. Hence, there are total number of 220 beds in the private hospital. Because bed occupancy rate was 97%, average number of inpatients in the private hospital were 213 patients per day. The following table is data required for calculating building cost of LC and OC groups.

Table 21: Data Required for Calculating Building Cost of LC and OC Groups

Average number of hospital inpatients per day= 213 patients
Total inpatient days of LC group= 158 days
Total inpatient days of OC group= 304 days

Hence, the building cost for laparoscopic and open cholecystectomy patient groups could be calculated as follow:

Table 22: Steps of Calculating Building Cost of both LC and OC Patient Groups (Unit: kyats)

1. Average building cost of inpatient wards per day =total building cost/365 =61,544,766/365 =168,616
2. Average building cost of inpatient wards per day per patient =average building cost per day/average number of hospital inpatients per day =168,616/213 =792
Building cost for LC group =average building cost per day per patient x total inpatient days of LC group =792 x 158 days =125,077
Building cost for OC group =average building cost per day per patient x total inpatient days of OC group =792 x 304 days =240,654

The following table shows the summary of building cost of both LC and OC groups.

Table 23: Building Cost of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)
Building cost	125,077	240,654

1.2 Ward Medical Equipment Cost

Ward material cost contained the cost of pulse oximeter, suction machine, sphygmomanometer, thermometer and other medical equipment used for the patients. The disposable materials cost were also considered in the calculation of ward medical equipment cost. Disposable materials included disposable syringe, glove, bandage, cannula and butterfly syringe and so on.

Because of numerous ward medical equipment and different utilization of each patient, it was difficult to calculate so that ward medical equipment charges to the patients by the hospital were used. In the table, total cost was the sum of all ward medical equipment cost and unit cost was ward medical equipment cost per patient. The data was obtained from the finance department of the private hospital.

Table 24: Ward Medical Equipment Cost of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)	Data Source
Total cost	9,627,800	4,047,200	Finance department
Unit cost	200,579	86,111	

According to above table, ward medical equipment cost of LC was greater than that of OC because of more complication cases of LC groups. If patients had complications, monitoring was needed hourly or very often. Hence, monitoring was done by ward medical equipment such as pulse oximeter, suction machine, sphygmomanometer and thermometer. Moreover, disposable materials such as glove

and bandage were also needed for accessing and treating complications such as wound cleaning. Hence, LC had more ward medical equipment cost than OC.

1.3 Investigation Cost

Investigation cost included total cost of both preoperative investigations and postoperative investigations while patient was in the hospital. The investigations contained various laboratory tests, chest X-ray, ultrasound, ECG, glucometer and so on. It was difficult to calculate the investigation cost due to numerous laboratory materials so that investigation charges to the patients by the hospital were used. In the table, total cost was the sum of cost of all investigations and unit cost was cost of all investigations per patient. The data was obtained from the finance department of the private hospital.

Table 25: Investigation Cost of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)	Data source
Total cost	2,562,500	6,636,600	Finance department
Unit cost	53,385	141,204	

According to the table, investigation cost for OC was higher than for LC. It might be because of some reasons. There are 7 surgeons who do LC or OC in the hospital. According to the preference of surgeons, pre-operative investigations can be different. Some may prefer only basic investigations, but some may ask to do all investigations according to patient conditions. If the one who prefer to do all investigations undergo most of all OC procedures, the investigation cost of OC group will certainly go up. Also, it is certain that investigations for laparotomy are greater than that of laparoscopic procedures in the usual operations.

Another reason is difference of length of stay of LC and OC groups. While mean hospital length of stay was only 3 days in LC group, mean hospital length of stay of

OC group was twice than that of LC group. It might be possible that the longer the hospital stay, the more chance the doctors ask to do post-operative investigations to check whether the patient condition is stable or not. Lastly, some patients may request doctors to do investigations after operations even though they only have mild post-operative symptoms. This can happen a lot in patients who stay in the hospital for a long time. Because of these possible reasons, investigation cost for OC was higher than for LC.

2 Labor Cost

2.1 Salary Cost

Salary cost can be divided into the cost of salary of doctors and nurses in the ward because both doctors and nurses provide the health care services to the patients. According to human resource management of the private hospital, the medical department manages working hours and working days of both doctors and nurses while the salary of doctors and nurses are managed by the human resource department.

There are three types of doctors in the private hospital according to position namely ward medical doctor, emergency medical doctor and medical checkup doctor. Similarly, the type of nurses are divided into four which are ward nurses, operation theatre nurses, emergency care nurses and medical checkup nurses. For salary cost related with patients in the ward, the salary of both ward doctors and nurses are only calculated in this part because they are only assigned in the ward and not responsible for outpatient, emergency and medical checkup.

When calculating salary cost of doctors and nurses, it was assumed that the salary cost was allocated equally to each patient, no matter gallstone patients or not. The only difference to consider was inpatient days. Hence, the longer the inpatient days, the higher the cost for the doctors and nurses.

2.1.1 Salary Cost of Ward Doctors

In the private hospital, there is no separate surgical ward for the patients who undergo surgery. There are 11 wards with 3 medical doctors in each ward so that total 33 medical doctors in 11 wards are assigned in the private hospital. The working days for medical doctors are 18 days per month and the average number of inpatients for 11 wards is 213 inpatients per day.

According to the data from the finance department, average salary of ward doctors is 900,000 kyats so that total salary of 33 ward doctors is 29,700,000 kyats. Because there are 18 working days per month for medical doctors, average salary of ward doctors per day is 1,650,000 kyats. There are average 213 inpatients per day so that average salary of ward doctors per day per patient is 7,764 kyats. The following table is data required for calculating salary cost of ward doctors for LC and OC groups.

Table 26: Data Required for Calculating Salary Cost of Ward Doctors for LC and OC Groups

Average salary cost of ward doctors per month= 900,000 kyats
Total number of ward doctors= 33 doctors
Working days of ward doctors per month= 18 days
Average number of hospital inpatients per day= 213 patients
Total inpatient days of LC group= 158 days
Total inpatient days of OC group= 304 days

Hence, the salary cost of ward doctors for laparoscopic and open cholecystectomy patient groups could be calculated as follow:

Table 27: Steps of Calculating Salary Cost of Ward Doctors (Unit: kyats)

(1) Total salary cost of ward doctors per month =average salary cost of ward doctors per month x total number of ward doctors =900,000 x 33

=29,700,000
(2) Average salary cost of ward doctors per day =total salary cost of ward doctors per month/working days of ward doctors per month =29,700,000/18 =1,650,000
(3) Average salary cost of ward doctors per day per patient =average salary cost of ward doctors per day/average number of hospital inpatients per day =1,650,000/213 =7,764
Salary cost of ward doctors for LC group = average salary cost of ward doctors per day per patient x total inpatient days of LC group
Salary cost of ward doctors for OC group = average salary cost of ward doctors per day per patient x total inpatient days of OC group

Table 28: Salary Cost of Ward Doctors of both LC and OC Patient Groups (Unit: kyats)

Patient code	Average salary of ward doctors per day per patient	Inpatient days (day)		Salary (kyats)	
		LC	OC	LC	OC
01	7,764	2	5	15,492	38,732
02		2	5	15,492	38,732
03		2	6	15,492	46,478
04		2	5	15,492	38,732
05		2	8	15,492	61,971
06		2	6	15,492	46,478
07		3	7	23,239	54,225
08		3	5	23,239	38,732

09		3	5	23,239	38,732
10		3	5	23,239	38,732
11		5	5	38,732	38,732
12		3	5	23,239	38,732
13		3	5	23,239	38,732
14		4	5	30,985	38,732
15		2	6	15,492	46,478
16		2	4	15,492	30,985
17		2	6	15,492	46,478
18		2	4	15,492	30,985
19		2	6	15,492	46,478
20		2	8	15,492	61,971
21		2	8	15,492	61,971
22		3	22	23,239	170,422
23		2	8	15,492	61,971
24		2	5	15,492	38,732
25		3	6	23,239	46,478
26		2	18	15,492	139,436
27		4	5	30,985	38,732
28		2	5	15,492	38,732
29		4	8	30,985	61,971
30		3	10	23,239	77,464
31		16	5	123,943	38,732
32		3	7	23,239	54,225
33		7	6	54,225	46,478
34		8	6	61,971	46,478
35		2	8	15,492	61,971
36		3	4	23,239	30,985
37		5	4	38,732	30,985
38		10	5	77,464	38,732

39		5	6	38,732	46,478
40		2	12	15,492	92,957
41		3	5	23,239	38,732
42		2	5	15,492	38,732
43		3	5	23,239	38,732
44		2	5	15,492	38,732
45		2	5	15,492	38,732
46		3	5	23,239	38,732
47		2	5	15,492	38,732
48		2	-	15,492	-
	Total	158	304	1,223,944	2,354,930

The following table shows the summary of salary cost of ward doctors for both LC and OC groups.

Table 29: Summary of Salary Cost of Ward Doctors for both LC and OC Groups (Unit: kyats)

	LC (n=48)	OC (n=47)
Salary cost of ward doctors	1,223,944	2,354,930

2.1.2 Salary Cost of Ward Nurses

The calculation of salary cost of ward nurses is similar with that of salary cost of ward doctors. There are 6 nurses in each ward with the total number of 66 ward nurses for 11 wards. The working days for ward nurses are 18 days per month and the average number of hospital inpatients for 11 wards is 213 inpatients per day.

According to the data from the finance department, average salary of ward nurses is 500,000 kyats so that total salary of 66 ward nurses is 33,000,000 kyats. Because there are 18 working days per month for medical doctors, average salary of ward nurses per day is 1,833,333 kyats. There are average 213 inpatients per day so

that average salary of ward nurses per day per patient is 8,607 kyats. The following table is data required for calculating salary cost of ward nurses for LC and OC groups.

Table 30: Data Required for Calculating Salary Cost of Ward Nurses for LC and OC Groups

Average salary cost of ward nurses per month= 500,000 kyats
Total number of ward nurses= 66 doctors
Working days of ward nurses per month= 18 days
Average number of hospital inpatients per day= 213 patients
Total inpatient days of LC group= 158 days
Total inpatient days of OC group= 304 days

Hence, the salary cost of ward nurses for laparoscopic and open cholecystectomy patient groups could be calculated as follow:

Table 31: Steps of Calculating Salary Cost of Ward Nurses (Unit: kyats)

(1) Total salary cost of ward nurses per month =average salary cost of ward nurses per month x total number of ward nurses =500,000 x 66 =33,000,000
(2) Average salary cost of ward nurses per day =total salary cost of ward nurses per month/working days of ward nurses =33,000,000/18 =1,833,333
(3) Average salary cost of ward nurses per day per patient =average salary cost of ward nurses per day/average number of inpatients =1,833,333/213 =8,607
Salary cost of ward nurses for LC group

= average salary cost of ward nurses per day per patient x total inpatient days of LC group
Salary cost of ward nurses for OC group = average salary cost of ward nurses per day per patient x total inpatient days of OC group

Table 32: Salary Cost of Ward Nurses of both LC and OC Patient Groups (Unit: kyats)

Patient code	Average salary of ward doctors per day per patient	Inpatient days (day)		Salary (kyats)	
		LC	OC	LC	OC
01	8,607	2	5	17,214	430,35
02		2	5	17,214	430,35
03		2	6	17,214	51,643
04		2	5	17,214	430,35
05		2	8	17,214	68,857
06		2	6	17,214	51,643
07		3	7	25,821	60,250
08		3	5	25,821	430,35
09		3	5	25,821	430,35
10		3	5	25,821	430,35
11		5	5	43,035	430,35
12		3	5	25,821	430,35
13		3	5	25,821	430,35
14		4	5	34,428	430,35
15		2	6	17,214	51,643
16		2	4	17,214	34,428
17		2	6	17,214	51,643
18		2	4	17,214	34,428
19		2	6	17,214	51,643
20		2	8	17,214	68,857

21		2	8	17,214	68,857
22		3	22	25,821	189,358
23		2	8	17,214	68,857
24		2	5	17,214	430,35
25		3	6	25,821	51,643
26		2	18	17,214	154,929
27		4	5	34,428	430,35
28		2	5	17,214	430,35
29		4	8	34,428	68,857
30		3	10	25,821	86,071
31		16	5	137,715	430,35
32		3	7	25,821	60,250
33		7	6	60,250	51,643
34		8	6	68,857	51,643
35		2	8	17,214	68,857
36		3	4	25,821	34,428
37		5	4	43,035	34,428
38		10	5	860,71	430,35
39		5	6	43,035	51,643
40		2	12	17,214	103,286
41		3	5	25,821	430,35
42		2	5	17,214	430,35
43		3	5	25,821	430,35
44		2	5	17,214	430,35
45		2	5	17,214	430,35
46		3	5	25,821	430,35
47		2	5	17,214	430,35
48		2	-	17,214	-
	Total	158	304	1,359,937	2,616,588

The following table shows the summary of salary cost of ward nurses for both LC and OC groups.

Table 33: Summary of Salary Cost of Ward Nurses for both LC and OC Groups (Unit: kyats)

	LC (n=48)	OC (n=47)
Salary cost of ward nurses	1,359,937	2,616,588

2.1.3 Summary of Salary cost

The following table shows the summary of salary cost of ward doctors and nurses for both LC and OC groups.

Table 34: Summary of Total Salary Cost of Ward Doctors and Nurses (Unit: kyats)

Salary cost	LC (n=48)	OC (n=47)
Ward doctors	1,223,944	2,354,930
Ward nurses	1,359,937	2,616,588
Total	2,583,881	4,971,518

According to result, salary cost of ward doctors for both LC and OC groups were less than that of ward nurses in both LC and OC groups. It happened because the number of ward doctors were twice lower than that of ward nurses in the hospital. Hence, the total salary cost of ward nurses were greater than that of ward doctors although a doctor's salary was higher than a nurse's salary in the hospital.

According to above table, ward salary cost for LC group was lower than that of OC group because OC group had longer hospital stay than LC group so that doctors and nurses had to take care OC patients longer than LC group resulting in increased ward salary cost in OC group.

2.2 Specialist Ward Round Cost

Specialist ward round cost means daily patient round fee for the specialist who did the surgery. In the private hospital, the specialist fee is not monthly salary but per round. There are different round fee depending on the patient conditions. In the table, total cost was the sum of specialist ward round cost and unit cost was specialist ward round cost per patient. The data was obtained from the finance department of the private hospital.

Table 35: Specialist Ward Round Cost of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)	Data Source
Total cost	2,632,500	6,614,000	Finance department
Unit cost	54,844	140,723	

According to above table, specialist ward round cost in OC was greater than LC because of longer hospital stay of OC group. The specialist ward round cost is not monthly salary but per round so that the longer the hospital stay, the higher the specialist ward round cost. Hence, OC group whose hospital stay was twice than LC group had higher specialist ward round cost.

3 Material Cost

3.1 Ward Drug Cost

Drug cost included all the costs of drugs used for the LC or OC patients in the ward. Because the private hospital did not provide the real cost of drugs, the drug charges to the patients by the hospital were used. In the table, total cost was the sum of ward drug cost and unit cost was ward drug cost per patient. The data was obtained from the finance department of the private hospital.

Table 36: Drug Cost of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)	Data Source
Total cost	9,900,243	16,149,489	Finance department
Unit cost	206,255	343,606	

According to the above table, the drug cost of OC was higher than that of LC group. This was because of longer length of hospital stay of OC group. The hospital stay of OC group was twice longer than that of LC group so that drugs given by the doctors would certainly be greater in OC group than in LC group resulting in increased drug cost in OC group.

3.2 Complication cost

Complication cost contained treatment and investigations given due to complications. The complication costs such as labor cost, complication related drug cost and equipment cost due to complications were included in calculation of ward cost so that remaining complication costs such as blood transfusion cost and oxygen cost were only calculated. The data was obtained from the finance department of the private hospital.

Table 37: Complication Cost of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)	Data source
Total cost	232,300	188,000	Finance department
Unit cost	4,839	4,000	

According to table, the complication cost of LC group was larger than that of OC group because LC group had greater complications than OC group.

4 Summary of Ward Cost

The following table 26 shows the summary of ward cost for both LC and OC patient groups. Unit is Myanmar currency (kyats).

Table 38: Summary of Ward Cost for both LC and OC Patient Groups (Unit: kyats)

	Cost type	LC (n=48)	OC (n=47)
Capital cost	Building cost	125,077	240,654
	Ward medical equipment cost	9,627,800	4,047,200
	Investigation cost	2,562,500	6,636,600
Labor cost	Salary cost	2,583,881	4,971,518
	Specialist ward round cost	2,632,500	6,614,000
Material cost	Drug cost	9,900,243	16,149,489
	Complication treatment cost	232,300	188,000
	Total	27,664,301	38,847,461

5.2.2.2 Operation Cost

1. Capital Cost

1.1 Operating Theatre Room Cost

The calculation of capital cost of operating room was similar with the calculation of building cost with the use of straight line formula to get the depreciation. Because all of the operating rooms are located in building 1 of the private hospital, depreciation cost of building 1 was only used and cost of building 2 was excluded. According to the hospital asset book, the original cost for building 1 was 535,190,665 kyats and lifetime was 30 years. Hence, the finance department calculated as follow:

Annual building cost (depreciation cost) for building 1 =1/30 x (535,190,665-0)

=17,839,688 kyats

Since operating rooms are occupied one story out of 10 stories of the building 1, percentage of occupying space of operating rooms is 10%. Hence, annual operating rooms cost was calculated as follow.

Table 39: Percentage of Occupied Space of Operation Theatre Room

Building 1	Percentage space occupied
Operation theatre	10%
Inpatient wards	70%
Intensive care unit and other	20%

Annual operating rooms cost =17,839,688 x 0.1

=1,783,969 kyats

There are 5 operating rooms and one operation uses one room. In this study, it was assumed that each room had the same depreciation and every patient in one hour consumed the same depreciation of operating rooms and the only difference was operation time. After calculating cost per operating room, the cost was allocated to the patients according to the operation hours of LC and OC groups. According to information from the operation theatre, average daily usage of a operating room is 16 hours per day. Average operating hours of LC and OC groups were 2,660 hours and 4,785 hours respectively. The following table is data required for calculating operating room cost of LC and OC groups.

Table 40: Data Required for Calculating Operating Room Cost of LC and OC Groups

Number of operating rooms= 5 rooms
Average daily usage of a operating room= 16 hours
Total operation hours of LC group= 2,660 hours
Total operation hours of OC group= 4,785 hours

Hence, operating theatre room cost for LC and OC groups was calculated as follow:

Table 41: Steps of Calculating Cost of Operating Theatre Room (Unit: kyats)

1. Average cost per operating room =annual operating rooms cost/number of operating rooms =17,83,969/5 =356,794
2. Average cost per operating room per day =average cost per operating room/365 =356,794/365 =978
3. Average cost per operating per hour =average cost per operating room per day/average daily usage of a operating room =978/16 =61
Operating theatre room cost for LC group =cost per operating per hour x total operation hours of LC group =61 x 2,660 =162,512
5. Operating theatre room cost for OC group =cost per operating per hour x total operation hours of OC group =61 x 4785 =292,339

The following table shows the summary of cost of operation theatre rooms of both LC and OC groups.

Table 42: Cost of Operation Theatre Room of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)
Operating theatre room cost	162,512	292,339

1.2 Operation Theatre Equipment Cost

Operation theatre equipment cost was divided into set of equipment needed for laparoscopic and open cholecystectomy. Straight line depreciation which was the same method for calculating building cost was used to analyze the annual cost for equipment. According to the hospital asset book, the lifetime of medical equipment is 5 years and there is no salvage value. According to the data from the finance department, the purchase value of laparoscopic set was 49,500,000 kyats and that of surgical instrument set was 1,409,767 kyats. Hence, the finance department calculated the annual equipment cost as follow:

Annual cost of laparoscopic set (depreciation cost) =1/5 x (49,500,000-0)
=9,900,000 kyats

Annual cost of surgical instrument set (depreciation cost) =1/5 x (1,409,767-0)
=281,953 kyats

According to information from the operation theatre, average daily usage of one set of both laparoscopic instrument and surgical instrument is 4 hours per day. One set of operation theatre equipment is used in one operation room. Hence, in this study, it was assumed that every patient in one hour consumed the same depreciation and the only difference was operation time of either laparoscopic or open cholecystectomy.

After calculating the capital cost of one set of operation theatre equipment, total cost was allocated into LC and OC patients according to operation hours of LC and OC groups. Average operating hours of LC and OC groups were 2,660 hours and 4,785 hours respectively.

1.2.1 Cost of Laparoscopic Set

Laparoscopic set contained laparoscopic machine, accessories and instruments. The following table is data required for calculating cost of laparoscopic set for LC group.

Table 43: Data Required for Calculating Cost of Laparoscopic Set for LC Group

Annual cost of laparoscopic set= 9,900,000 kyats
Usage hours of laparoscopic set per day= 4 hours
Total operation hours of LC group= 2,660 hours

To calculate the cost of laparoscopic set, underlying formulas could be taken as follow:

Table 44: Steps of Calculating Cost of Laparoscopic Set (Unit: kyats)

(1) Average cost of laparoscopic set per day =annual cost of laparoscopic set/365 =9,900,000/365 =27,123
(2) Average cost of laparoscopic set per hour =average cost of laparoscopic set per day/usage hours of laparoscopic set per day =27,123/4 =6,780
Cost of laparoscopic set for LC group =average cost of laparoscopic set per hour x total operation hours of LC group =6,780 x 2,660 =18,036,986

1.2.2 Cost of Surgical Instrument Set

The way to calculate the cost of surgical instrument set was similar to that of laparoscopic set. The following table is data required for calculating cost of laparoscopic set for LC group.

Table 45: Data Required for Calculating Cost of Surgical Instrument Set for OC Group

Annual cost of surgical instrument set= 281,953 kyats
Usage hours of surgical instrument set per day= 4 hours
Total operation hours of OC group= 4,785 hours

To calculate the cost of surgical instrument set, underlying formulas could be taken as follow:

Table 46: Steps of Calculating Cost of Surgical Instrument Set (Unit: kyats)

(1) Average cost of surgical instrument set per day =annual cost of laparoscopic set/365 =281,953/365 =772
(2) Average cost of surgical instrument per hour =average cost of laparoscopic set per day/usage hours of surgical instrument per day =772/4 =193
Cost of surgical instrument set for OC group =average cost of laparoscopic set per hour x total operation hours of OC group =193 x 4,785 =924,073

1.2.3 Summary of Operation Theatre Equipment Cost

Table 47: Cost of Operation Theatre Equipment of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)
Cost of operation theatre equipment	18,036,986	924,073

2. Labor Cost

2.1 Salary Cost

Salary cost for the operation included only salary of operation nurses because medical doctors are not assigned for the surgical procedures in the private hospital. The medical department manages working days of operation theatre nurses while the salary is managed by the human resource department.

When calculating salary cost of operation theatre nurses, it was assumed that the salary cost was allocated equally to each patient, no matter gallstone patients or not. The only difference to consider was operation time. Hence, the longer the operation, the higher the cost for the operation nurses.

2.1.1 Salary Cost of Operation Theatre Nurses

In the operation theatre, there are 21 total number of nurses. The working days for operation theatre nurses are 20 days per month and working hours are 12 hours per day. According to the procedure of two surgical treatment of the private hospital, both laparoscopic and open cholecystectomy need 3 nurses for each operation. The total operation time of LC group was 2,660 hours and that of OC group was 4,785 hours. The following table is data required for calculating salary cost of operating theatre nurses for LC and OC groups.

Table 48: Data Required for Calculating Salary Cost of Operation Theatre Nurses for LC and OC Groups

Total salary cost of operation theatre nurses per month= 12,600,000 kyats
Total number of operation theatre nurses= 21 nurses
Working days of a operation theatre nurse per month= 20 days
Working hours of a operation theatre nurse per day= 12 hours
Total operation hours of LC group= 2,660 hours
Total operation hours of OC group= 4,785 hours

Hence, the salary cost of operation theatre nurses for laparoscopic and open cholecystectomy patient groups could be calculated as follow:

Table 49: Steps of Calculating Salary Cost of OT Nurses (Unit: kyats)

(1) Average salary cost per operation theatre nurse per month =total salary cost of operation theatre nurses per month/ total number of operation theatre nurses =12,600,000/21 =600,000
(2) Average salary cost per operation theatre nurse per day =average salary cost per operation theatre nurse per month/working days of a operation theatre nurse per month =600,000/20 =30,000
(3) Average salary cost per operation theatre nurse per hour =average salary cost per operation theatre nurse per day/working hours of a operation theatre nurse per day =30,000/12 =2,500
Average salary cost per operation theatre nurse for LC patients

= average salary cost per operation theatre nurse per hour x total operation hours of LC group =2,500 x 2,660 =6,650,000 Salary cost of operation theatre nurses for LC patients = average salary cost per operation theatre nurse x number of nurses needed for LC group =101,458 x 3 =19,950,000
Average salary cost per operation theatre nurse for OC patients = average salary cost per operation theatre nurse per hour x total operation hours of OC group =2500 x 4785 =11,962,500 Salary cost of operation theatre nurses for OC patients = average salary cost per operation theatre nurse x number of nurses needed for OC group =186,458 x 3 =35,887,500

The following table shows the summary of salary cost of operation theatre nurses of both LC and OC groups:

Table 50: Salary Cost of Operation Theatre Nurses of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)
Salary cost of operation theatre nurses	19,950,000	35,887,500

According to above table, OT nurse salary cost for OC was higher than LC because of longer operating time of OC. The operating time of OC was two times greater than that of LC so that OT nurse salary cost was higher in OC than in LC.

2.2 Operation Theatre Team Cost

Operation theatre team cost contained surgeon and anesthesiologist fee for the operation. Operation theatre team cost was different according to patient condition and surgical procedures. Operation theatre team cost did not depend on the duration of operation. In the table, total cost was the sum of operation theatre team cost and unit cost was operation theatre team cost per patient.

Table 51: Operation Theatre Team Cost of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)	Source
Total cost	19,830,000	19,156,000	Finance Department
Unit cost	413,125	407,574	

According to above table, the operation theatre team cost of both LC and OC were not much different because operation theater team cost did not depend on the duration of operation, but on the case of operation. Since LC and OC were the same case, there were no much difference between operation theater team cost.

3. Material Cost

3.1. Operation Theatre Drug Cost

Operation theatre drug cost included all the costs of drugs used for the LC or OC patients in the operation theatre. According to payment records, operation theatre drug cost was calculated. In the table, total cost was the sum of operation theatre drug cost and unit cost was operation theatre drug cost per patient.

Table 52: Operation Theatre Drug Cost of both LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)	Source
Total cost	2,761,600	3,056,200	Finance department
Unit cost	57,533	65,026	

4. Summary of Operation Cost

Table 53: Summary of Operation Cost for both LC and OC Patient Groups (Unit: kyats)

	Cost type	LC (n=48)	OC (n=47)
Capital cost	Operating theatre room cost	162,512	292,339
Labor cost	Salary cost	19,950,000	35,887,500
	Operating theatre team cost	19,830,000	19,156,000
Material cost	Operating theatre equipment cost	18,036,986	924,073
	Drug cost	2,761,600	3,056,200
	Total	60,741,099	59,316,112

5.2.3 Summary of Direct Cost for LC and OC Patients

Table 54: Summary of Direct Cost for LC and OC Patient Groups (Unit: kyats)

	LC (n=48)	OC (n=47)
Ward cost	28,303,645	40,336,549
Operation cost	60,741,099	59,316,112
Total cost	88,259,138	97,900,468

5.2.4 Summary of Total Cost for LC and OC Patients

Table 55 Summary of Total Cost for LC and OC Patient Groups (Unit: kyats):

	LC (n=48)	OC (n=47)
Direct cost	88,259,138	97,900,468
Indirect cost	871,644	1,677,088
Total cost	89,130,783	99,577,556

5.3 Effectiveness Analysis

This study used two outcomes which were cases of complication avoided and cases with shorter hospital stay as effectiveness. After analyzing the collected data from the private hospital, there were 44 cases of complication avoided with the success rate of 91% in LC patient group while cases of complication avoided in OC patient group were 45 cases with the success rate of 95%.

Table 56: Summary of Complications in both LC and OC Groups

	Type	Name	LC	OC
No complication			44	45
Complication	Bile duct injury	intraoperative	1	
	Wound infection	postoperative	2	1
	Bleeding	postoperative	1	1
Total number			48	47
Success rate			91%	95%

The outcome of cases with shorter hospital stay was calculated according to two types of cutoff point: published article's mean hospital stay and medium hospital stay of LC and OC groups. For the first type, the cutoff point of published article's mean hospital stay for LC was 3 days while that of OC was 6 days. there were 34 cases which were shorter than 3 day cutoff point for LC group with the success rate of 79%

and 32 cases shorter than 6 day cutoff point for OC group with the success rate of 74% respectively.

Table 57: Summary of Hospital Stay in both LC and OC Groups

	LC	OC	Cutoff point (published article's mean hospital stay)
≤ 3 days	38		3 days
>3 days	10		
≤ 6 days		35	6 days
>6 days		12	
Total number	48	47	
Success rate	79%	74%	

For the second type, median hospital stay of LC was 2 days and that of OC was 5 days. The hospital stay of 24 cases were less than median hospital stay in LC group while that of 26 cases were shorter than median hospital stay in OC group. The following table shows the comparison of median hospital stay of LC and OC groups.

Table 58: Comparison of Median Hospital Stay of LC and OC groups

	LC	OC	Cutoff point (median hospital stay of LC and OC groups)
≤ 2 days	24		2 days
> 2 days	20		
≤ 5 days		26	5 days
> 5 days		21	
Total number	48	47	
Success rate	50%	55%	

5.4 Cost-effectiveness (CE) Analysis

To calculate the cost-effectiveness, cost/effectiveness formula was used to calculate the cost-effectiveness of both laparoscopic and open cholecystectomy

according to total cost and two outcomes. Because the sample size was different in LC and OC groups, percentage of successful cases was used as effectiveness instead of number of cases. The result was changed from Myanmar kyats into US dollars. In 2017, 1 dollar was approximately equal to 1,360 kyats. The exchange rate was taken from the Central bank of Myanmar. ("Reference Exchange Rate," 2018)

Unit cost of laparoscopic cholecystectomy
=89,277,044/48
=1,859,938 kyats ≈ $1,368

Unit cost of open cholecystectomy
=99,840,661/47
=2,124,269 kyats ≈ $1,562

1. Cost-effectiveness (cases of complication avoided)
Laparoscopic cholecystectomy
=89,277,044/91%
=98,106,641 kyats ≈ $72,137

Open cholecystectomy
=99,840,661/95%
=105,095,432 kyats ≈ $77,276

2. Cost-effectiveness (cases with shorter hospital stay)
(1) Published article's mean hospital stay
Laparoscopic cholecystectomy
=89,277,044/79%
=113,008,916 kyats ≈ $83,095

Open cholecystectomy

=99,840,661/74%

=134,919,812 kyats ≈ $99,206

(2) Median hospital stay of LC and OC groups

Laparoscopic cholecystectomy

=89,277,044/50%

=178,554,087 kyats ≈ $131,290

Open cholecystectomy

=99,840,661/55%

=181,528,474 kyats ≈ $133,477

3. Summary of Cost-effectiveness of both LC and OC Groups

Table 59: Summary of Cost-effectiveness of both LC and OC Groups (Unit: dollars)

Effectiveness	Cost-effectiveness	
	LC (n=48)	OC (n=47)
Unit cost	$1,368	$1,562
Cases of complication avoided	$72,137	$77,276
Cases with shorter hospital stay		
Published article's mean hospital stay	$83,095	$99,206
Median hospital stay of LC and OC groups	$131,290	$133,477

According to the result, cost-effectiveness with outcome of cases of complication avoided was $72,137 in LC group and $77,276 in OC group. For outcome of cases with shorter hospital stay (published article's mean hospital stay), cost-effectiveness for LC was $82,095 and for OC was $99,206 respectively. For outcome of

cases with shorter hospital stay (median hospital stay of LC and OC groups), there was $131,290 for cost-effectiveness of LC and $133,477 for cost-effectiveness of OC. Hence, it can be concluded that laparoscopic cholecystectomy is more cost-effective than open cholecystectomy according to two outcomes.

5.5 Sensitivity analysis

In this study, sensitivity analysis was ran to change some parameters for two outcomes because there were some limitations for this study. In calculating the total cost, drug cost, investigation cost and medical equipment cost were used to perform sensitivity analysis because these costs used in this study were the charges to the patients by the hospital. Sensitivity analysis was evaluated to analyze whether the result was robust or not if these charges were increased or decreased by 10%.

Table 60: Cost-effectiveness of both LC and OC Groups when Drug Cost was changed by 10%

	LC	OC
When drug cost is increased by 10%		
Total cost	90,543,228 kyats	101,761,229 kyats
Cost-effectiveness (cases of complication avoided)	99,498,053 kyats ≈ $73,160	107,117,084 kyats ≈ $78,763
Cost-effectiveness (published article's mean hospital stay)	114,611,681 kyats ≈ $84,137	137,515,175 kyats ≈ $101,114
Cost-effectiveness (median hospital stay)	181,086,456 kyats ≈ $133,152	185,020,417 kyats ≈ $136,044
When drug cost is decreased by 10%		
Total cost	88,010,859 kyats	97,920,092 kyats
Cost-effectiveness (cases of complication avoided)	96,715,230 kyats ≈ $71,114	103,073,781 kyats ≈ $75,790

Cost-effectiveness (published article's mean hospital stay)	111,406,151 kyats ≈ $81,916	132,324,448 kyats ≈ $97,297
Cost-effectiveness (published article's mean hospital stay)	176,021,718 kyats ≈ $129,428	178,036,530 kyats ≈ $130,909

According to sensitivity analysis from above table, when drug cost was increased by 10%, cost-effectiveness of LC in all outcomes was lower than that of OC. When drug cost was decreased by 10%, LC had still lower cost-effectiveness ratios in all outcomes than OC. Hence, there was no difference from the primary result even though drug cost was changed by 10%.

Table 61: Cost-effectiveness of both LC and OC Groups when Investigation Cost was changed by 10%

	LC	OC
When investigation cost is increased by 10%		
Total cost	89,533,294 kyats	100,504,321 kyats
Cost-effectiveness (cases of complication avoided)	98,388,235 kyats ≈ $72,344	105,794,022 kyats ≈ $77,790
Cost-effectiveness (published article's mean hospital stay)	113,333,283 kyats ≈ $83,333	135,816,649 kyats ≈ $99,865
Cost-effectiveness (published article's mean hospital stay)	179,066,587 kyats ≈ $131,667	182,735,128 kyats ≈ $134,364
When investigation cost is decreased by 10%		
Total cost	89,020,794 kyats	99,177,001 kyats
Cost-effectiveness (cases of complication avoided)	97,825,048 kyats ≈ $71,930	104,396,843 kyats ≈ $76,762

Cost-effectiveness (published article's mean hospital stay)	112,684,549 kyats ≈ $82,856	134,022,974 kyats ≈ $98,546
Cost-effectiveness (published article's mean hospital stay)	178,041,587 kyats ≈ $130,913	180,321,819 kyats ≈ $132,590

According to sensitivity analysis from above table, when investigation cost was increased by 10%, cost-effectiveness of LC in all outcomes was lower than that of OC. When investigation cost was decreased by 10%, LC had still lower cost-effectiveness ratios in all outcomes than OC. Hence, there was no difference from the primary result even though investigation cost was changed by 10%.

Table 62: Cost-effectiveness of both LC and OC Groups when Medical Equipment Cost was changed by 10%

	LC	OC
When medical equipment cost is increased by 10%		
Total cost	90,239,824 kyats	100,245,381 kyats
Cost-effectiveness (cases of complication avoided)	99,164,641 kyats ≈ $72,915	105,521,453 kyats ≈ $77,589
Cost-effectiveness (published article's mean hospital stay)	114,227,625 kyats ≈ $83,991	135,466,730 kyats ≈ $99,608
Cost-effectiveness (median hospital stay)	180,479,647 kyats ≈ $132,706	182,264,328 kyats ≈ $134,018
When medical equipment cost is decreased by 10%		
Total cost	88,314,264 kyats	99,435,941 kyats
Cost-effectiveness (cases of complication avoided)	97,048,641 kyats ≈ $71,359	104,669,411 kyats ≈ $76,963

Cost-effectiveness (published article's mean hospital stay)	111,790,207 kyats ≈ $82,199	134,372,893 kyats ≈ $98,804
Cost-effectiveness (median hospital stay)	176,628,527 kyats ≈ $129,874	180,792,619 kyats ≈ $132,936

According to sensitivity analysis from above table, when medical equipment cost was increased by 10%, cost-effectiveness of LC in all outcomes was lower than that of OC. When medical equipment cost was decreased by 10%, LC had still lower cost-effectiveness ratios in all outcomes than OC. Hence, there was no difference from the primary result even though medical equipment cost was changed by 10%.

For the outcome of cases with shorter hospital stay, both cutoff points, which are published article's mean hospital stay and medium hospital stay of LC and OC groups were needed to do sensitivity analysis by increasing or decreasing 1 day.

For published article's mean hospital stay, if hospital stay cutoff point was changed to increase by 1 day, it would become 4 days for LC group and 7 days for OC group. If the cutoff point was decreased by 1 day, it would become 2 days for LC group and 5 days for OC group. Afterward, cost-effectiveness ratios of both two treatments were calculated again and compared the results whether the results were robust or not.

Table 63: Cost-effectiveness of both LC and OC Groups when Mean Hospital Stay was changed by 1 Day

	LC	OC
When published article's mean hospital stay is increased by 1 day		
Total cost	89,277,044 kyats	99,840,661 kyats
Cost-effectiveness (cases with shorter hospital stay)	105,031,816 kyats ≈ $77,229	126,380,584 kyats ≈ $92,927

When published article's mean hospital stay is decreased by 1 day		
Total cost	89,277,044 kyats	99,840,661 kyats
Cost-effectiveness (cases with shorter hospital stay)	178,554,088 kyats ≈ $131,290	181,528,475 kyats ≈ $133,477

According to sensitivity analysis from above table, when published article's mean hospital stay was increased by 1 day, cost-effectiveness of LC was lower than that of OC. When published article's mean hospital stay was decreased by 1 day, LC had still lower cost-effectiveness ratios in all outcomes than OC. Hence, there was no difference from the primary result even though published article's mean hospital stay was changed by 1 day.

For median hospital stay of LC and OC groups, if median hospital stay was changed to increase by 1 day, it would become 3 days for LC group and 6 days for OC group. If the cutoff point was decreased by 1 day, it would become 1 days for LC group and 4 days for OC group. Afterward, cost-effectiveness ratios of both two treatments were calculated again and compared the results whether the results were robust or not.

Table 64: Cost-effectiveness of both LC and OC Groups when Median Hospital Stay was changed by 1 Day

	LC	OC
When median hospital stay is increased by 1 day		
Total cost	89,277,044 kyats	99,840,661 kyats
Cost-effectiveness (cases with shorter hospital stay)	113,008,916 kyats ≈ $83,095	134,919,812 kyats ≈ $99,206
When medium hospital stay is decreased by 1 day		
Total cost	89,277,044 kyats	99,840,661 kyats
Cost-effectiveness (cases with shorter hospital stay)	892,770,440 kyats ≈ $656,449	1,109,340,678 kyats ≈ $815,692

According to sensitivity analysis from above table, when median hospital stay was increased by 1 day, cost-effectiveness of LC was lower than that of OC. When median hospital stay was decreased by 1 day, LC had still lower cost-effectiveness ratios in all outcomes than OC. Hence, there was no difference from the primary result even though median hospital stay was changed by 1 day.

CHAPTER VI

CONCLUSION

6.1 Conclusion of the Result between LC and OC Groups

Table 65: Conclusion of the Result between LC and OC Groups

	LC	OC
Number of patients	48	47
Total cost	$65,645	$73,412
Unit cost	$1,368	$1,562
Number of cases of complication avoided	44	45
Success rate	91%	95%
Cost-effectiveness	$72,137	$77,276
Number of cases with shorter hospital stay		
1. Published article's mean hospital stay	38	35
Success rate	79%	74%
Cost-effectiveness	$83,095	$99,206
2. Median hospital stay	24	26
Success rate	50%	55%
Cost-effectiveness	$131,290	$133,477

According to the table, after calculating cost and effectiveness of laparoscopic and open cholecystectomy, it is clear that open procedure was more expensive than laparoscopic procedure.

In analyzing first effectiveness, laparoscopic group had lower complication avoided cases than open group. For the second effectiveness with published article's mean hospital stay, there were higher cases with shorter hospital stay in laparoscopic

group compared with open group. However, laparoscopic group had lower cases with shorter hospital stay than open group when the effectiveness was measured by medium hospital stay.

As a result, cost-effectiveness of both outcomes of laparoscopic group were lower than that of open group. In 1% of cases of complication avoided, the cost was $72,137 in LC group which was lower than $77,276 in OC group. Moreover, for effectiveness with published article's mean hospital stay, 1% of cases with shorter hospital stay in LC group cost $83,095 which was lower than $99,206 of 1% of cases in OC group. For the effectiveness with median hospital stay, the cost was $131,290 in 1% of cases with shorter hospital stay in LC group while the cost was $133,477 in 1% of cases with shorter hospital stay in OC group. Hence, it can be concluded that laparoscopic cholecystectomy is more cost-effective than open cholecystectomy according to thes outcomes.

6.2 Discussion

Gallstone diseases are one of the most significant problem and becoming health burden in Myanmar. Although incident rate of gallstone diseases in Myanmar has not been known, it is estimated that the rate is increasing rapidly year by year due to life style changes of Myanmar people. Since traditional method of removal of gall bladder is open cholecystectomy, it has been popular in Myanmar for many years until now. In 2010, laparoscopic method for cholecystectomy was started to use in the private sector of Myanmar and only after 2015, it has been widely accepted in both private and public hospitals in Myanmar (Sein et al., 2014). Although safety and efficacy of laparoscopic method has been proved, it is still controversial in Myanmar that whether laparoscopic method is more cost-effective than open method due to high investment cost of laparoscope and need of skillful trained surgeons. Since Myanmar is a developing country and has limited resources, optimal allocation of resources is extremely important.

There are many studies regarding comparison of laparoscopic cholecystectomy and open cholecystectomy for treatment of gall stone diseases. According to literature review, most of the researchers did the calculation of total costs including both direct and indirect cost from societal perspective. Most studies showed that open cholecystectomy had lower cost but for the effectiveness, laparoscopic cholecystectomy had more favorable outcome because of shorter hospitalization and faster recovery time. The studies also suggested that if cost could be reduced to certain extent, laparoscopic method was more cost-effective than open method.

In this study, one of the economic evaluation methods which is cost-effectiveness analysis is used to compare two treatment methods of gallstone diseases. The cost result is consistent with that of previous study carried out in developing country, Thailand of which Teerawattananon and his partner stated that laparoscopic method was cost saving procedure compared with open method (Teerawattananon & Mugford, 2005).

For effectiveness, this study used two outcomes as complications avoided and shorter hospital stay. The number of cases with these two outcomes are not much different between laparoscopic and open patient groups. In other studies (Silverstein et al., 2016; Teerawattananon & Mugford, 2005), the researchers used another effectiveness such as quality-adjusted life years (QALYs) as outcome. If QALY was accounted into this study as effectiveness, the result could change. However, this study provides the same result with literature review that laparoscopic method is more cost-effective than open method whatever first outcome or second outcome is used.

For the cutoff point with mean hospital stay, the published article (McKellar et al., 1995) was chosen because the cutoff point of mean hospital stay in the article was the same with average hospital stay of both LC and OC groups of the private hospital. Hence, it was clear that the cutoff point could be used for the hospital in Myanmar.

In calculation of cost-effectiveness, percentage of cases was used as effectiveness in all outcomes instead of number of cases because of the different sample size of LC and OC groups. To be comparable, both LC and OC groups should have same sample size. While LC group had sample size of 48 cases, there were only 47 cases in OC group in this study. Hence, there were unequal number of cases in each group of LC and OC. Therefore, to get the optimal cost-effectiveness ratios, effectiveness was calculated in percentage term.

Similar to previous studies (McINTYRE et al., 1992; McKellar et al., 1995), average hospital length of stay of laparoscopic group is shorter than open group in Myanmar. However, result of average operating time in this study is opposite with previous studies in which laparoscopic cholecystectomy had longer operating time compared with open cholecystectomy. Besides, this study did not follow the patients after they discharged from the hospital so that recovery days to their full activities or work has been excluded.

Drug cost of ward and operation theatre, salary cost and investigation cost in OC group were higher than in LC group except ward medical equipment cost. This is because hospital length of stay and operation time of OC was twice than that of LC. In general, the longer the hospitalization stay and operation time, the higher the cost because the doctors have chances to ask the patients to do investigations and take drugs if the patients are in the hospitals. Moreover, caregiving time given by the doctors and nurses will increase when the patients stay in the hospital for a long time so that the salary of doctors and nurses also increase in OC group. For ward medical equipment cost, the cost of LC was higher than the cost of OC because of more complication cases of LC groups. Medical equipment such as pulse oximeter, suction machine, sphygmomanometer and thermometer were needed in monitoring of complications. Moreover, disposable materials such as glove and bandage were also needed for accessing and treating complications such as wound cleaning. Hence, LC had more ward medical equipment cost than OC.

In this study, in calculating operating theatre equipment cost, average daily usage of operating theatre equipment was used according to hospital data. The average daily usage was not maximal volume. If the maximal volume capacity of daily usage of operating theatre equipment was used to calculate, average cost of operating theatre equipment would be lower which could further reduce cost-effectiveness ratios of both LC and OC groups. Moreover, by using optimal volume service, the hospital can also apply the instrument efficiently.

After doing sensitivity analyses according to all outcomes, the results were consistent with primary one so that laparoscopic method is still more cost-effective than open method. Hence, it is pointed out that laparoscopic method should become the main choice for hospitals in Myanmar due to less expense and more effectiveness.

This study has some assumptions. In calculation of salary cost, this study did not use the number of patients as the index to get the result but calculate the result according to patient hospital days and operating hours. Another assumption is that doctors and nurses can provide health care services equally on each patient according to the hospitalization days and operating hours. But in reality, the doctors and nurses are difficult to provide the same health care services on each patient accordingly.

This study is done from the provider perspective due to some reasons. The first one is time limitation of the study. If the study was evaluated from other perspective such as societal perspective, it would take too much time to finish the study because of the calculation of both direct and indirect costs. Another reason is that this study is a retrospective study so that it is quite difficult to follow to the patients and ask the required information. This can happen because the patients may not provide the phone number to the hospital or the patients cannot be contacted according to their given address and phone number. Hence, cost of this study is taken from provider perspective so that indirect costs such as transportation cost, food cost and so on is not accounted into the calculation of total cost. Hence, if the study is done from

another perspective such as societal perspective, the cost-effectiveness of two treatment can possibly change.

6.3 Limitations of the Study

1. There are some limitations in this study. This study includes only 95 patients from one hospital so that it is the limitation of database and the sample size is small. Moreover, because this study is analyzed only in one hospital, it is difficult to express that the result represents all public and private hospitals of Myanmar. In other words, the result cannot generalize to other hospitals.

2. Due to time limitation, for outcome in term of cases with complications avoided, intermediate-term (3 years) and long-term (5 years and 10 years) outcomes of both laparoscopic and open procedures cannot be followed in this study whether complications are avoided or not. If the study followed long term, the result may change and the study may face different significance.

3. For outcome of cases of shorter hospital stay, this study uses mean hospital stay as cutoff point from one published article (McKellar et al., 1995) to define the hospitalization days of the patients. However, if the cutoff was taken from another article and mean hospital stay was different, the result of this study could change.

4. The private hospital does not provide the real cost of drugs so that drug charges to the patients have to be used in this study. Moreover, it is also difficult to calculate the investigation cost and ward medical equipment cost due to numerous laboratory materials and ward medical equipment materials so that investigation and ward medical equipment charges to the patients are used in this study.

5. The hospital which will provide data for this study does not want to express its name in the research so that it is nominated only as a private hospital in this study.

6. Because of excluding patients with underlying diseases such as hypertension and diabetes in both LC and OC groups, this study limits the generalizability of the result. If the study considers the patients with underlying diseases, the sample size will change to a larger group that can alter the result.

6.4 Policy Implications and Suggestions

This study has demonstrated that which method can provide more cost-saving and effective treatment for gallstone diseases from the provider perspective. According to study result, laparoscopic cholecystectomy is more cost-effective than open cholecystectomy so that decision makers from the private hospital should consider to choose the suitable treatment method for cholecystectomy which is laparoscopic method.

Moreover, in the private hospital, there are no specific surgeons for LC and OC. The surgeons perform both LC and OC according to the patients' conditions. Therefore, it is required to discuss by the hospital authority to have specific LC surgeons in the private hospital. By emphasizing in the particular area surgeons are interested such as LC, the surgical skill of surgeons will definitely improve resulting in better outcomes. The better outcomes will lead to shorter hospital stay, minimal operating time and lower drug and investigation cost. Finally, this will affect cost-effectiveness of LC resulting in lower cost-effectiveness ratio. Hence, the hospital should try to train the doctors to be skillful surgeons in the area of laparoscopic technique.

For the private sector, due to increasing particular income and development of national economics, there is increasing demand of high quality treatment and less invasive and time shortening procedure so that the hospitals should invest more on laparoscopic method which is the minimally invasive surgery for cholecystectomy. The hospitals should focus on developing sections of innovative, cost saving laparoscopic procedure such as dissection, clipping, knot typing and suturing while viewing image from television and also train healthcare personal to fill the gap of skillful surgeons.

Although this study focuses only on the private sector and cannot represent the result for public sector, policy makers should consider to do further systematic research for cholecystectomy in the public hospitals and promote laparoscopic technique in the public sector. Since laparoscopic method has many benefits such as shorter hospital stay, minimal operating time and less scarring, the policy markers should emphasize on the laparoscopic technique to apply in the public sector. Hence, not only the private hospitals but also public hospitals in Myanmar should adopt the laparoscopic technique after doing further analysis and investigations based on the result of this study because it will give obvious savings to both the hospitals and patients.

The government should also support to develop the laparoscopic method not only by providing the laparoscopic machine to the public hospitals to reduce the initial cost but also by cooperating and collaborating with corresponding organizations and foreign hospitals to develop laparoscopic technique. Moreover, the government should also encourage to develop competent surgeons and nurses to handle the laparoscopic practice so that the public hospitals can initiate the laparoscopic method efficiently.

Since Myanmar is trying to develop payment mechanism of diagnosis-related group (DRG) for Universal coverage, it is certain that cholecystectomy will be one of the DRG groups to be decided for payment amount to both public and private hospitals. Although this study cannot generalize public sector, it supports the theoretical basis of cost-effectiveness of open and laparoscopic cholecystectomy so that policy makers can make the basic decision making about cholecystectomy related with treating cost, payment methods and medical standards based on the result of this study before doing further study.

6.5 Suggestion for further study

This study was done in private sector so that the result cannot be generalized for public sector. Hence, further study is needed to make effective policy implementations about cholecystectomy in Myanmar public hospitals. Moreover, to evaluate effective decisions and allocate resources efficiently related with treatment interventions of gallstone diseases by the decision makers of the hospitals, further study is needed to analyze carefully because this study has some limitations such as small sample size, private sector, provider perspective and exclusion of long term effectiveness.

Further study should be carried out with larger sample size in other public and private hospitals in Myanmar. Furthermore, the long-term effectiveness should be followed to get the precise result. The further study can also account into both direct and indirect cost from societal perspective whether to see laparoscopic cholecystectomy is more cost-effectiveness or not compared with provider perspective in Myanmar. Further study should also emphasize optimal caseload and skill of the doctors to achieve better outcomes and get the correct cost-effectiveness ratios. Moreover, further study should also access the technical efficiency of the operating theatre equipment so that volume of services will be optimal and cost-effectiveness ratios will be the lowest.

In summary, this study not only emphasize on the impact of the benefits of clinical effectiveness but also considers for saving the cost of the hospital. Hence, according to the result of this study, the hospitals in Myanmar should consider strongly for evaluating laparoscopic method which has lower cost-effectiveness than open method in the treatment of gallstone diseases.

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