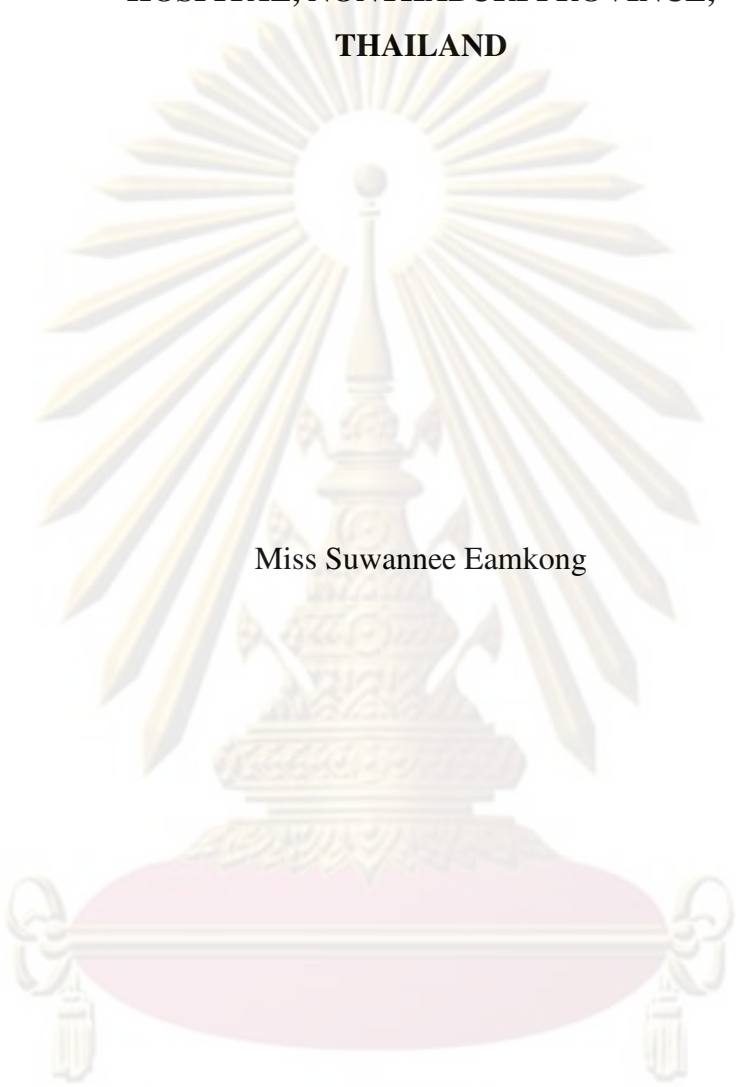
ค่าใช้จ่ายการใช้หนอนบำบัดแผลเรื้อรังโดยเปรียบเทียบกับวิธีเดิมที่โรงพยาบาลบางใหญ่ จังหวัดนนทบุรี ประเทศไทย

นางสาวสุวรรณี เอี่ยมคง

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรมหาบัณฑิต
สาขาวิชาการพัฒนาระบบสาธารณสุข
วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2552

CURING COST OF MAGGOT THERAPY IN CHRONIC WOUNDS COMPARED TO CONVENTIONAL THERAPY AT BANG YAI HOSPITAL, NONTHABURI PROVINCE, THAILAND

Miss Suwannee Eamkong



A Thesis Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Public Health Program in Health Systems Development
College of Public Health Sciences
Chulalongkorn University
Academic Year 2009

Thesis Title	CURING COST OF MAGGOT THERAPY IN CHRONIC WOUNDS COMPARED TO CONVENTIONAL THERAPY AT BANG YAI HOSPITAL, NONTHABURI PROVINCE, THAILAND
By	Miss Suwannee Eamkong
Field of Study	Health Systems Development
Thesis Advisor	Associate Professor Sathirakorn Pongpanich, Ph.D.

Accepted by the College of Public Health Sciences, Chulalongkorn University in Partial Fulfillment of the Requirements for the Master's Degree

.....Dean of College of Public Health Sciences
(Professor Surasak Taneepanichskul, M.D.)

THESIS COMMITTEE

..... Chairman
(Alessio Panza, M.D., M.P.H.)

..... Thesis Advisor
(Associate Professor Sathirakorn Pongpanich, Ph.D.)

..... External Examiner
(Professor Sirikul Isaranurug, M.D., M.P.H.)

สุวรรณี เอี่ยมคง : ค่าใช้จ่ายการใช้หนอนบำบัดแผลเรื้อรังโดยเปรียบเทียบกับวิธีเดิมที่โรงพยาบาลบางใหญ่ จังหวัดนนทบุรี ประเทศไทย.(CURING COST OF MAGGOT THERAPY IN CHRONIC WOUNDS COMPARED TO CONVENTIONAL THERAPY AT BANG YAI HOSPITAL, NONTHABURI PROVINCE, THAILAND) อ. ที่ปรึกษาวิทยานิพนธ์หลัก: รศ.ดร.สถิรกร พงศ์พานิช,61 หน้า

การศึกษาย้อนหลังเชิงพรรณนานี้มีวัตถุประสงค์ในการประเมินประสิทธิภาพของการรักษาแผลเรื้อรังโดยใช้ตัวหนอน โดยมีการวิเคราะห์ค่าใช้จ่ายของการรักษาแผลเรื้อรังด้วยตัวหนอนเทียบกับการรักษาแผลเรื้อรังแบบเดิม ประชากรในการศึกษานี้ใช้ผู้ป่วยที่มีแผลเรื้อรังที่มารับการรักษาทั้งในแผนกผู้ป่วยนอกและผู้ป่วยในของโรงพยาบาลบางใหญ่ จังหวัดนนทบุรี ประเทศไทย โดยผู้ป่วยเหล่านั้นได้รับการรักษาโดยใช้ตัวหนอนและการรักษาแบบเดิมในช่วงเดือนมกราคมถึงตุลาคมปี พ.ศ. 2552 รวมประชากรศึกษาทั้งสิ้น 150 คน ซึ่งแบ่งเป็น 80 คนที่รักษาด้วยตัวหนอน และ 70 คนที่รักษาด้วยวิธีเดิม ข้อมูลที่ศึกษารวบรวมจากบันทึกผู้ป่วยและนำมาวิเคราะห์โดยใช้สถิติเชิงพรรณนา จากผลการศึกษาพบว่าเวลาเฉลี่ยที่ใช้ในการรักษาแผลเรื้อรังโดยตัวหนอน (6.5 วัน) สั้นกว่าเวลาเฉลี่ยที่ใช้ในการรักษาแผลเรื้อรังโดยวิธีเดิม (14 วัน) ผู้ป่วยที่ได้รับการรักษาแผลเรื้อรังโดยตัวหนอนส่วนใหญ่ไม่ต้องรับการรักษาโดยการตัดอวัยวะ (98.75%) แต่ผู้ป่วยที่ได้รับการรักษาแผลเรื้อรังโดยวิธีเดิมส่วนใหญ่กลับต้องรับการรักษาโดยการตัดอวัยวะ (7.14%) ค่าใช้จ่ายเฉลี่ยในการรักษาแผลเรื้อรังโดยตัวหนอน (6,700 บาทต่อคน) ต่ำกว่าค่าใช้จ่ายเฉลี่ยในการรักษาแผลเรื้อรังโดยวิธีเดิม (16,133.33 บาทต่อคน) การศึกษานี้แสดงให้เห็นว่าการรักษาแผลเรื้อรังโดยตัวหนอนสามารถลดค่าใช้จ่ายในการรักษาแผลเรื้อรังในโรงพยาบาลได้ อีกทั้งมีประสิทธิภาพในการลดระยะเวลาการรักษาแผลเรื้อรังและลดความเสี่ยงที่จะต้องรับการรักษาโดยการตัดอวัยวะ ดังนั้นการรักษาแผลเรื้อรังโดยตัวหนอนจึงเป็นทางเลือกหนึ่งในการรักษาแผลเรื้อรังที่มีค่าใช้จ่ายลดลงและมีประสิทธิภาพ

สาขาวิชา การพัฒนาระบบสาธารณสุข ลายมือชื่อนิสิต .....

ปีการศึกษา 2552 ลายมือชื่ออาจารย์ที่ปรึกษาวิทยานิพนธ์หลัก .....

##5179165553: MAJOR HEALTH SYSTEMS DEVELOPMENT
KEYWORDS: CURING COST / MAGGOT THERAPY / CHRONIC WOUNDS/ CONVENTIOANAL THERAPY / EFFECTIVENESS

SUWANNEE EAMKONG: CURING COST OF MAGGOT THERAPY IN CHRONIC WOUNDS COMPARED TO CONVENTIONAL THERAPY AT BANG YAI HOSPITAL, NONTHABURI PROVINCE, THAILAND. THESIS ADVISOR: ASSOC.PROF.SATHIRAKORN PONGPANICH, Ph.D., 61 pp.

This retrospective descriptive study aimed to evaluate effectiveness of maggot therapy in wound curing. Cost analysis of maggot therapy in hospital setting was undertaken. Cost of maggot therapy was also compared to that of conventional therapy. Study populations included all OPD and IPD patients with chronic wounds who underwent either maggot or conventional therapies in January to October 2009 (Total 150 cases, 70 cases with maggot therapy and 80 cases with conventional therapy) at Bang Yai Hospital, Nonthaburi Province, Thailand. Data on patients' general characteristics and costs of therapies were collected from patients' records. Data were analyzed using descriptive statistics. It was revealed that maggot therapy resulted in shorter wound healing time (6.5 days) when compared to that of conventional therapy (14 days). The majority of patients receiving maggot therapy did not have organ amputated (98.75%) while most of those receiving conventional therapy contrastively had limb amputated (7.14%). The average cost of maggot therapy was lower (6,700 Baht per case) when compared to the conventional ones (16,133.33 Baht per case). It is well illustrated that maggot therapy could potentially reduce wound curing care cost in hospital and effectively resulted in shorter curing period and less likeliness of having limb amputated. Ultimately, maggot therapy should be considered as a rational alternative for wound curing in terms of the economical cost and wound curing effectiveness.

Field of Study : Health Systems Development Student's Signature .....

Academic Year : 2009 Advisor's Signature .....

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude and deep appreciation to Associate Professor Sathirakorn Pongpanich, Ph.D., my thesis advisor, who provided invaluable advice for forming the research proposal. This study could not be initiated and completed without them who kindly provided invaluable guidance and shared their thoughts with me towards this research project. Special thanks to Dr. Mongkol Marjareonrungrung. Dr. Level 7 Annual Hospital, Nonthaburi, Bang Yai is a worm treatment to try to have a few minutes ago. Moreover, enjoy the amazing performance of them. In additional, who saved my life when it came to the point that I had to select the area of study where there must be the useful data, which met the criteria of my study. He provided me the great opportunity to experience the way that Maggot Therapy were provided for rural community at Bang Yai Hospital, a district hospital in Nonthaburi province, Thailand. I am really appreciated his kind support during my data collection and data validation phases. My gratefulness also goes to Mr. Pooh-me-rat Kokirakanitha, Ms. Vidar Punyawut, and other administrative staffs for their support during my study in this college. I am also grateful for Ms. Sununta Wongchalee and Ms.Surada Suwannapak, helpful and energetic librarians of this college library, who provided support in many ways, especially the provision of literatures.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

MGT	Maggot Therapy
IPD	Inpatient
OPD	Outpatient

CHAPTER I
INTRODUCTION

1.1 Background and Rationale

Care for patients with chronic wounds is the important role for nursing because today found that patients with traumatic chronic has increased the primarily reason from the longevity of the population increased and persistent to more affect the wound chronic diseases, including diabetes and coronary artery disease and vein (Whitney, 2005). A chronic wound is a wound that has not healed completely as healing process and take longer time as usual. A chronic wound can emerging repeatedly slowly healing wound may caused by complications such as infection affect quality of patients' life (Wysocki, 1999), longer treatment time in hospitals, increasing costs (Harding, 2002) mental patients will be affected (Wientjes, 2002). Chronic wounds were commonly found in diabetic ,pressure wounds and scars of ischemic disorders of the veins. Wound assessment is important in a data base for planning patient care. If the lack of a comprehensive assessment plan may cause improper care or lack of performance (Harding, 2002).Mental patients will be affected with nurses are critical in caring for patients with wounds (Wysocki, 1999). But may lack knowledge in patients with chronic wounds that have, so nurses should understand about the physiology of normal wound healing of the wound path physiology of chronic wound assessment and find opportunities to practice caring for patients with chronic wounds in order to provide more care for these patients are appropriately considered as a challenging role for nurses today (Tomaselli, 2005).

Wound healing process: Wound healing reaction is caused between the epidermal cells and dermal cells compounds between cells (extracellular matrix: ECM). A vascular New (angiogenesis) and protein in serum, all of which will be interoperable by various cytokines and other factors related to growth (growth factors) process of healing scars process starts when the injured tissue and will end on wound healing sealed completely and scarring occurs (Harding, 2002), which in some cases than the wounds will disappear might take several years (Bale, 1997). The healing wound is frequently each term to the process changes that occur as overlapping can be

divided into four distances. Wounds is cell damage on skin and risk of bacteria infected on wounds tissue, this wounds characterized by hypoxia, necrosis and weaken immunity response. According to wounds healing must process four stages as followed,

1. The inflammatory stage where numerous inflammatory factor respondence is released.

2. The destructive stage which appear the phagocytosis of necrotic or sloughy tissue, bacteria killing and growth factors are released.

3. The proliferative stage indicates new capillary loops and promotes granulation tissue, fibroplasia, new matrix and collagen on wounds.

4. The maturation stage present wound collagen is new reform compilatory

These stages often occurs during wound healing and complication between the various stage and entire healing process can shortly complete with maturation not a long time after the wound was initiated. Type of wounds has two types, acute wounds and chronic wounds which are difference for curing time process (Nigam, 2006).

Chronic wounds is a problem for heal wounds today and wounds care is field for doctors and nurses practise to treatment and curing chronic wounds successful. Chronic wounds represent a serious challenge because they are defined as having been present more than six weeks without progressing (Thomas, 2000). Normal primary wounds management and repair is complex but the curing time and process repair under conditions proceed rapidly to treated and healing by first intension. Therefore treatment chronic wounds is serious more complex and management (John, 2001).Technological advance have improve chronic wounds healing and nonhealing to significant and the cost of wounds care exceeds $20 billion (Frykberg, 2006).Chronic wounds is very slowly treatment and the patients stay a long time in hospital thus chronic wounds care provide optimal treatment to the skill of nurses.

Patients are diabetic foot ulcers approximately 15% of all diabetes patients and they have at least 70,000 patient's amputations of 1.5 million population. (Frykberg, 1998).Venous leg ulcer are common type of chronic wounds in the United Kingdom and also costly. The prevalence of venous leg ulcer increase with more than age 65 years old is approximately 1.7%, the Healthcare Commission analyze yearly National Health Service for treatment this wounds have cost of 300-600 million Euro in year

2004 and the cost is increase by 8.5% in year 2005(Dumville, 2009).Pressure ulcer is incidence with older age that reduce mobility, deteriorate nutrition, vascular disease and injure skin as risk factors for pressure ulcers. This wounds occurrence in acute hospital is informed to be as high as 38% and also occurrence in extended care approximately 24% increase the duration and cost of hospitalization and also can set pressure ulcers patients at a four to sixfold increased chance of death (Sherman, 2002).In the rural Midwest region of Western Australia (WA), an audit of outpatient services found that the management of conditions involving wounds constituted 41% of all presentations (Barrett, 2009).

Chronic and complex wounds often have prolonged healing times and require frequent assessment and treatment from a healthcare professional. Their management represents a significant burden on the healthcare system, with the annual cost of treating chronic wounds worldwide estimated at US$7 billion. In the region wounds are managed in diverse care settings, such as an out-patient clinic, at the hospital, or by domiciliary nurse. A Study in the region found that the best wound care was hampered by the restrictions concerned with several health care suppliers. Less confidence, and restricted training in the management of chronic wounds among nurses; Limited to receive an experts examine, incomplete and incompatible with historical trauma and document management and no methods or tradition of exchange of medical records among providers.

Type of wounds debridement: There are several different types of wound debridement available. The type you have will depend on the healthcare professional treating you. The debridement is how to remove dead tissue from wounds and wound edges are decorated with shabby wrapping tissue death. This may be caused by ischemia or inflammation of the scar tissue or organ, including the contaminated dirt or foreign objects are away. The disappearance of the scar to go well. Free from infection. It also includes a wound dressing wound edges to smooth before sewing shabby. To disappear with minimal scarring debridement good can prevent inflammation of the wound more and better antibiotics. The Debridement will adds mechanical self-defense of the body and prevent infection by reducing the number of growth factor and tissue cytokines and Debridement helps promote the blood vessels within the granulation tissue diagnosis that wounds the infection requires clinical

skill. Complex but important indicators of local and systemic host characteristic the effectiveness of wounds debridement interventions. The effectiveness of wounds debridment interventions as agents that would be used primarily as follow,

1. Dextranimer polysaccharide beads or paste
2. Cadexomer iodine polysaccharide beads or paste
3. Hydrogels
4. Enzymatic agents
5. Adhesive zinc oxide tape
6. Surgery or sharp debridement
7. Maggot therapy
8. Hydrocolloid dressings
9. Antibiotics
10. Antiseptic agents

All products of wounds debridement have various function and cost effectiveness on wounds healing thus provider should be have acknowledgment treat specific wounds types (Bradley, 1999).

History of Maggot therapy: Written records have documented that maggots have been used since antiquity as a wound treatment (Whitaker, 2007). There are reports of the successful use of maggots for wound healing by Maya Indians and Aboriginal tribes in Australia. During warfare, many military physicians observed that soldiers whose wounds had become colonized with maggots experienced significantly less morbidity and mortality than soldiers whose wounds had not become colonized. These physicians included Napoleon's surgeon general, Baron Dominique Larrey, who reported during France's Egyptian campaign in Syria, 1829, that certain species of fly destroyed only dead tissue and had a positive effect on wound healing (Baer, 1931). During World War I, Dr. William S. Baer, an orthopedic surgeon, recognized on the battlefield the efficacy of maggot colonization for healing wounds.More than 300 American hospitals employed maggot therapy during the 1940s. Maggot therapy's extensive use period to World War II was curtailed when the discovery and growing use of penicillin caused it to be deemed outdated. With the advent of antibiotic-resistant bacteria, In 1989 Dr. Ronald Sherman, a physician previously at the University of California, Irvine, sought to re-introduce maggot therapy into the

armamentarium of modern medical care. The therapeutic maggot used by Sherman is a strain of the green bottle fly *Lucillia sericata* and marketed under the brand name Medical Maggot (Sherman, 2000).

What is Lucilia sericata: Flies are an astonishingly biologically diverse group of insects. An estimated 120,000 various species of flies are distributed throughout the world, around 10,000 of these species are found in Europe. *Lucilia sericata* is a species within the genus of the greenbottles (*Lucilia*). Greenbottles belong to the family of the blow flies (*Calliphoridae*), which, in turn, are assigned to the order of the true (two-winged) flies (*Diptera*). Flies are widely distributed throughout all of Europe. In the wild, *Lucilia sericata* develops through the classic stages of insect metamorphosis. Following emergence from the pupae, adult specimens become able to reproduce approximately 7 days later and have a life expectancy of about 45 days. Females lay as many as a total of 15 clusters containing between 100 and 200 eggs each during their lifetime. Maggots hatch from these eggs and progress through three larval instars, during which they shed their skin twice. This larval stage (up to 6 days) is the most intensive stage of growth in the life of a fly. Maggots continuously secrete proteolytic substances, thereby liquefying necrotic tissue and material in their environment, which is then ingested. During this period, the body weight of the animals increases by a factor of 100. In the next stage of metamorphosis, maggots pupate in a warm and dry place. Depending on temperature and humidity conditions, the next generation of adult specimens then emerges from the pupae after 2 to 8 weeks *Lucilia sericata* is a necrophagous insect which derives its nourishment solely from dead tissues. This characteristic is the decisive principal prerequisite for the application of maggot therapy in wound management (BioMonde GmbH & Co.KG, 2004).

Maggot therapy application: Maggot therapy is frequency used when conventional therapy had failed and used prolong time for wounds healing. It is suggested that maggot therapy can debride necrotic tissue and recognized to work for wounds healing by potential mechanisms the following

1. Debridement: The secretion of proteolytic enzyme that thaw necrotic tissue or sloughy tissue and ingestion of necrotic tissue leaving healthy cells

2. Antimicrobial activity: Maggot secretions have antibacterial substances and destruction bacteria wounds colonization with topical antibiotics is controversial. The secretion can annihilate methicillin resistant *Staphylococcus aureus*.

3. Healing: Maggot stimulating the granulation tissue and promote wounds healing (Sherman, 2000).

Where is support Maggot therapy in Thailand:BioMonde (Thailand) Co., Ltd. a German-Thai Joint Venture between BioMonde Germany and B.Grimm Healthcare of Thailand, now starts production of biological Healthcare solutions in Thailand. The business is the very first of it's kind in Asia and hopes to follow the huge success that it has already made in Europe and the United States. Using the living things with the complicated physiology will be the next step of the new innovation that were tried in Thailand since July 2004 together with research on benefit of patients who use the maggot therapy and if it is cover the cost both international and domestic. Our company wants to try the maggots in Thailand cause of Thailand have 38,740 – 50,660 patients who suffer from ulcers. Both the patients and hospital always pay a lot of money to treating approx 200,000 million baths a year (12^{th} of the world). The currency of domestic pharmaceutical market is 42,000 million baths which imported raw materials is 24,000 million baths. Therefore, BioMonde GmbH & Co. KG thought to bring the great innovation in medical technology to Thailand that is Maggot therapy.

How to use Maggot therapy: Prepare the material as below

1. Wounds cleaning equipments
2. Normal Saline
3. Biobag (medium size) 5 x 6 cm. contain 200 larvae of *Lucilia sericata*
4. Skin barrier (if necessary)
5. Sterile cloth
6. Sterile gauze

Application of Biobag: The Biobag should be applied to the wound on the day of delivery, however, if the application is delayed the Biobag can be stored at 8-10°c for 24 hours.

1. Ensure that any previous dressing is fully removed, especially hydrogels. Place the Biobag directly onto the wound, either side up.

2. Provided the Biobag does not overlap the wound edge, the intact skin does not need to be protected, however, if you are concerned, a thin layer if a skin barrier preparation can be applied.

3. Place some slightly moistened gauze over the Biobag.

4. Cover the Biobag and damp gauze with any additional padding required (e.g. gauze) and lightly bandage to secure that Biobag and padding.

5. Do not cover with any occlusive dressings, as the sterile larvae need a constant oxygen supply to survive.

The Biobag should remain in place for three to four days, and then a re-assessment of the wound should be made.

The outer dressing can be changed as frequently as required remember there will be an increase in amount of exudates and a change in odor, this is normal and should clear as soon as outer dressings are changed. If further debridement is needed and the sterile larvae are still active (growing), the same Biobag can be re-applied for a further 24 to 48 hours.

How to remove maggot on wound

1. If possible, place the red clinical waste bag underneath the wound dressing.

2. Remove all outer dressings and place into the red clinical waster bag.

3. Remove the Biobag into the clinical waster bag when discontinuing treatment.

4. The clinical waster bag must be sent for incineration if treating patients in the community, this must be within five days.

The wound can now be re-assessed and a further application applied if necessary. Once the wound is fully debrided, it should then be covered with an appropriate conventional dressing.

Therapeutic Indications**:** Live maggots are primarily applied in the treatment of the following:

1. Diabetic foot ulcers
2. Decubitus ulcers
3. Ulcus cruris
4. MRSA and other wound infections
5. Necrotizing tumor wounds

6. Necrotizing fasciitis
7. Burns
8. Thrombangitis obliterans
9. Bacterial soft tissue infections

The treatment of bacterial wound colonization with topical antibiotics is controversial. The line between colonization and infection has not been well defined, nor has the level at which colonization leads to an inflammatory response. Lastly, bacterial biofilms, which are resistant to topical antibiotics, theoretically serve as a source for an uncontrolled inflammatory response. In chronic wounds, the balance between tissue degradation and synthesis is shifted toward degradation, resulting in impaired wound healing. Care of the cancer patient requires treatment modalities aimed at restoring the balance with recognition that this process may be further impaired through chemotherapy, radiation, malnutrition, or the malignancy itself. Irrigation and debridement are the primary methods of initial management to break the cycle of chronic inflammation. Dressings provide a protective barrier and should match the wound characteristics to prevent further damage; negative pressure devices may help prepare the wound bed to facilitate wound healing. Other adjunctive methods include antibiotics, growth factors, hyperbaric oxygen, and skin and dermal substitutes. Great care should be taken to tailor these methods to the appropriate patient. No treatment strategy will promote healing until the wound is modulated by changing the protease-laden, inflammatory microenvironment into one that is moving forward to produce healthy granulation tissue. Then and only then can the wound be stimulated to heal by a variety of therapies.

In January 2004, the U.S. Food and Drug Administration granted permission to produce and market maggots for use in human or other animals as a prescription only medical device for the following indications: "For debriding non-healing necrotic skin and soft tissue wounds, including pressure ulcers, venous stasis ulcers, neuropathic foot ulcers, and non-healing traumatic or post surgical wounds.”. In February 2004, the British National Health Service permitted its doctors to prescribe maggot therapy.For Thailand in 2005, Thai Food and Drug Administration has been approved maggot therapy as “Herb”.

In Thailand, there are many cases of ulcers, approximately 3 – 28 % of bedsore per year. The patients were treated in the Hospitals of Nursing Center for a long time. The serious bedsores approximately 38,740 – 50,660 per year. Both of them waste the huge treatment costs. The diabetes patients founded 2.3 % (male: 2.0 % and female 2.8 %) and the most common of diabetes is type 2 diabetes (90 %) which increasing to the age of the patients. Over 65 year-old patients approx.15 % are diabetic foot ulcers and 14 – 24 % of these patients were amputated. As the record in Thailand, the ulcers cruris is the most common cause of non-healing wounds, waste large money and some cases must amputated. The nursing costs is around 200,000 million baths per year (12^{th} of the world), domestic pharmaceutical market is around 42,000 million baths and export medicine around 24,000 million baht (BioMonde GmbH & Co.KG, 2004).

Bang Yai Hospital

At Bang Yai hospital has chronic wounds patients admit for healing more than 15 cases per month. In the past the patient had been cured wound as conservative treatment and some patient had amputated foot or organ for save life because of infected wounds and total curing cost approximately 8,000 Baht per person. The treatment with maggot from *Lucilia sericata* is the great way to heal the wounds and infected wounds; it is the Bio-therapy which takes a little healing time and also reduces treatment costs. From literature data reviewed suggests that further comprehensive research into the mechanisms involved in maggot therapy is required to ensure that it may be used to best medical advantage.

Concept of health care reform, Health service system and unit cost

Hospital Cost**:** Hospital cost refers to the expense of the hospital in managing or operating the patient service. Examples of vital hospital costs are out-patient and in-patient cost. There costs can be identified as the standard unit cost and determined by the type of patient service. It is called as unit cost of out-patient per case or per visit and unit cost of in-patient per patient day. Moreover, the hospital cost also refers to the full cost of every department which involving in patient service area. Generally, hospital consists of several departments, which their functions associated to the work of all other departments. Therefore, hospital cost finding is different from the business organization cost finding.

Although hospital operation is divide into different departments, every department works together cooperatively according to their functions. In order to provide correct service to patient, no single department works independently. As a result, there is a cost allocation amongst department reciprocally and the full cost will be gradually summed up in direct patient service area. When dividing the full cost by the number of patients or number of visits, the unit cost can be determined eventually.

Unit Cost: Unit cost refers to the comparison between the resource used and result or output. Unit cost can be a tool to measure the efficiency of resource management, budget allocation, service charge determination or the decision to maintain or cancel some services. Unit cost or average cost is the calculation of the health institutions' possible expense that will be incurred in operating the health service for on patient or per visit or per patient day.

Average cost is the value, which illustrating the overall of the production cost or a service cost on the average. The value can be calculated from the full cost divided by the final output, for example, the average cost of out-patient service is the full cost of the out-patient service divided by the number of all out-patients. A similar calculation can be also done for the average cost of in-patient service per case or per patient day. Hence, the average cost will represent the value that can equally be compared regardless of the size of the production.

Unit cost analysis will be carried out in the period of time. Normally, it will be done on the yearly basis, during the end of fiscal year. However, to gain the better control of the resource, it can be conducted more often than once a year.

$$\text{Unit cost} = \frac{\text{Full Cost of Patient Service}}{\text{Number of Patient Service Unit}}$$

Steps in Hospital Cost Analysis: The hospital cost analysis is based on the statistical expenditure data and operating time from the all departments within the hospital cost finding. Therefore, it is crucial to have accurate information that associating to actual situation in each hospital cost finding procedure can be divided down into five following steps.

1. Cost center identification and grouping

2. Direct cost determination

3. Allocation criteria determination

4. Full cost determination

5. Unit cost calculation

Direct cost determination aims to identify the value of all resource that cost center used up. It divides the resource nit small units so that it will be easier to analyze its relation to the final product or output. Cost data of each cost center are gathered in logical steps depending on the characteristic of each cost center. The study will start with indentifying the elements of production, how much each element is used and calculating the cost. This will allow us to calculate the cost of each element in the production process.

Total direct cost of each cost center is found by summing their labor cost, material cost and capital cost.

Total direct cost = Labor cost + Material cost + Capital cost

Labor cost means the cost that paid to the staffs in exchange of their work. This includes wage, salary, overtime and other expenditure in performing their duty. Additionally, it includes the other allowance that paid out in term of money such as child tuition fee, medical fee, housing allowance. In accounting viewpoint, it is quite complicate to determine the labor cost as an indirect cost or direct cost. Overtime is generally regarded as indirect cost of overhead cost. However, in the cost analysis of medical care service, overtime can be specified directly to one patient service area, for example, Accident and Emergency patient or patient who get operation after normal operating hours, in-patient in each ward. The next thing to be considered is whether to separate cost analysis during the normal operating hours or after normal operating hours.

Some organization treated all kinds of the allowance as the indirect cost. In this case, all allowance is gathered to the central unit or administration unit. While some organizations will consider which department the allowance belongs to. If the allowance belongs to the person whose work directly associated with operation process or service provision, the allowance will be considered as the indirect cost. In

this case, allowance and fringe benefit will be added directly to the other labor cost of that cost center.

In economic viewpoint, the fringe benefit can be in the other form, which is not the monetary form, such as, cars and houses that provide for staff. However, this can be converted into monetary form by using the housing and car rental rate. In addition, some people will further consider the future staff benefit, such as, retirement mutual fund.

1. Material Cost refers to all kinds of material supplies that each cost center requisite from the disbursement unit during the study period. The primary disbursement units include material Supply and Pharmacy. The material cost also refers to the maintenance cost and utility cost. Estimating the material cost can be done by using material requisition record if the record is particularly accurate. If the requisition record does not exist, the unit cost of material needs to be calculated by finding the price of the materials and their quantity.

2. Capital Cost refers to annual depreciation costs of equipment and building, including the training expense that affect the hospital cost in the long run. This kind of cost generally occurs once in a long while. In accounting viewpoint, depreciation cost will be calculated by using Straight-line method. This means the depreciation cost will be equally averaged out by their total life. Otherwise it can be calculated by taking the initial cost subtracted by the salvage value (the price when the equipment reach its total life) and divided by the total life of building or equipment. Total life of building and equipment generally equals to 20 years while total life of vehicle equals to 3 to 5 years. The medical equipment's total life equals to 5 to 15 years depending upon the type of equipment.

$$Depreciation\ \ Cost = \frac{Initial\ \ Cost - Salvage\ \ Value}{Total\ \ Life\ \ (Year)}$$

Generally, one building will be utilized by various departments in a period of time. Therefore, after getting the depreciation cost of each building, the cost must be divided by the number of departments, which utilize that building in accordance with its usage proportion. In case the area of the building is occupied by more than one department, the proportion of their time spent need to be included in the calculation accordingly (College of Public Health Sciences, 2009).

1.2 Research questions

1. How many patients receiving maggot therapy not have amputated limbs?
2. Can maggot therapy reduce curing care cost in hospital?

1.3 Objectives

1. To evaluate effectiveness of maggot therapy in wounds curing and cost analysis of maggot therapy during treatment in hospital.

2. To study average curing cost of Maggot Therapy in chronic wounds compare to the average cost in conventional therapy.

1.4 Hypothesis

Maggot therapy can reduce cost and effectiveness in hospital when compare to conventional therapy.

1.5 Conceptual Framework of research

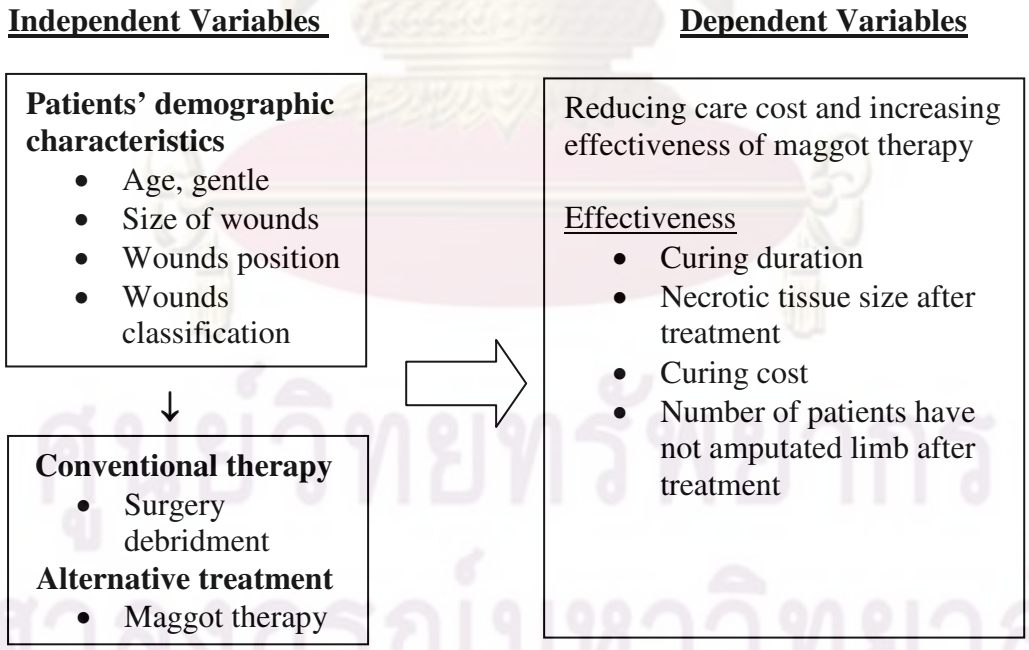


Figure 1 Conceptual Framework

Steps in Bang Yai Hospital Cost Analysis

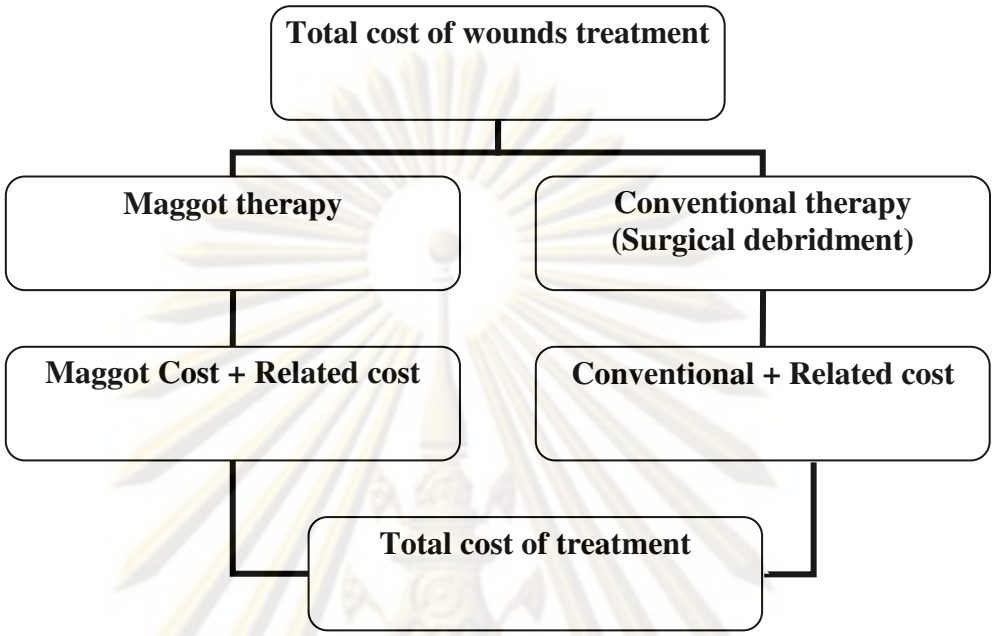


Figure 2 Steps in Hospital Cost Analysis

This retrospective quantitative study included all OPD and IPD patients with chronic wounds who underwent either maggot or conventional therapies in January to October 2009 (Total 150 cases, 70 cases with maggot therapy and 80 cases with conventional therapy) at Bangyai Hospital, Nonthaburi Province, Thailand. Data on patients' general characteristics and costs of therapies were collected from patients' medical records. Data collected for each patient included age, gender, wounds position, size of wound and wound classification; such as pressure sore wound, diabetic wound, burn wound and infected wound.

Cost management

1. Nursing care cost
2. Number of date admition
3. Price of wound dressing and material for treatment
4. Price of room service including food

Total cost management = Main therapeutic cost + Related cost

1.6 Research limitation

This study is retrospective and the sample populations have chronic wounds that was visit at Bangyai hospital for treatment chronic wounds, researcher collected data during January – October 2009.The sample population of receiving conventional therapy, in some cases can not search data of necrotic tissue size on wounds because the doctor did not record wounds size thus some sample populations may not have representative. This study can not control sample populations between receiving maggot therapy and conservative therapy because there was a limitation of time for the research.

1.7 Operational Definitions

1. **Gender**: referred as male and female**.**

2. **Age**: referred to how old the younger, young and older at the time of receiving therapy for treatment.

3. **Chronic wounds patients**: Patients who have chronic wound at Bang Yai hospital admit and visit for wound healing with Maggot therapy and conservative therapy, in the past the patient had been cured wound as conventional treatment and some patient had amputated limb for save life.

4. **Length of stay**: Duration of patient has receiving maggot therapy and conventional therapy for IPD and OPD cases. The researcher search and collected duration time from the hospital computer database.

5. **Admission**: Receiving patients have receiving treatment in hospital.

6. **Necrotic tissue size before and after receiving treatment**: The doctor determines only dead tissue or sloughy tissue on wound dimension with square centimeters.

7. **Surgical debridment**: Debridement could be achieved by surgical, mechanical or enzymatic means. Mechanical debridement refers to a range of techniques like wet-to-dry dressings, which cause separation of necrotic tissue and its removal with the dressing; wound irrigation, which ideally is irrigation of the wound.

8. **Amputation**: means the removal of a body extremity by trauma or surgery as a surgical measure, it is used to control pain or a disease process in the affected limb, such as malignancy or gangrene. The chronic have prolonged healing times and

require frequent assessment and treatment from a healthcare professional. These effects have clinically translated to bad healing rates or infected of wounds, therefore the doctor will inform patient and desire to limb amputation against secure of patient.

1.8 Expected benefit from research

1. Data from this study indicate that maggot therapy reduce curing care cost in hospital or not. If maggot can decrease total cost of curing, we are saving in financial cost between patients and hospital.

2. Effectiveness using maggot therapy can be save life and limb of many patients.

ต้นฉบับไม่มีหน้านี้
NO THIS PAGE IN ORIGINAL

CHAPTER II

LITERATURE REVIEW

2.1 Overview the history of chronic wounds treatment using maggot therapy

As reviewed many literatures ago, still apposite (Steenvoorde, 2007). Maggot therapy or larval therapy has been used for the debridment of wounds for several hundred years. Extensive use of maggot therapy during the World War II was abridged by the discovery and arising use of penicillin. Nevertheless, an emerging problem of antibiotic resistant bacteria has initiated concern to reuse maggot therapy in modern chronic wound care (Sherman, 2003). *Lucillia sericata*, a strain of green bottle fly, is currently utilized as therapeutic maggots.

Maggot therapy has been recognized as an effective method of wound debridement this therapy has treat of wounds with live fly larvae and the advantages of maggot therapy include its profound efficacy in removing necrotic tissue, its safety, and its simplicity. These and other advantages have been responsible for the recent revival in the use of Maggot therapy. Maggots used for medicinal purposes secrete digestive enzymes that selectively dissolve necrotic tissue, disinfect the wound, and stimulate wounds healing (Sherman, 2003). A plethora of literature is available on larval therapy, but many authors acknowledge the paucity of large scale clinical trials supporting its effectiveness. While the exact mechanism of larval therapy remains unknown, it encompasses three processes: debridment, disinfection and promotion of healing tissue. According literature review discusses the applications, benefits and disadvantages of larval therapy as well as the processes involved. Maggot therapy has been shown by multiple researchers to have wound healing properties. Maggot secretions appear to amplify the wound healing effects of host epidermal growth factor and Interleukin 6 secretions are able to stimulate the growth of human fibroblasts and slow-growing chondrocytes and maggot secretions also contain a substance called allantoin (also found in many shaving gels) which has a soothing effect on the skin (Mckeever, 1933). Some patients with leg ulcers with a significant arterial component complain that their wounds become more painful on the second or third day of maggot therapy. During the early years of MDT, the use of “non sterile”

(non disinfected) larvae was associated with at least 1 case of erysipelas and 2 cases of tetanus. Although there is no proof that the maggots were the cause of these wound infections, it was decided 170 years ago that maggots used for medicinal purposes should be disinfected. Disinfection of larvae used for medicinal purposes has been the standard practice ever since. A recent cluster of cases of bacteremia associated with the use of contaminated larvae emphasizes the importance of this standard (Sherman, 2003).

In Germany, more than 3 million persons suffer from chronic wounds, and the majority of these chronic wounds can be classified according to three different categories: indolent leg ulcers (ulcus cruris), diabetic foot ulcers and decubitus ulcers. Total annual costs for the management of chronic wounds currently comprise approximately Euro 5 billion. With an occurrence of 57-80% among all chronic wounds. Recently, Decubitus ulcers present the greatest problem for wound management in hospitals and other nursing care facilities. As many as 14% of all stationary patients in hospitals and care facilities as well as up to 40% of persons who are cared for at home suffer from decubitus ulcers. The total number of persons afflicted by the condition in Germany is estimated at 1.4 million, with a large assumed number of unreported cases. Several institutions, such as The German Diabetes Society (Deutsche Diabetesgesellschaft) or the German Society for Angiology (Deutsche Gesellschaft fuer Angiologie), have assessed the quality of diagnostics, treatment and rehabilitation management for diabetic foot syndrome as being inadequate, those wounds are treated by Hydrocolloid which takes long term and some cases have to amputate. Several European countries lead the maggot for healing wounds (BioMonde GmbH & Co.KG, 2004).

2.2 The effectiveness of maggot therapy

Maggot Therapy today: Maggot therapy is becoming the popular and alternative choice for treatment chronic wounds in many countries such as Europe, America, Australia and Asia (Lau, 2000) the end of year 1980, antimicrobial resistance was increasing number of pressure sore, infected wounds and diabetic foot ulcers and also the conventional therapy use prolong time for curing these wounds. Therefore this was the backcloth for research of Sherman, R.A. had the question that

how would maggot therapy compare to modern wounds healing care but why maggot therapy was used only as a last choice for treatment with patients (Sherman, 2009). However his research result demonstrated that maggot therapy is as accurate debridment, efficacy and safety as high skill performance in micro surgeon and although the populations in his study area have a low cultural for use maggot but patients and clinicians are shifting back to receiving maggot therapy for their wound healing and now they are using maggot therapy in new and improved for the 21st century. Invariably of Sherman research shown that the highly efficacy of maggot therapy for limb amputate prevention, amount saving pre amputation maggot therapy is reported to save 40-50% of limb and increasing oxygen perfusion, granulation tissue and promote wound healing with the secretion of maggot during using this therapy. According to Thomas S. wording is "Maggots are being applied earlier in disease process and are now often the first choice of treatment with some specialist practitioners" (Thomas, 1997).

In 2002, Sherman reported results of maggot therapy in comparison to conservative forms of treatment for 103 patients with pressure sores. In this study he analyzed the clearly evident superiority of maggot therapy. With maggot treatment 80% of wounds demonstrated complete debridement in less than 5 weeks, whereas only 48% of wounds achieved the same results with conventional treatment methods. After three weeks, the wounds treated with larvae contained twice as much granulation tissue as did the control group (Sherman, 2002). Total healing rates for the group receiving maggot therapy was 39% after 14 weeks, and only 21% for the group of patients who had received conventional treatment during the same time period. In a recently published study, Wollina also describes the positive effects of maggot therapy with 30 patient's demonstrated significantly improved wound severity scores within three days ($p < 0.001$). Treatment was well tolerated. Several patients experienced pain during therapy, but this pain required management with analgesics in only two cases. Interestingly, Wollina were able to show, on the basis of spectroscopic measurements, that maggot therapy significantly improves the supply of oxygen to tissues. The authors attribute this to the growth factors comprised in maggot secretions, which may possibly also show angiogenetic potential (Wollina, 2002). In research of Courtenay, in their studies describe multicentric, prospective

investigations which examined the effects of standardized maggot therapy for 47 patients with large (average wound surface area: 80 cm^2) chronic wounds resulting Maggot therapy comprised three applications of Lucilia sericata maggots for a period of three days per application, with a complete treatment cycle ending after nine days. The total surface area of the wound was examined as well as the extent of necrotic and granulation tissue. In addition to exudate, odor and pain experienced by the patient. Following an average of nine days of maggot therapy, significant improvements were observed. Refer this study shown that maggot therapy can be reduction in necrotic tissue, increase in granulation tissue, decrease in wound exudation and odor, pain reduction. Moreover, this study demonstrated that maggot therapy reduced the amount of time patients spent in hospitals (34%), eliminated the need for surgical procedures (27%), prevented stationary hospitalization (16%) and reduced the use of antibiotics (26%)(Courtenay, 2000).

In the report of Wayman, they applied the blow fly larvae (maggots from *Lucilia sericata*) into diabetic ulcers patients which 7 cm^2.The wounds were completely treated only 1 month and reduced the treatment costs of each patient. Maggot therapy comprised three applications of *Lucilia sericata* maggots for a period of three days per application, with a complete treatment cycle ending after nine days. The total surface area of the wound was examined as well as the extent of necrotic and granulation tissue, in addition to exudate, odor and pain experienced by the patient. Following an average of nine days of maggot therapy, significant improvements were observed. The utilization of larvae for wound healing has been well documented across the centuries in different cultures, including the Chinese. In Europe, larval therapy is currently available in two formulations: loose or ‘free-range’ larvae placed directly into the wound, and bagged larvae (where the larvae are contained in a meshed polyvinyl alcohol bag). The bagged formulation was methodological flaws and is at risk of selection and assessment bias. As a result, their conclusions, although providing a foundation for further work, cannot be used as evidence that larval therapy speeds debridement or healing.

2.3 The cost effectiveness using maggot therapy

From the study of Soares, in 2009.The average total costs estimated cost of the trial treatment per application was: loose larvae £71.70 (SD £13.40; minimum-maximum: £51.50-£132.50), bagged larvae £111.90 (SD 33.6; £80.10-£218.50), and hydrogel £1.50 (SD 0). Stratification variables shows that treatment with larvae costs, on average, £96.70 more per participant per year (95% confidence interval £491.90 to £685.80) than treatment with hydrogel. Participants treated with Maggot therapy healed, on average, 2.42 days before those in the hydrogel arm (95% confidence interval 0.95 to 31.91 days) and had a slightly better health related quality of life, as the annual difference was 0.011 (95% confidence interval 0.067 to 0.071). However, none of these differences was statistically significant. The incremental cost effectiveness ratio for the base case analysis was estimated at £8826 and £40 per ulcer free day. Considerable uncertainty surrounds the outcome estimates, conclusions of this study shown that debridement of sloughy or necrotic leg ulcers with larval therapy is likely to produce similar health benefits and have similar costs to treatment with hydrogel. This research maggot therapy economically dominates hydrogel as a treatment for leg ulcers. Given this uncertainty we carried out an economic evaluation alongside a large multicentre randomized controlled trial to investigate the cost effectiveness of larval therapy compared with hydrogel in patients with venous or mixed venous and arterial leg ulcers. The impact of larval therapy on health related quality of life. As a consequence of the high levels of morbidity in patients with leg ulcers, it could be argued that generic health related quality of life (Soares, 2009).

Sherman, in 2003 reported that Maggot therapy treated wounds saw a 50% reduction in necrotic surface area (“half debrided”) in 9 days, During the first 14 days of conventional therapy, there was no significant debridement of necrotic tissue; during the same period with maggot therapy, necrotic tissue decreased by an average of 4.1 cm^2 (P=0.02). After 5 weeks of therapy, conventionally treated wounds were still covered with necrotic tissue over 33% of their surface, whereas after only 4 weeks of therapy maggot treated wounds were completely debrided (P =0.001). Maggot therapy was also associated with hastened growth of granulation tissue and greater wound healing rates. Maggot therapy was more effective and efficient in debriding non healing foot and leg ulcers in male diabetic veterans than was

continued conventional care (Rayman,1998) and Similarly found maggot therapy to be a valuable treatment for debriding diabetic foot wounds (Fleischmann, 1999).

In 2000, researcher demonstrated that Maggot Therapy was associated with more rapid debridement and can reduced cost when compared with hydrogel for treatment wounds (Wayman, 2000).

These studies demonstrated that Maggot Therapy are rapid debridment and reduce cost for treatment chronic wounds but compare with only Hydrogel for conventional therapy. The study shown that the patients who have treated with the conservative therapy is surgical debridment sterile set. Therefore the result of total cost between Hydrogel and surgical debridment are different.

Wayman demonstrated the cost effectiveness of MDT in patients with chronic venous ulcers. In their study, the median cost of treatment per patient in the larval group was 79 Euro compared to 136 Euro for the hydrogel controls ($P<0.05$). The MDT group required fewer visits to achieve debridement than the controls ($P<0.05$), According to Thomas and Jones, when nursing costs were included, the total expenditure on materials to successfully debride one wound was 82 Euro versus 503 Euro of Maggot therapy. The reduction in total costs could be attributed to reduced debridement times as well as reduced number of hospital visits or bed days, all of which resulted in significant savings for the health care system (McKeever, 1933).

Dominic concluded that the Maggot therapy have proven to be a safe and effective method of debridement, for a variety of notoriously difficult-to-treat wounds. Although Maggot therapy is not without limitations, it remains a viable option for wounds or ulcers that fail to respond to conventional therapy. In Hong Kong, local experience of Maggot therapy is lacking with only individual cases reported. Although alternative methods such as ultrasound and waterjet debridement are available and yield results that are at least equivalent if not better than conventional therapy, whether Maggot therapy can be introduced for local patients will depend on the availability of sterile maggots. Use of maggots requires facilities to breed and produce them in sterile conditions. The therapy can then become both accessible and cost-effective. Overcoming political and administrative obstacles may also pose challenges, and include concerns with sterility and acceptance by nurses and patients. Meanwhile, new delivery systems may emerge and provide more promising,

acceptable, and popular means of garnering the benefits of Maggot therapy (Dominic, 2007).

Refer to the research in 2009 shown that, between July 2004 and May 2007 the trial recruited 267 people aged 20–94 years at trial entry. There were more female than male participants (59.2% compared with 40.8%) and most ulcers (75.7%) were classified by the nurses as having an area greater than 5 cm^2, there was no evidence of a difference between the three treatment arms in the time to healing of venous leg ulcers (p = 0.62). Their base-case economic evaluation suggested a large decision uncertainty associated with the cost effectiveness of larval therapy when compared with hydrogel with a 50% probability of larval therapy being cost-effective. The nature of the uncertainty associated with our estimates of difference in costs and health benefit suggests that larval therapy and hydrogel are likely to have similar costs and effects in the treatment of slough leg ulcers (Dumville, 2009).

Maggot therapy significantly reduced the time to debridement of slough or necrotic, chronic venous and mixed venous/arterial leg ulcers, compared with hydrogel; however, larval therapy did not significantly increase the rate of healing of the ulcers. It was impossible to distinguish between larval therapy and hydrogel in terms of cost effectiveness. Maggot therapy significantly reduced the time to debridement of slough or necrotic chronic venous and mixed venous or arterial leg ulcers compared with hydrogel. However, larval therapy did not increase the rate of healing of the ulcers and was associated with significantly more ulcer pain. It was impossible based on this evidence to distinguish between larval therapy and hydrogel in terms of cost effectiveness.

Regarding to all above researchers, their study showed the effectiveness of maggot therapy such as maggot therapy benefits patients through rapid wound debridment, elimination of infection and possible prevention of amputation (File, 2006). It can be decrease antibiotic use, prevent hospital admission, decrease outpatient visits. Moreover maggot therapy is relatively cheap and may save money by those factors mentioned above and by reducing bed occupancy. As antibiotic resistance becomes increasingly prevalent (Gould, 2005).

2.4 Acceptance of maggot therapy

Wound management techniques which make use of fly larvae can naturally be met with a certain degree of reservation on the part of physicians, nursing staff as well as patients. In addition to the frequently mentioned "feeling of disgust" evoked by maggots, the occasionally somewhat complicated dressing application procedure as well as the short shelf life of live maggot products are factors which must also be taken into consideration. In order to more accurately assess the acceptance of this form of treatment, more than 2,000 clinicians and physicians were surveyed in a recent study on maggot therapy. With a total of more than 740 completed and returned questionnaires, the number of persons participating in the survey was surprisingly high (Gunther, 2002). The following results can be summarized from this survey:

1. More than 95% of the physicians questioned were aware of the possible application of fly larvae in wound treatment.

2. 27% of the physicians questioned had already used maggots for the treatment of wounds. The largest group of those physicians who had done so were surgeons.

3. In 90% of treatment applications, maggots were used for the debridement of chronic wounds. In 4% of the cases identified, maggots were used for the treatment of wounds infected with antibiotic-resistant bacteria.

4. The efficacy of wound treatment using maggots was described by more than 75% of the physicians questioned as good and very good, with Biobag perceived as being more effective than individual specimens.

5. According to the physicians questioned, patients have a more favorable opinion of Biobag (83.6% good and very good) than of individual specimens (68.5% good and very good).

6. 65% of the physicians who have not yet worked with maggots would, in principle, be willing to do so.

2.5 Side effect and indications to using maggot therapy

1. Exudate production is often increased during maggot therapy, the exudate may darkness color and have distinctive odour. Clinicians would explain and inform to patient because in this point the patient may be worry and mistakenly be interpreted as more infection (Mumcuoglu, 2001).

2. In case the patient complains of pain during using maggot therapy. It is commonly determine of ischemic wounds and pH change on wound (Thomas, 1996).

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research design

This research study and collect the data with retrospective quantitative research.

3.2 Study area and study population

Study the populations at Bangyai hospital area with patients who have chronic wounds during to January 2009 to October 2009.

3.3 Sampling technique and sample size

This study, the researcher collected retrospective data with the doctor who have experience to use maggot therapy and conservative therapy with patients have chronic wounds such as pressure sore ulcers, diabetic ulcer, infected ulcer and other chronic wounds. From the IPD and OPD informations, there was 80 cases of use Maggot therapy and 70 cases of conservative therapy (N=150) during January to October 2009.

3.4 Measurement tools

In this study, measurement tool is patient collection sheet, cost assessment form and informations from hospital computer database and comparison of curing cost and curing time between maggot therapy and conservative for chronic wound care. Step in how to calculate cost assessment and curing cost of maggot therapy and conventional therapy follow as data analysis process.

3.5 Data collection

This retrospective quantitative collected from the hospital computer database included all OPD and IPD patients with chronic wounds who received either maggot or conventional therapies in January to October 2009 (Total 150 cases, 70 cases with

maggot therapy and 80 cases with conventional therapy) at Bang Yai Hospital, Nonthaburi Province, Thailand.

According to patients had been received maggot therapy amount 80 cases during on January 2009 to October 2009, researcher collected maggot therapy cost, duration time and necrotic tissue size before treatment and after treatment from the doctor who is the one have experience to use maggot therapy at Bang Yai hospital and had recorded data of patients receiving maggot therapy 80 cases with collection sheet. Data on patients' general characteristics and costs of therapies were collected from patients' medical records. Data collected for each patient included age, gender, wounds position, size of wound and wound classification.

Furthermore the staffs at OPD and IPD search for fulfill completely patient's data follow as collection sheet and double checking data again.

3.6 Data analysis

Analyze quantitative data SPSS version 17. Descriptive statistics was used to describe what was observed in the study populations. According to cost analysis effectiveness of curing duration**,** necrotic tissue size after treatment and curing cost.

Cost comparison between maggot therapy and conventional therapies

In maggot therapy, cost calculation:

1. Main therapeutic cost (maggot therapy) = 3,000 Baht per one tube of maggot for the use of 3 days duration (It should be noted that there was a sale promotion that for 2 tubes of maggot purchased, one tube would be obtained for free.)

2. Related cost (maggot therapy) = related cost for OPD cases (wound dressing set costing 70 Baht per visit) plus related cost for IPD cases (room service + food + nursing care cost + dressing set = 740 Baht per day)

3. Total cost (maggot therapy) = main therapeutic cost plus related cost

In conventional therapy, cost calculation was as followed:

1. Main therapeutic cost (conventional therapy) = cost of sterile set for wound debridement (300 Baht per set)

2. Related cost = related cost for IPD cases (room service + food + nursing care cost = 600 Baht per day) It should be noted that there was no related cost for OPD cases as they spent only on main therapeutic expenditure.

Total cost is main therapeutic cost plus related cost .When the main therapeutic costs of both therapies were compared, it was evident that the median cost of maggot therapy was significantly cheaper than that of conventional therapy.

Comparison of curing duration in maggot therapy and conventional therapy

According to how to evaluated healing of wound by assessing the curing duration after receiving maggot therapy and conventional therapy The result can demonstrated that maggot therapy was more effective in decreasing the necrotic tissue than the conventional ones. Furthermore, when the curing duration was considered, maggot therapy also resulted in shorter median curing duration**.**

The effectiveness of maggot therapy and conventional therapy

1. Number of patients has success in wounds curing and management
2. Reducing curing duration
3. Number of patients have to amputated limb after treatment

The reducing care cost in hospital

1. Inexpensive total cost of maggot therapy
2. Nursing care reducing
3. Number of patients are quickly discharge from IPD

3.7 Ethical consideration

The proposal has been submitted to the Ethical Research Committee, Chulalongkorn University.

Furthermore the doctor already explains and informs patients for maggot therapy before treatment and introduce this is alternative choice for chronic wound care when the patient has acknowledge indication for use between maggot therapy and conventional therapy and also have acceptance to received maggot therapy, therefore the doctor can use maggot therapy in this case.

3.8 Limitation

In this research limited number of hospitals and do not study in private hospital therefore the estimate cost not coverage worldwide for public data and just only for Bangyai hospital.

3.9 Obstacles and strategies to solve the problem

1. Lack of knowledge indication of use maggot therapy with medical team, it may not successful in treatment.
2. Maggots have a short shelf life, which prevents long term storage before use.

CHAPTER IV

RESULTS

This chapter summarizes results of this study. This chapter is organized into topics as followed:

4.1 Characteristics of 150 chronic wounds either with or without maggot therapy

Since the distribution of patients' ages is not normally distributed, median of age is reported instead of mean. The median age of patients receiving maggot therapy is 56 years old, which is slightly greater than that of those patients with conservative therapy (51years old). The maximum age of the whole group of patients is 86 years old while the lowest age is 3 years old. The study reveals comparable percentages of male patients receiving maggot therapy (48.75%) and conservative therapy (51.25%). Nevertheless, there is a greater difference in percentages of female patients receiving maggot therapy (58.57%) and conservative therapy (41.43%). The majority of outpatients have received maggot therapy (96.78%). However, conservative therapy dominates in the group of inpatients (58.12%). The three main types of chronic wounds include diabetic ulcer, pressure sore ulcer, and infected ulcer.

In each type of chronic wound, comparable percentages of cases receiving maggot therapy and conventional therapy are found patients with chronic wound as diabetic ulcer 112 cases. (74.67%) treatment by maggot therapy 60 cases (53.57%) and patient's number 52 cases (46.43%) receiving treatment by conservative therapy. Patients with pressure ulcers for 19 cases (12.67%) treatment by maggot therapy 10 cases (52.63%) and 9 cases (47.37%). Patients with chronic wound Infected ulcer for 16 cases (10.66%) treated by maggot therapy 7 cases (43.75%) and 9 cases (56.25%) treated by conventional therapy. In addition, patients with other types of chronic wounds for 3 cases (2.0%) The patient is a boy aged 3 years scald wounds on the arms of 1 patient was treated with lesions to maggot therapy. And 2 patients with chronic wounds corn use a method of treatment maggot therapy as well.

Locations of lesions in patients with chronic total 150 cases are as follows: at the foot gangrene 109 of cases were treating by maggot therapy 62 cases (77.5%) Patients treated with maggot therapy 47 cases use conventional therapy (67.1%) of

patients treated with conventional therapy). Patients with chronic ulcers at the leg for 21 cases were treated by maggot therapy for 7 cases (8.8% of patients treated with maggot therapy) and 14 cases use conventional therapy (20.0% of patients treated with conventional therapy). Patients with chronic wounds at the back for 19 cases treated by Maggot therapy 10 cases (12.5% of patients treated with maggot therapy) and 9 cases were treated by conventional therapy (12.9% of all treat conventional therapy). 1 List of patients with chronic wounds on the arms and hands were treated for maggot therapy. (Table 1)

Table 1: Characteristics of study population and chronic wounds classified by received wound therapies. (1)

Features	**Maggot therapy (n = 80)**	**Conventional therapy (n = 70)**
Age		
Median age	56	51
Range (Min. – Max.)	82 (3-85)	67 (19-86)
Gender		
Male	39 (48.75%)	41 (51.25%)
Female	41 (58.57%)	29 (41.43%)
Cases by department		
OPD cases	31 (96.78%)	2 (3.21%)
IPD cases	49 (41.88%)	68 (58.12%)
Types of wound		
Diabetic ulcer 112 (74.67%)	60 (53.57%)	52 (46.43%)
Pressure sore ulcer 19 (12.67%)	10 (52.63%)	9 (47.37%)
Infected ulcer 16 (10.66%)	7 (43.75%)	9 (56.25%)
Other wounds 3 (2%)	3 (100%)	0

Table 1: Characteristics of study population and chronic wounds classified by received wound therapies. (2)

Features	Maggot therapy (n = 80)	Conventional therapy (n = 70)
Wound locations		
Foot	62 (56.88%)	47 (43.12%)
Leg	7 (33.33%)	14 (66.7%)
Back	10 (52.63%)	9 (47.37%)
Hand and arm	1 (100%)	0
Necrotic tissue size before therapy		
Median size	12 cm^2	25.5 cm^2
Range (Min. – Max.)	67 (3-70) cm^2	44 (6-50) cm^2
Interquartile range	8.25-22.25 cm^2	15-35 cm^2
Necrotic tissue size after use		
Median size	0 cm^2	3 cm^2
Range (Min. – Max.)	18(0-18) cm^2	37(0-37) cm^2
Interquartile range	0-0 cm^2	2-5 cm^2
Limb amputation		
Having limb amputated after therapy	1 (1.25%)	5 (7.14%)
No limb amputated after therapy	79 (98.75%)	65 (92.85%)

Size of wound and amputation limb rate in patient use maggot therapy and use conservative therapy

Wound locations in the whole group of patients were as followed: foot ulcers (109 cases, 72.67%), leg ulcers (21 cases, 14%), back (19 cases, 12.67%), and hand and arm (1 case, 0.66%). More number of patients with foot and back ulcers received maggot therapy. In contrast, the number of patients with leg ulcer who received conventional therapy was doubled the number of patients receiving maggot therapy. There was only a case of hand and arm ulcer found in this study.

Median size of necrotic tissue found before treatment was larger in the group of patients receiving conventional therapy (25.5 cm^2). The largest size of necrotic tissue was 70 cm^2 while the smallest size was 3 cm^2. As revealed from interquartile

ranges of necrotic tissue size, 50 percent of the cases receiving conventional therapy had necrotic tissue sizes between 15 to 35 cm^2, while 50 percent of patients receiving maggot therapy had necrotic tissue sizes in the range of smaller sizes (8.25 – 22.25 cm^2).

From patients with chronic wounds all 150 cases the size of patients admitted with a wound to Maggot Therapy after maggot therapy has been provided, median size of necrotic tissue was decreased to 0 cm^2. As revealed from the interquartile range, up to 75 percent of the patients receiving maggot therapy had complete wound healing. In contrast, in the group of those receiving conventional therapy, median size of the necrotic tissue after treatment was 3 cm^2 and 50 percent of them had remaining chronic wound sized 2 to 5 cm^2.

The number of patients admitted to Maggot Therapy with all 80 cases. Patients 79 cases (98.75% of all cases 80 cases) with not amputate limb in the area of chronic wounds and found that patients with chronic wounds were 1 case (1.25% of all cases 80 cases) must be sent to another hospital to cut leg ulcers due to the nature of the patient does not improve blood circulation system, because the blood circulation on legs and feet are not good, but before Prior to this patient to be treated with Maggot Therapy._Patients admitted to Bang Yai hospital (IPD case) 17 days ago Maggot Therapy 1 time and the total duration of treatment in the hospital 21 days and costs for treatment were 18,540 Baht. Number of patients admitted chronic wounds in hospital of 70 cases with conventional therapy found that patients 65 cases (92.85% of the total patients 70 cases) with no having amputate of limb around the wound. Chronic and found those patients with chronic wounds were 5 cases (7.14% of all cases 70 cases) that need to be amputation. Therefore after completed treatment found that only 1.25% of patients receiving maggot therapy had limb amputation while 7.14% of patients receiving conventional therapy had the amputation. The results also showed that more than 90 percent of patients receiving either maggot or conventional therapies did not have limb amputation after the therapies. (Table 1)

4.2 Comparison cost of maggot therapy and conventional therapy

For cost comparison between maggot and conventional therapies, three cost categories have been compared. These categories included main therapeutic cost, related cost, and total cost. In maggot therapy, cost calculation was as followed.

The cost of patients use maggot therapy

The expense for patients with wound treatment by maggot Therapy method as followed:

1. Price for main therapeutic cost (maggot therapy) = 3000 Baht per one tube for use of 3 days duration (It should be noted that there was sale promotion that for 2 tubes of maggot product purchased, one tube would be obtained for free

2. Related cost (maggot therapy) = related cost for OPD cases (wound dressing set costing 70 Baht per visit)

3. Related cost (maggot therapy) for IPD cases = 740 Baht per day (room service + food + nursing care cost + dressing set)

4. Total cost (maggot therapy) = main therapeutic cost plus related cost

Case No.21 no data for necrotic tissue size because the patient has bad blood circulation and refer to another hospital for amputation after use maggot therapy on date 21

The cost of patients use conservative therapy

In the past and present, Bang Yai Hospital use the treatment of chronic wounds in patients was a way of trimming out the dead tissue with a surgical knife or scissors. The expense for patients with wound treatment method is as follows: conventional therapy.

1. Conventional therapy = Sterile set for wound debridement = 300 Baht/set
2. Material cost IPD = Room+food+nurse service=600 Baht/day
3. Material cost OPD = debridement set = 300 baht/time

Table 2: Cost comparison between maggot therapy and conventional therapy

Costs	Maggot therapy cost (Thai Baht), (n = 80)	Conventional therapy cost (Thai Baht), (n = 70)
Main therapeutic cost		
Median cost	3,000	8,400
Range (Min. – Max.)	6,750 (2,250 – 9,000)	14,400 (3,000 – 17,400)
Interquartile range	3,000 – 6,000	4,200 – 12,000
Related cost		
Median cost	2,960	8,400
Range	15,330	17,400
(Min. – Max.)	(210 – 15,540)	(0 –17,400)
Interquartile range	210 – 8,140	4,100 – 11,100
Total cost		
Median cost	6,700	16,800
Range	16,080	30,300
(Min. – Max.)	(2,460 – 18,540)	(4,500 – 34,800)
Interquartile range	3,210 – 14,140	8,400 –22,200

To compare wounds type, which included in therapies, 1 burn case and other wounds case that are not present in this table at Bangyai Hospital, Nonthaburi, Thailand, we found the result of curing cost as followed:

Average curing cost of Maggot Therapy in chronic wounds compare to the average cost in conventional therapy, the number of patients with chronic wounds from pressure ulcer treated by maggot therapy. The average cost is 13,018 Baht and the patient treated by conventional therapy the average cost is 16,133.33 Baht. Patients with chronic wounds from diabetic ulcer treated by maggot therapy the average cost is 8,784.66 Baht and the patients treated by conventional therapy the average cost is 14,700 Baht.

Patients with chronic wounds from infected wound treated by maggot therapy. The average cost is 9,244.28 Baht and the patient was treated by conservative therapy the average cost is 24,577.77 Baht (Table 3).

Table 3: Comparison average cost of maggot therapy and conventional therapy

	Maggot therapy Average cost (Baht)	Conventional therapy Average cost (Baht)
Type of wounds		
Pressure ulcer	13,018	16,133.33
Diabetic ulcer	8,784.66	14,700
Infected wound	9,244.28	24,577.77

4.3 Curing time of wounds were treated maggot therapy and were treated conservative therapy

Length of treatment time for patients with chronic wounds 150 cases treated by maggot therapy and conventional therapy as following:

1. Patients with chronic wounds 80 cases treated by maggot therapy. Length of treatment time is 3 days minimum and maximum date is 21 days, the median 6.5 days.

2. Patients with chronic wounds 70 cases treated by conventional therapy. Length of treatment time is 5 days minimum and maximum date is 45 days, the median 14 days

Median curing duration of wounds treated by maggot therapy was 6.5 days which was shorter than that of conventional therapy (14 days). Curing durations in 50 percent of patients receiving maggot therapy were in smaller range (3 – 11 days) when compared to that of conventional ones (7 – 20 days).(Table 4)

Table 4: Comparison of curing duration in maggot therapy and conventional therapy

	Maggot Therapy (Days), (n = 80)	Conventional therapy (Days), (n=70)
Curing duration		
Median	6.5	14
Range (Min-Max)	18(3-21)	40(5-45)
Interquatire range (IQR)	3-11	7-20

4.4 Analysis of comparison cost management data for patients with wounds that were or were not treated with maggot therapy.

Data on patients' general characteristics and costs of therapies were collected from patients' records. Data were analyzed using descriptive statistics. It was revealed that maggot therapy resulted in shorter wound healing time (6.5 days) when compared to that of conventional therapy (14 days). The majority of patients receiving maggot therapy did not have limb amputated (98.75%) while most of those receiving conventional therapy contrastively had limb amputated (7.14%). The average cost of maggot therapy was lower (6,700 Baht per case) when compared to the conventional ones (16,800 Baht per case).

It is well illustrated that maggot therapy could potentially reduce wound curing care cost in hospital and effectively resulted in shorter curing period and less likeliness of having limb amputated. Ultimately, maggot therapy should be considered as a rational alternative for wound curing in terms of the treatment cost and wound curing effectiveness.

We find any evidence of treatment with either Maggot therapy reduced the time to wounds healing compared with conservative therapy. Maggot therapies showed very similar results for healing and were considered as one group in the main

analysis. Number of The patients receiving maggot therapy who do not have amputated organ are 79 cases from total 80 cases and curing time for treated wounds average 6.5 days and average cost for use this treatment is 9,376.23 Baht excluded 1 burn case and 2 other wounds case but The average cost of maggot therapy was lower (6,700 Baht per case) when included 1 burn case and 2 other wounds case. Number of The patients receiving Conservative therapy who do not have amputated organ are 65 cases from total 70 cases and curing time for treated wounds average 14 days and average cost for use this treatment is 16,800 Baht.

From the case study found that the treatment cost of patients with chronic wounds who were treated by maggot therapy. The use of maggot therapy in the treatment of wound care will take less time than conventional therapy. Form the result, after the doctors using Maggot therapy on wound of patients then don't have to clean or disinfect the wounds for 3 days of using maggot therapy.

CHAPTER V

SUMMARY, DISCUSSION AND RECOMMENDATION

5.1 Summary of the study

This retrospective quantitative study included all OPD and IPD patients with chronic wounds total 150 cases, 70 cases with maggot therapy and 80 cases with conventional therapy, the median age of patients receiving maggot therapy is 56 years old, which is slightly greater than that of those patients with conservative therapy (51years old). The maximum age of the whole group of patients is 86 years old while the lowest age is 3 years old. The study reveals comparable percentages of male patients receiving maggot therapy (48.75%) and conventional therapy (51.25%). Nevertheless, there is a greater difference in percentages of female patients receiving maggot therapy (58.57%) and conventional therapy (41.43%). The majority of outpatients have received maggot therapy (96.78%). However, conventional therapy dominates in the group of inpatients (58.12%). The three main types of chronic wounds include diabetic ulcer, pressure sore ulcer, and infected ulcer. From the result, we find any evidence that a phase of treatment with either maggot therapy reduced the time to wounds healing compared with conventional therapy. Maggot therapy showed very similar results for healing and was considered as one group in the main analysis.

The result show any evidence of treatment with either maggot therapy reduced the time to wounds healing compared with conservative therapy. Maggot therapy showed very similar results for healing and was considered as one group in the main analysis. Number of The patients receiving maggot therapy who do not have amputated organ are 79 cases from total 80 cases and curing time for treated wounds average 6.5 days and average cost for use this treatment is 9,376.23 Baht excluded 1 burn case and 2 other wounds case but The average cost of maggot therapy was lower (6,700 Baht per case) when included 1 burn case and 2 other wounds case. Number of The patients receiving Conservative therapy who do not have amputated organ are 65 cases from total 70 cases and curing time for treated wounds average 14 days and average cost for use this treatment is 16,800 Baht.

The median curing times (6.5 days for the participants receiving maggot therapy and 14 days for the conservative therapy group) were longer than in our previous trial.

Data from this study indicate that maggot therapy reduce curing care cost in hospital or not. If maggot can decrease total cost of curing, we are saving in financial cost between patients and hospital. Effectiveness using maggot therapy can be save life and save having amputation limb of many patients.

Data on patients' general characteristics and costs of therapies were collected from patients' records. Data were analyzed using descriptive statistics. It was revealed that maggot therapy resulted in shorter wound healing time (6.5 days) when compared to that of conventional therapy (14 days). The majority of patients receiving maggot therapy did not have limb amputated (98.75%) while most of those receiving conventional therapy contrastively had organ amputated (7.14%). The average cost of maggot therapy was lower (6,700 Baht per case) when compared to the conventional ones (16,133.33 Baht per case). It is well illustrated that maggot therapy could potentially reduce wound curing care cost in hospital and effectively resulted in shorter curing period and less likeliness of having organ amputated. Ultimately, maggot therapy should be considered as a rational alternative for wound curing in terms of the economical cost and wound curing effectiveness.

In this study, it is well illustrated that maggot therapy could potentially reduce wound curing care cost in hospital and effectively resulted in shorter curing period and less likeliness of having limb amputated. Ultimately, maggot therapy should be considered as a rational alternative for wound curing in terms of the treatment cost and wound curing effectiveness.

5.2 Discussion

This study simply evaluated healing of wound by assessing the size of necrotic tissue after receiving maggot and conventional therapies. The result demonstrated that maggot therapy was more effective in decreasing the necrotic tissue than the conventional ones. Furthermore, when the curing duration was considered, maggot therapy also resulted in shorter median curing duration. These findings were consistent with the findings reported by Sherman that up to 80 percent of pressure

ulcers treated by maggot therapy were completely debrided while less than half of pressure ulcers (48%) treated by conventional therapy alone were completed debrided. He also concluded that maggot therapy was more efficient and effective in debridement of chronic pressure ulcers than were the prescribed conventional treatment (Sherman, 2002).

In addition, when the percentages of case having limb amputated in this study was considered, just one case or 1.25% of those receiving maggot therapy had limb amputation. In this case, maggot therapy was prescribed late as the last alternative to amputation and that did not improve the prognosis. In contrast, up to 5 cases or 7.14% of those receiving conventional therapy had limb amputated. These evidences also indicated that maggot therapy could potentially reduce the number of case to have limb amputated. Collectively, these findings suggest that maggot debridement therapy should not be considered as the last alternative to limb amputation, instead, it should be earlier prescribed to aid further surgical wound closure or even complete healing without surgical intervention. Nevertheless, it should not be misinterpreted that conventional therapy was not effective since the efficacy of conventional therapy was assessed to be effective in treatment most of the wounds.

Although the result was not a full economic evaluation, it was well illustrated that the cost of maggot therapy was more economical than that of conventional therapy in all of the cost categories. The median cost of maggot therapy (6,700 Baht) was even less than half of the expenditure for conventional therapy (16,800 Baht). The cost saving by the use of maggot therapy was due to its shorter curing duration, about half of the curing duration for conventional therapy. The economical feature of maggot therapy would be useful in the health care setting where health resources are limited for chronic wound care, especially in the district hospitals and in developing country, such as Thailand.

In this study, direct cost of limb amputation was not included in cost calculation. Nevertheless, if such cost of limb amputation was include in the calculation, it would be event more apparent that maggot therapy could potentially save cost of treatment than conventional therapy.

Regarding to the sample size of chronic wounds patients receiving conventional therapy, the data collection a few specific biases in necrotic wound size

during receiving conventional therapy because no data in the collecting sheet of doctor.

5.3 Recommendation

As this study was an anecdotal study, the wound healing was still subjective, therefore, the prospective study with a large number of study subjects and controlled group for comparison with that receiving maggot therapy would be strongly recommended to further be undertaken to apparently demonstrate the effectiveness of maggot therapy in chronic wound healing. Full cost benefit and cost effectiveness should also be undertaken for further decision making in clinical practice and policy planning at the national level.

In this research limited number of hospitals and do not study in private hospital therefore the estimate cost not coverage worldwide for public data and just only for Bangyai hospital. Obstacles and strategies to solve the problem are lack of knowledge indication of use maggot therapy with medical team, it may not successful in treatment.Maggots have a short shelf life, which prevents long term storage before use.

In order to recommend maggot therapy as one of the main treatments of chronic wound in the national policy, more evidences for decision making should further be provided. These evidences include the results of cost benefit analysis and cost-effectiveness analysis in Thai hospital settings, views and attitudes of health care providers and patients towards maggot therapy, and evidences from biomedical research assuring proper chronic wound healing and patient safety.

Since manufacturers producing materials used for maggot therapy are only in the private sector, the cost of the therapy is still high and may not be appropriate for patients who are unable to afford the cost. Thus, it is recommended that the manufacturing technology should be developed for the public use by the government sector as well in order to reduce the cost and provide sufficient products if the therapy is to be used nationally.

5.4 Further study

As this study was an anecdotal study, the wound healing was still subjective, therefore, the prospective study with a large number of study subjects and controlled group for comparison with that receiving maggot therapy would be strongly recommended to further be undertaken to apparently demonstrate the effectiveness of maggot therapy in chronic wound healing. Full cost benefit and cost effectiveness should also be undertaken for further decision making in clinical practice and policy planning at the national level.

REFERENCES

Baer, W. S. (1931): The treatment of chronic osteomyelitis with the maggot larvae of the blowfly. **Journal of Bone and Joint Surgery** 13: 438-475.

Bale, S., and Jones, V. (1997). **Wound care nursing: A patient-centred approach**. London: Bailliere Tindall.

Bale, S., and Jones, V. (2006). **Wound care nursing: A patient-centred approach**. 2nd ed. Edinburgh: Mosby Elsevier.

Barrett, M., Larson, A., Carville, K., and Ellis I. (2009). **Challenges faced in Implementation of a telehealth enabled chronic wound care system: Rural and Remote Health 9** [Online]. Available from: http://www.rrh.org.au/articles/showarticleaust.asp?ArticleID=1154 [2010, January 9]

BioMonde GmbH & Co.KG. (2004). **Biomonde Fly larva handbook**. Barsuttel: BioMonde GmbH. (Mimeographed).

Blake, F., Abromeit, N., Bubenheim, M., Li, L., and Schmelzle, R. (2007). The biosurgical wound debridment: Experimental investigation of efficiency and practicability. **Wound Rep Reg** 15: 756-761.

Bradley, M., Cullum, N., and Sheldon, T. (1999).**Review of the debridment of chronic wound: a systematic** [Online]. Available from: http://www.ncchta.org/execsumm/summ3171.htm [2009**,** September 17]

Church, J. (2002). Maggot Debridement Therapy for Chronic Wounds. **Lower Extremity Wounds** 1(2): 124-134.

College of Public Health Sciences, Chulalongkorn University. (2009). **Medical Health Business Training program: Costing analysis and health economics**. Bangkok: College of Public Health Sciences. (Mimeographed).

Courtenay, M., Church, J., Ryan, T. (2000). Larva therapy in wound management**. J of the Roy. Soc. of Med** 93: 72-74.

Dumville, J., et al. (2009). VenUS II: a randomized controlled trial of larval therapy in the management of leg ulcers. In **Health Technology Assessment**, pp.1-201.Perth: The Dorset Press.

File, T.M. (2006). Clinical implications and treatment of multi resistant *Streptococcus pneumoniae* pneumonia.**Clin Microbial Infect** 12: 31-41.

Fleischmann, W., Russ, M., Moch, D., and Marquardt, C. (1999). Biosurgery: Maggot are they really the better surgeons. **Chirurg** 70:1340-1346.

Frykberg, R., Haershaw, G., and Chrzan, J. (1998). Epidermiology of the diabetic foot: ulcerations and amputations. In Veves A. (ed.). **Contemporary endocrinology: Clinical management of diabetic neuropathy**, pp.273. Totowa: Humana Press.

Frykberg, R., et al. (2006).A clinical practice guideline. **J Foot Ankle Surg** 45: 61-66.

Gould, I.M. (2005).The clinical significance of methicillin-resistant *Staphylococcus aureus*. **J Hosp Infect** 61: 277-282.

Gunther, M. (2002). On the acceptance of maggot therapy studies at German Hospitals. **Management and Hospital** 11: 24-30.

Harding, K.G., Morris, H.L., and Patel, G.K. (2002). Science, medicine and the future: Healing chronic wounds. **British Medical Journal**, 324: 160–163.

Jones, M., and Thomas S. (2000).Larval therapy.**Nursing standard** 14:47-51.

Lau, H., and Lee, F. (2000). Maggot in surgery. **Ann Coll Surg** 4: 50-53.

Mckeever, D.C. (1933). Maggots in treatment of osteomyelitis: A simple inexpensive method. **Journal of Bone and Joint Surgery** 15: 85-93.

Mumcuoglu, K.Y. (2001). Clinical Applications for Maggots in Wound Care. **Am J Clin Dermatol** 2 (4): 219-227.

Nigam, Y., Bexfield, A., Thomas, S., and Ratcliffe, N. (2006) Maggot Therapy: The Science and Implication for CAM Part I-History and Bacterial Resistance. **eCAM** 3(2):223-227.

Petherick, E.S., Meara, S.O., Spilsbury, K., Iglesias, C.P., Nelson, E.A., and Torgerson, D.J. (2006). Patient acceptability of larval therapy for leg ulcer treatment: a randomised survey to inform the sample size calculation of a randomised trial. **BMJ Medical Research Methodology** [Online]. Available from: http://www.biomedcentral.com/1471-2288/6/43 [2010, January 9]

Rayman, A., Stansfield, G., Woollard, T., Mackie, A., Rayman, G. (1998). Use of larvae in the treatment of the diabetic necrotic foot. **The Diabetic Foot** 1: 7-13.

Sherman R.A., Hall M.J., and Thomas, S. (2000). Medicinal maggots: an ancient remedy for some contemporary afflictions. **Annu. Rev. Entomol**. 45: 55–81.

Sherman, R.A. (2002). Maggot versus conservative debridement therapy for the treatment of pressure ulcers. **Wound Repair and Regeneration** 10(4): 208-214.

Sherman, R.A. (2003). Maggot therapy for treating diabetic foot ulcers unresponsive to conventional therapy**. Diabetes Care** 26 (2): 446–51.

Sherman, R.A. (2009). Maggot Therapy Take Us Back to the Future of Wound Care: New and Improved Maggot Therapy for the 21st Century. **Journal of Diabetes Science and Technology** 3(2): 336-344.

Soares, M.O., et al.(2009). Cost effectiveness analysis of larval therapy for leg ulcers. **BMJ Medical Research Methodology** [Online]. Available From: http://www.ncbi.nlm.nih.gov/pubmed/19304578 [2010, March 10]

Steenvoorde, P., Doorn, L.P., Jacobi, C.E., and Oskam, J. (2007).Maggot debridement therapy in the palliative setting. **The American journal of hospice & palliative care** 24 (4): 308–310.

Thomas, S., Jones, M., Shutler, S., and Jones S. (1996). Using larvae in modern wound management.**J Wound Care** 5: 60–69.

Thomas, S., Jones, M., and Andrews, A. (1997). The use of fly larvae in the treatment of wounds. **Nurs Stand** 12: 54–59.

Tomaselli, N.L. (2005). Teaching the patient with a chronic wound. **Advance in Skin and Wound Care** 18(7): 379–387.

Wayman, J., Nirojogi, V., and Walker, A. (2000). The cost effectiveness of larval therapy in venous ulcers. **J of Tiss. Viab**.10: 91-94.

Whitaker, I.S., Twine, C., Whitaker, M.J., Welck, M., Brown, C.S., and Shandall, A. (2007).Larval therapy from antiquity to the present day: mechanisms of action, clinical applications and future potential. **Postgraduate medical journal** 83 (980): 409–13.

Whitney, J.D. (2005). Overview acute and chronic wounds. **Nursing Clinics of North America** 40(2): 191–205.

Wientjes, K.A. (2002). Mind Body Techniques in Wound Healing. **Ostomy Wound Management** 48(11): 62-67.

Wollina, U., et al. (2002). Biosurgery supports granulation and debridement in chronic wounds: clinical data and remittance spectroscopy measurement. **International Journal of Dermatology** 41: 635-639.

Wysocki, A.B. (1999). Skin anatomy, physiology and pathophysiology. **Nursing Clinics of North America** 34(4): 777–797.

APPENDICES

APPENDIX A

The result of study population and chronic wounds classified by received maggot and conventional therapy.

Case No.	Sex	Age	Type of wound	Type of patient	Position of wound
1	Male	35	DM	IPD	Rt. Foot
2	Male	55	DM	IPD	Rt. Foot
3	Female	56	DM	OPD	Lt.foot
4	Female	67	DM	OPD	Lt.foot
5	Female	67	DM	OPD	Lt.foot
6	Female	67	DM	OPD	Lt.foot
7	Male	45	DM	OPD	Rt.foot
8	Female	43	DM	OPD	Lt.leg
9	Female	43	DM	OPD	Lt.leg
10	Male	32	Other wound	OPD	Rt.foot
11	Male	44	DM	IPD	Rt.foot
12	Male	56	DM	IPD	Rt.foot
13	Female	56	DM	OPD	Rt.foot
14	Female	3	Burn	IPD	Lt.hand
15	Male	59	Pressure sore	IPD	Back
16	Female	35	Infected wound	OPD	Rt.foot
17	Male	66	DM	IPD	Rt.foot
18	Female	44	Other wound	OPD	Rt.foot
19	Female	55	DM	IPD	Rt.foot
20	Male	58	DM	IPD	Rt.foot
21	Female	47	DM	IPD	Lt.foot
22	Male	34	Infected wound	OPD	Lt.leg
23	Male	67	Pressure sore	IPD	Back
24	Female	56	DM	OPD	Lt.foot
25	Female	44	DM	IPD	Rt.foot
26	Male	56	DM	IPD	Rt.foot
27	Female	72	DM	IPD	Lt.foot
28	Male	67	DM	IPD	Lt.foot
29	Female	57	DM	IPD	Rt.foot
30	Male	55	DM	OPD	Lt.foot
31	Female	58	Pressure sore	IPD	Back
32	Male	67	DM	OPD	Lt.foot
33	Male	45	DM	OPD	Rt.foot
34	Male	39	DM	OPD	Lt.foot
35	Female	45	Pressure sore	IPD	Back
36	Female	52	DM	IPD	Rt.foot
37	Male	55	DM	OPD	Lt.foot
38	Male	47	DM	OPD	Rt.foot

Case No.	Sex	Age	Type of wound	Type of patient	Position of wound
39	Male	55	DM	OPD	Rt.foot
40	Female	43	Infected wound	IPD	Lt.foot
41	Female	41	DM	IPD	Lt.foot
42	Male	47	DM	IPD	Rt.foot
43	Female	76	Pressure sore	IPD	Back
44	Female	59	Infected wound	IPD	Rt.leg
45	Male	39	DM	IPD	Rt.foot
46	Male	61	DM	IPD	Rt.foot
47	Female	55	DM	OPD	Rt.foot
48	Male	61	Pressure sore	IPD	Back
49	Male	56	Pressure sore	IPD	Back
50	Female	44	Infected wound	OPD	Rt.foot
51	Male	66	DM	IPD	Rt.foot
52	Female	48	DM	OPD	Rt.foot
53	Female	77	DM	IPD	Lt.foot
54	Female	81	DM	IPD	Rt.foot
55	Female	71	DM	IPD	Rt.foot
56	Male	49	DM	IPD	Rt.foot
57	Female	67	DM	OPD	Rt.foot
58	Male	58	DM	OPD	Rt.foot
59	Male	59	Pressure sore	IPD	Back
60	Female	39	DM	IPD	Rt.foot
61	Male	44	DM	IPD	Rt.foot
62	Female	56	DM	IPD	Lt.foot
63	Female	36	DM	OPD	Rt.foot
64	Female	43	DM	OPD	Rt.foot
65	Female	40	Infected wound	IPD	Lt.leg
66	Male	85	DM	IPD	Lt.foot
67	Male	80	DM	IPD	Rt.foot
68	Male	78	Pressure sore	IPD	Back
69	Female	59	Infected wound	IPD	Rt.leg
70	Female	57	DM	IPD	Rt.foot
71	Male	69	DM	IPD	Rt.foot
72	Male	79	DM	IPD	Rt.foot
73	Male	56	DM	IPD	Rt.foot
74	Female	67	DM	OPD	Rt.foot
75	Male	46	DM	OPD	Rt.foot
76	Male	72	Pressure sore	IPD	Back
77	Female	56	DM	IPD	Rt.foot
78	Female	49	DM	IPD	Rt.foot
79	Male	45	DM	OPD	Lt.foot
80	Female	39	DM	OPD	Rt.foot

Case No.	Necrotic tissue size before use maggot(cm^2)	Necrotic tissue size after use maggot(cm^2)	Curing time	Maggot cost(Baht)	Related cost(Baht)	Total cost (Baht)
1	37	0	3	3000	2220	5220
2	8	0	8	6000	5920	11920
3	25	18	3	2250	210	2460
4	18	10	3	2250	210	2460
5	10	5	3	2250	210	2460
6	5	0	3	2250	210	2460
7	12	0	3	3000	210	3210
8	6	3	3	3000	210	3210
9	3	0	3	3000	210	3210
10	12	0	3	3000	210	3210
11	12	0	10	6000	7400	13400
12	70	6	10	3000	7400	10400
13	6	0	3	3000	2220	5220
14	9	0	3	3000	2220	5220
15	20	0	5	3000	3700	6700
16	12	0	3	3000	210	3210
17	20	0	10	6000	7400	13400
18	12	0	3	3000	210	3210
19	35	0	10	6000	7400	13400
20	16	0	7	6000	5180	11180
21	35	N/A	21	3000	15540	18540
22	42	0	3	3000	210	3210
23	42	0	10	6000	7400	13400
24	12	0	3	3000	210	3210
25	8	0	3	3000	2220	5220
26	37	0	10	9000	7400	16400
27	20	0	10	3000	7400	10400
28	32	0	3	6000	2220	8220
29	35	0	3	3000	2220	5220
30	6	0	3	3000	210	3210
31	12	0	3	3000	2220	5220
32	15	0	3	3000	210	3210
33	9	0	6	6000	420	6420
34	6	0	3	3000	210	3210
35	35	0	14	6000	10360	16360
36	12	0	14	6000	10360	16360
37	8	0	9	6000	630	6630
38	12	0	3	3000	210	3210

Case No.	Necrotic tissue size before use maggot(cm^2)	Necrotic tissue size after use maggot(cm^2)	Curing time	Maggot cost(Baht)	Related cost(Baht)	Total cost (Baht)
39	6	0	3	3000	210	3210
40	35	0	10	6000	7400	13400
41	20	0	15	6000	11100	17100
42	20	0	15	6000	11100	17100
43	30	0	15	6000	11100	17100
44	42	0	11	6000	8140	14140
45	20	0	11	6000	8140	14140
46	15	0	3	3000	2220	5220
47	6	0	3	3000	210	3210
48	20	0	10	6000	7400	13400
49	20	0	5	3000	3700	6700
50	11	0	3	3000	210	3210
51	20	0	12	6000	8880	14880
52	10	0	3	3000	210	3210
53	9	0	10	6000	7400	13400
54	20	0	15	6000	11100	17100
55	15	0	11	6000	8140	14140
56	10	0	3	3000	2220	5220
57	6	0	3	3000	210	3210
58	6	0	3	3000	210	3210
59	30	0	15	6000	11100	17100
60	9	0	10	6000	7400	13400
61	12	0	14	6000	10360	16360
62	8	0	9	6000	6660	12660
63	12	0	3	3000	210	3210
64	6	0	3	3000	210	3210
65	35	0	10	6000	7400	13400
66	20	0	15	6000	11100	17100
67	20	0	15	6000	11100	17100
68	30	0	15	6000	11100	17100
69	40	0	11	6000	8140	14140
70	18	0	11	6000	8140	14140
71	23	0	15	6000	11100	17100
72	12	0	11	6000	8140	14140
73	10	0	3	3000	2220	5220
74	6	0	3	3000	210	3210
75	6	0	3	3000	210	3210
76	28	0	15	6000	11100	17100
77	8	0	10	6000	7400	13400
78	10	0	14	6000	10360	16360
79	8	0	9	6000	630	6630
80	6	0	3	3000	210	3210

Case No.	Sex	Age	Type of wound	Type of patient	Position of wound
1	Male	59	DM	IPD	Foot
2	Female	65	DM	IPD	Lt.foot
3	Female	75	DM	IPD	Rt.foot
4	Male	67	DM	IPD	Rt.foot
5	Male	41	DM	IPD	Lt.foot
6	Female	53	DM	IPD	Rt.foot
7	Male	67	DM	IPD	Lt.leg
8	Female	72	DM	IPD	Rt.foot
9	Female	39	DM	IPD	Rt.foot
10	Male	48	DM	IPD	Lt.foot
11	Male	59	DM	IPD	Lt.foot
12	Female	61	DM	IPD	Rt.foot
13	Male	44	DM	IPD	Rt.foot
14	Male	58	DM	IPD	Lt.leg
15	Male	51	DM	IPD	Rt.leg
16	Male	58	DM	IPD	Lt.foot
17	Female	46	DM	IPD	Rt.foot
18	Female	56	DM	IPD	Lt.foot
19	Male	62	DM	IPD	Rt.foot
20	Female	49	DM	IPD	Rt.foot
21	Female	41	DM	IPD	Lt.foot
22	Male	71	DM	IPD	Rt.foot
23	Female	61	DM	IPD	Rt.leg
24	Male	49	DM	IPD	Lt.foot
25	Male	51	DM	IPD	Rt.foot
26	Female	62	DM	IPD	Rt.foot
27	Female	44	DM	IPD	Rt.leg
28	Male	52	DM	IPD	Lt.foot
29	Male	61	DM	IPD	Rt.foot
30	Male	49	DM	IPD	Rt.foot
31	Female	55	DM	IPD	Lt.foot
32	Female	48	DM	OPD	Rt.foot
33	Male	39	Pressure sore	IPD	Back
34	Male	47	Pressure sore	IPD	Back
35	Male	86	Pressure sore	IPD	Back
36	Female	52	Pressure sore	IPD	Back
37	Female	56	Pressure sore	IPD	Back
38	Male	71	Pressure sore	IPD	Back
39	Male	59	Pressure sore	IPD	Back
40	Female	62	Pressure sore	IPD	Back
41	Female	47	Pressure sore	IPD	Back
42	Male	61	Infected wound	IPD	Lt.leg

Case No.	Sex	Age	Type of wound	Type of patient	Position of wound
43	Male	34	Infected wound	IPD	Lt.leg
44	Male	46	Infected wound	IPD	Rt.foot
45	Male	41	Infected wound	IPD	Lt.foot
46	Female	19	Infected wound	IPD	Rt.leg
47	Female	49	Infected wound	IPD	Lt.foot
48	Male	51	Infected wound	IPD	Rt.leg
49	Male	32	Infected wound	IPD	Rt.foot
50	Female	28	Infected wound	IPD	Rt.leg
51	Female	44	DM	IPD	Rt.foot
52	Male	39	DM	IPD	Lt.foot
53	Male	76	DM	IPD	Rt.foot
54	Female	35	DM	IPD	Lt.leg
55	Male	58	DM	IPD	Rt.foot
56	Male	39	DM	IPD	Rt.foot
57	Female	41	DM	IPD	Lt.foot
58	Male	35	DM	IPD	Rt.leg
59	Male	41	DM	IPD	Lt.foot
60	Female	42	DM	IPD	Rt.foot
61	Female	72	DM	IPD	Lt.foot
62	Male	44	DM	IPD	Rt.foot
63	Male	51	DM	IPD	Lt.foot
64	Male	44	DM	IPD	Rt.foot
65	Female	57	DM	IPD	Foot
66	Male	59	DM	IPD	Lt.foot
67	Male	49	DM	IPD	Rt.foot
68	Male	41	DM	IPD	Rt.foot
69	Female	82	DM	IPD	Lt.foot
70	Male	55	DM	OPD	Rt.foot

Case No.	Necrotic tissue size before use conventional(cm^2)	Necrotic tissue size after use conventional(cm^2)	Curing time	Conventional cost(Baht)	Related cost(Baht)	Total cost (Baht)
1	40	30	14	8400	8400	16800
2	32	30	6	3600	3600	7200
3	35	26	10	6000	6000	12000
4	8	2	7	4200	4200	8400
5	12	3	5	3000	3000	6000
6	50	23	15	9000	9000	18000
7	12	2	5	3000	3000	6000
8	23	10	5	3000	3000	6000
9	25	4	7	4200	4200	8400
10	20	0	15	9000	9000	18000
11	32	10	7	4200	4200	8400
12	37	8	10	6000	6000	12000
13	45	5	15	9000	9000	18000
14	37	23	5	3000	3000	6000
15	20	3	7	4200	4200	8400
16	34	2	14	8400	8400	16800
17	12	0	28	16800	16800	33600
18	30	4	15	9000	9000	18000
19	15	8	18	10800	10800	21600
20	15	4	20	12000	12000	24000
21	12	5	7	4200	4200	8400
22	15	5	10	6000	6000	12000
23	6	3	15	9000	9000	18000
24	12	2	5	3000	3000	6000
25	30	5	7	4200	4200	8400
26	23	0	14	8400	8400	16800
27	25	2	7	4200	4200	8400
28	28	0	5	3000	3000	6000
29	10	4	15	9000	9000	18000
30	6	0	5	3000	3000	6000
31	8	0	7	4200	4200	8400
32	12	2	15	4500	0	4500
33	35	3	10	6000	6000	12000
34	30	6	7	4200	4200	8400
35	40	2	22	13200	13200	26400
36	34	4	14	8400	8400	16800
37	33	4	6	3600	3600	7200
38	25	5	15	9000	9000	18000
39	15	2	5	3000	3000	6000

Case No.	Necrotic tissue size before use conventional therapy(cm^2)	Necrotic tissue size after use conventional therapy(cm^2)	Curing time	Conventional cost(Baht)	Related cost(Baht)	Total cost (Baht)
40	35	2	20	12000	12000	24000
41	36	6	22	13200	13200	26400
42	40	5	21	12600	12600	25200
43	35	0	15	9000	9000	18000
44	30	2	24	14400	14400	28800
45	42	0	29	17400	17400	34800
46	20	3	25	15000	15000	30000
47	35	4	23	13800	13800	27600
48	20	4	22	13200	13200	26400
49	15	4	10	6000	6000	12000
50	13	5	7	4200	4200	8400
51	37	5	22	13200	13200	26400
52	20	3	14	8400	8400	16800
53	30	32	6	3600	3600	7200
54	6	0	15	9000	9000	18000
55	35	33	5	3000	3000	6000
56	36	0	20	12000	12000	24000
57	25	3	25	5000	5000	30000
58	28	4	20	12000	12000	24000
59	10	0	15	9000	9000	18000
60	12	0	14	8400	8400	16800
61	30	34	7	4200	4200	8400
62	6	0	14	8400	8400	16800
63	24	0	28	16800	16800	33600
64	20	2	15	9000	9000	18000
65	26	1	18	10800	10800	21600
66	30	3	20	12000	12000	24000
67	16	0	10	6000	6000	12000
68	42	35	15	9000	9000	18000
69	35	37	14	8400	8400	16800
70	30	3	45	0	13500	13500

APPENDIX B

Collect data form

แบบฟอร์มการศึกษาข้อมูลผู้ป่วยแผลเรื้อรัง โรงพยาบาลบางใหญ่ จังหวัด นนทบุรี

ประวัติผู้ป่วย

ชื่อ-สกุล ..... เพศ ☐ หญิง ☐ ชาย

อายุ ..... ปี ภูมิลำเนาจังหวัด.....

ลักษณะแผล

☐ แผลเบาหวาน ตำแหน่งของแผล ..... ขนาดแผล.....cm^2.

☐ แผลกดทับ

☐ แผลติดเชื้ออื่นๆ

วันที่เข้ารับการรักษา.....

ระยะเวลาการรักษาแผล.....วิธีการรักษาแผล .....

.....

.....

.....

ค่าใช้จ่ายการทำแผล..... ค่าใช้จ่ายในการนอนรักษา.....

ค่าใช้จ่ายอื่นๆ.....

.....

.....

หมายเหตุ .....

.....

.....

.....

วันที่เก็บข้อมูล..... ผู้เก็บข้อมูล.....

APPENDIX C

Administration and Time Schedule

Research/Project Activities	Time Frame (Month)				
	1	2	3	4	5
1. Literature review	✓	✓			
2. Tool development for data collecting		✓			
3. Field data collection		✓	✓		
4. Data analysis and interpretation			✓	✓	
5. Report writing				✓	✓

APPENDIX D

Budget

1. Documentary for project summary	1,000 Baht
2. Data collection	2,000 Baht
3. Data analysis and full paper	2,000 Baht
4. Travelling expense	3,000 Baht
5. Printing cost	2,000 Baht
6. Other cost	500 Baht

Total budget 10,500 Baht

VITA

Name:	Miss Suwannee Eamkong
Address:	59/13 Ladsawai road, LadsawaiDisrict, Lamlukka, Phatumthani, Thailand.12150
Date of birth:	26 November 1977
Education:	Bachelor degree medical technology (1999) B.Sc. (Medical Technology) Rangsit University, Thailand
Professional training:	Maggot therapy, BioMonde GmbH.Hamburg Germany for 1 month.
Current Office	MAQUET (THAILAND) Co., Ltd.
Position	Product specialist
Telephone	0866689985
E-mail	jeabboys@hotmail.com