Abstract of the dissertation entitled

The use of negative pressure wound therapy for adult patient with split thickness skin grafts

Submitted by
Hui Yat Nam

For the Degree of Master of Nursing
at The University of Hong Kong
in August 2015

Split-thickness skin grafting is a common technique in the orthopedic department. The partial or total loss of the graft may need a repeated skin grafting and debridement hence increase the length of hospital stay. And it will become a burden of patients, their family members both psychosocially and economically.

Compare with conventional dressing, studies showed that negative pressure wound therapy is an effective advanced wound management therapy in managing split-thickness skin graft. It can increase graft take as a result lower the length of hospital stay and lower wound infection rate. Patients and health care providers will be benefited if it applies properly.

In local setting, patients with split-thickness skin graft receive conventional dressing rather than negative pressure wound therapy. Precision of performing each procedure from care providers may directly affect patients’ outcome. Hence, there is a need of the systematic review for an updated evidence based guideline of NPWT for patients with split thickness skin graft.

This dissertation aims to systematically review the gathered evidences of negative pressure wound therapy for adult patients with split thickness skin graft, to develop negative pressure wound therapy guideline, assesses the implementation potential and plan for a pilot and an evaluation of the guideline.

A systematic search of British Nursing Index, PubMed, CINHAL and MEDLINE identified 4 randomized controlled trials (RCTs) that assessed the
effectiveness of negative pressure wound therapy for patients with split thickness skin graft for adult patient. Using the Scottish Intercollegiate Guidelines Network (SIGN) checklist, two of them had high methodological quality, and two had acceptable quality. Three studies reported negative pressure wound therapy increase graft take. Thus, it is considered sufficient evidence that supported the implementation of the negative pressure wound therapy for patients with split thickness skin graft. An evidence-based guideline was then developed. The local setting shared similar characteristics of the eligible participants with the selected studies, are similar to the local setting, and it also had the staff supportive to the change with resources available. Moreover, there would be a cost saving of around HKD 600,000 for every one hundred patients. Hence, the proposed intervention is feasible and transferable to the local setting.

A 6-month pilot study on split skin graft patients with communication plan will be conducted before embarking on 3-month evaluation study. The primary outcome is the graft-take rate, while the secondary outcome are wound infection rate and length of hospitalization time. Finally, the primary and secondary outcome will be evaluated to identify the effectiveness of the proposed guideline.
An evidence-based guideline for using negative pressure wound therapy for patient with split thickness skin graft

by

Hui Yat Nam

B.Nurs. H.K.U.

A dissertation submitted in partial fulfillment of the requirements for the Degree of Master of Nursing at The University of Hong Kong August 2015
Declaration

I declare that this dissertation thereof represents my own work, except where due acknowledge is made, and that it had not been previously included in a thesis, dissertation or report submitted to this University or to any other institution for a degree, diploma or other qualifications.

Signed __________________________________________________________________________

Hui Yat Nam
Acknowledgements

I would like to express my sincere gratitude to my supervisor, Ms. POON Po Wah, Rebecca, for her generous guidance, enlightenment and patience in directing me to the right track throughout the dissertation process.

I would also like to thank the staff of the School of Nursing for their assistance and teaching in my master study.

Finally, I must express my immense gratitude and appreciation to my dear family, classmates, friends and colleagues for their love, support and encouragement throughout my study.
# Table of content

**Abstract of the dissertation entitled** .............................................................. i

**Declaration** .................................................................................................. ii

**Acknowledgements** .................................................................................. iii

**Table of content** ........................................................................................ iv

**Chapter 1 Introduction** ............................................................................... 1

1.1 Background ............................................................................................... 1
   1.1.1 Split-thickness skin graft .................................................................. 1
   1.1.2 Negative pressure wound therapy .................................................. 1

1.2 Affirming need .......................................................................................... 2

1.3 Research Question, Objective and Significance .................................... 3
   1.3.1 Research Question ......................................................................... 3
   1.3.2 Aim ............................................................................................... 4
   1.3.3 Objectives ..................................................................................... 4

**Chapter 2 Critical Appraisal** ................................................................. 5

2.1 Search strategies ...................................................................................... 5
   2.1.1 Searching Engines ......................................................................... 5
   2.1.2 Study selection criteria .................................................................. 5
   2.1.3 Keywords ...................................................................................... 6

2.2 Extraction of Evidence ........................................................................... 7

2.3 Critical Appraisal and Quality Assessment .......................................... 7

2.4 Summary for quality assessment ......................................................... 8

2.5 Summary and Synthesis of Evidence ................................................... 9
   2.5.1 Summary of Evidence .................................................................... 9
   2.5.2 Synthesis of Evidence .................................................................. 12

**Chapter 3 implementation** ................................................................. 14

3.1 Implementation Potential ..................................................................... 14
   3.1.1 Target setting ................................................................................. 14
   3.1.2 Target audience ............................................................................ 14

3.2 Transferability of the finding ............................................................... 14
Chapter 4 Implementation plan .................................................. 23

4.1 Communication plan ........................................................................ 23
   4.1.1 Administrators Level ................................................................. 23
   4.1.2 Top level administrators ............................................................ 24
   4.1.3 Care providers ........................................................................ 24
   4.1.4 Orthopedic surgeons ................................................................. 25
   4.1.5 Therapist ............................................................................. 25
   4.1.6 Clerical staff .......................................................................... 25
   4.1.7 End user .............................................................................. 25
4.2 Pilot Study ............................................................................................................................................. 26
  4.2.1 Target setting and target audience ................................................................................................. 26
  4.2.2 Sampling plan ................................................................................................................................. 26
  4.2.3 Workflow of pilot study ..................................................................................................................... 27
  4.2.4 Evaluation of Pilot Study .................................................................................................................. 27

4.3 Evaluation Plan .................................................................................................................................... 28
  4.3.1 Expected Outcome ............................................................................................................................ 28
  4.3.2 Patients involved ............................................................................................................................... 29
  4.3.3 Data collection .................................................................................................................................... 30
  4.3.4 Data analysis ..................................................................................................................................... 30
  4.3.5 Criteria for effectiveness .................................................................................................................. 31

Chapter 5 Conclusion ................................................................................................................................. 33

Reference: .................................................................................................................................................. 34

Appendix ................................................................................................................................................... 40
  Appendix 1 Searching result with Prisma Flow Diagram .......................................................................... 40
  Appendix 2 Table of evidence ................................................................................................................... 41
  Appendix 4 Cost-Benefit Ratio of the innovation ..................................................................................... 47
  Appendix 5 Evidence-based guideline for the use of negative pressure wound therapy for adult patients with split thickness skin graft ..................................................................................... 48
  Appendix 6 Level of Evidence Developed by the SIGN ......................................................................... 53
  Appendix 7 SIGN-Grading of recommendations ................................................................................... 54
  Appendix 8 Gantt chart Of Negative Pressure Wound Therapy In Split-Thickness Skin Graft Patients ................................................................................................................................. 55
  Appendix 9 Nursing Procedure Audit Form ............................................................................................ 56
Chapter 1 Introduction

1.1 Background

1.1.1 Split-thickness skin graft

Skin grafting is a type of surgery referring to removal of skin on one area and transplantation to another area. A split-thickness skin graft (STSG) is a kind of skin grafts, which involves the two top layers of skin, that is full layer of epidermis and part of the dermis layer (Mackay & Miraliakbari, 2006). The common sites of split-thickness skin graft are abdomen, thigh or back. The healthy split-thickness skin grafts are being removed from the common sites and sown or stapled into the required sites.

Skin graft is recommended for:

- Injury or infection with a large area of skin loss
- Burn
- Cosmetic reason after skin damage or skin loss
- Skin cancer surgery
- Complicated ulcer that do not heal such as diabetic ulcer, venous ulcer or pressure ulcer.
- Very big area wound
- Difficulty in closing a wound

1.1.2 Negative pressure wound therapy

Since 1990s, Negative Pressure Wound Therapy (NPWT) started to use in treating wound (Fleischmann, Lang & Russ, 1997). Negative pressure wound therapy can be applied on various kinds of wounds in both surgical and orthopedic department. In surgical department, negative pressure wound therapy can be used in abdominal wound (Stevens, 2009) and burn (Molnar et al., 2005) cases. In orthopedic department, it can be used in many cases such as open fracture (Stannard et al., 2009), split thickness skin grafting (Blume et al., 2010), pressure ulcer (Ford et al., 2002), diabetic foot amputation (Armstrong, Lavery, & Boulton, 2007) and lower extremity traumatic
wound (Stannard et al. 2006). There are four mechanisms of action to promote wound healing in NPWT (Orgill, & Bayer, 2011):

- Macro-deformation - drawing the wound edges together leading to contraction.
- Stabilization of the wound environment - ensuring it is protected from outside microorganisms in a warm and moist environment.
- Reduced edema - with removal of soft tissue exudates.
- Micro-deformation- leading to cellular proliferation on the wound surface.

There are many NPWT devices currently in circulation. The system consists of a few fundamental components, including foam dressing, suction tube, adhesive dressings and a negative pressure source. There are different kinds of NPWT devices such as V.A.C Therapy System (KCL), negative pressure wound therapy by Smith and Nephew and extriCARE® Negative Pressure Wound Therapy (NPWT) System. In addition, a study by Dorafshar et al., (2011) had shown that using a suction force produced by connecting to the central aspiration system of the hospital, instead of connecting to a designated vacuum pump can provide a similar effect without complication but lower the cost of therapy on various kinds of wounds in both surgical and orthopedic department.

### 1.2 Affirming need

Split-thickness skin grafting is a common technique in the care of skin loss due to infection and injury, trauma, burn, skin cancer, and cosmetic surgery. The skin graft management plan in Queen Mary Hospital orthopaedics and traumatology ward takes around 1-2 weeks. The plan use the conventional dressing that consists of vaseline gauze, cotton pads and cotton bandage or elastic adhesive bandage In this period, the formation of blisters and hematoma, the infection of the graft will cause the partial or total loss of the graft. Loss of skin graft may need to operate skin grafting again. Hence, the length of hospital stay will increase. Also, it will become a burden to the patients and their family psychosocially and economically.

Compare with the conventional dressing which consists of vaseline gauze, cotton pads and cotton bandage or elastic adhesive bandage, many studies had shown that
negative pressure wound therapy is an effective advanced wound management therapy in managing split-thickness skin grafting. It can promote a shorter healing time resulting in shortens the length of hospital stay (Petkar et al., 2011, Liao et al., 2012, Llanos et al., 2006) and lower infection rate (Bloemen et al., 2012, Liao et al., 2012). Studies had also shown that the graft take increased (Petkar et al., 2011) and graft loss decreased (Llanos et al., 2006) by using negative pressure wound therapy. Patients and health care providers will gain benefit on it if they apply it properly. Health care providers will have a lesser workload due to lesser patients stay in hospital.

I considered an orthopedic ward setting in public hospital of the Hong Kong Authority, where patients admitted for different kinds of reason who need for split-thickness skin graft. According hospital record and admission record, there were about 7% of orthopedic patients were admitted at the orthopedic ward that I was working for split thickness skin graft care.

Split-thickness skin grafting with negative pressure wound therapy is not a new intervention in Hong Kong. But there is still lacking of evidence-based guideline for split-thickness skin grafting with negative pressure wound therapy. Nurses have to make their own decision according to their experience and knowledge. Since the systematic review was done (Azzopardi et al., 2013); systematic evidence was identified afterwards. So a standardized and latest evidence-based guideline on managing the split-thickness skin grafting with negative pressure wound therapy is needed. The guideline will also include Chinese studies and exclude animal studies to fulfill Hong Kong situation.

1.3 Research Question, Objective and Significance

1.3.1 Research Question
Would negative pressure wound therapy improve the wound healing in adult patient with split thickness skin graft?

Primary outcome:
Wound healing in terms of graft-take percentage, graft-loss percentage, Survival rate of skin graft and wound epithelialization
Secondary outcome

The length of hospital stay, wound infection rate and the need for second coverage procedure (e.g. re-grafting, debridement)

1.3.2 Aim

The aim of my study is to develop an evidence-based guideline for using negative pressure wound therapy for patients with split thickness skin graft.

1.3.3 Objectives

1. To investigate and gather evidence on the effectiveness on healing process by using NPWT for patients with split thickness skin graft.

2. To develop clinical guideline on negative pressure wound therapy for patients with split thickness skin graft

3. To investigate the potential in implementation of clinical guideline on negative pressure wound therapy for adult patients with split thickness skin graft in Hong Kong.

4. To plan how to implement and evaluate of the proposed guideline

5. To concluded the effectiveness of using negative pressure wound therapy for adult patients with split thickness skin graft in Hong Kong
Chapter 2 Critical Appraisal

The affirming needs of negative pressure therapy with split-thickness skin graft were discussed in the previous chapter. In order to develop an evidence-based guideline on negative pressure wound therapy with split thickness skin graft for adult patient, relevant studies are going to be identified and critical appraisals on them thereafter.

2.1 Search strategies

2.1.1 Searching Engines

A systematic search was done from 1 September 2013 to 1 September 2014, a systematic search was done via The University of Hong Kong library electronic searching engine to identify relevant studies.

1. MEDLINE
2. CINAHL
3. British Nursing Index
4. PubMed

2.1.2 Study selection criteria

Inclusion criteria

1. The studies is randomized controlled trials

2. The targeted population is adult patient in ward setting

3. The intervention is negative pressure wound therapy compared with usual practice in managing split thickness skin graft.

4. The studies outcome included wound healing (in terms of graft-take percentage graft-loss percentage, survival rate of skin graft, wound epithelialization, wound infection rate and the need for second coverage procedure) and cost (hospitalization day, dressing change).

5. The studies are reported in English or Chinese
Exclusion criteria

1. The population group of studies are pediatric
2. The population group of studies are animals
3. The studies setting is outside hospital
4. Negative pressure wound therapy is not the only intervention
5. Full thickness and composite skin graft

2.1.3 Keywords

Keywords used for searching were:

“Split thickness skin graft” OR “Skin graft” OR “skin transplantation” OR “Dermatoplasty” OR “Skin Grafting” and “Negative pressure wound therapy” OR “Topical negative pressure” OR “Vacuum assisted wound therapy” OR “Vacuum Assisted Closure Wound Therapy” Or “negative pressure closure” Or “negative pressure”

The result is shown in Appendix 1.

After searching four electronic databases, 457 citations were retrieved. 28 citations were randomized control trial. The title, abstract and full text were reviewed according to the study selection criteria. Total of 5 papers obtained finally.

These 5 articles are randomized controlled trials. 4 papers were written in English (Moisidis et al., 2004, Bloemen et al., 2012, Petkar et al., 2011, Llanos et al., 2006) and 1 article was written in Chinese (Liao et al., 2012).
2.2 Extraction of Evidence

The data of study type, study population, sample size, interventions, measured outcomes and the results were extracted and summarized in the table of evidence (Appendix 2).

2.3 Critical Appraisal and Quality Assessment

The 5 randomized controlled trails (RCT) were appraised by using Scottish Intercollegiate Guideline Network (SIGN) (2012) tools with the methodology checklist for randomized controlled trails (Appendix 3). The purpose of using SIGN is to improve the quality and maintain the consistency of health care for patients by reducing the difference in practice and outcome. SIGN developed and disseminated the national clinical guidelines with effective recommendations on clinical practice based on existing evidence. The level of evidence in SIGN was graded by the study design and has high reputation among guideline developers and used globally.
2.4 Summary of quality assessment

Randomized controlled trials (5 studies)

There are 5 RCT studies at the evidence level 1+ to 1-.

One of the studies (Moisidis et al., 2004) is excluded due to poor quality in randomization.

The reason is as the followings:

After the preparation of the skin graft wound, the wound were divided in half size, then randomly applied negative pressure wound therapy dressing or standard pressure bolster dressing. But the study didn’t mention the method of assigning the dressing. In addition, both negative pressure wound therapy and standard pressure bolster dressing were applied on the same wound. There is an uncertainty on the dressing and wound environment.

Besides, the study stated that the wound is divided by using multilayered comfeel (coloplast A/S, Humlebaek, Denmark) as a bridge to prevent the transmission of negative pressure. However, the ability of multilayered comfeel in preventing negative pressure transmission is uncertain. And the side effect acting on the wound under the bridge is not mentioned. Due to the above uncertainties in the study, so this study is being excluded.

Finally, four papers are reviewed.

Two of the selected studies (Petkar et al., 2011, Liao et al., 2012) did not mention the concealment method. Blinding for patients is difficult with negative pressure wound therapy. Patients and physicians can easily notice the difference between the intervention group and the control group because the difference in the appearance of dressing materials and the suction forced applied on the wound.

In all the selected studies, the intervention groups and the control groups are similar at the start of the trial. The sites of the wounds in the intervention group were different such as limbs and trunk. And the natures of injury were mainly due to burn and orthopedic problem such as trauma, amputation and open fracture. All studies had shown that the socio-demographic variable (Sex, age, other comorbidities, etiology) between the groups were no statistically significant differences (p-value > 0.05). And the method of surgical cleaning and graft taking were using common technique. So the only difference between groups is the intervention under investigation.

Two studies (Petkar et al., 2011, Liao et al., 2012) provide the percentages of
graft take but did not mention the way of measurement.
One of the selected studies (Bloemen et al., 2012) reported the dropout rate of the control group in the follow up is 25%. All studies subjects are analyzed in the groups to which they were randomly allocated. One of the studies (Bloemen et al., 2012) is carried out at more than one site.
The qualities of these 4 papers accordingly are 1++ (Bloemen et al., 2012), 1++ (Llanos et al., 2006), 1+ (Petkar et al., 2011) and 1+ (Liao et al., 2012)

2.5 Summary and Synthesis of Evidence
In this section, summary and synthesis of evidence will be presented as followed.

2.5.1 Summary of Evidence

Study Population

Petkar et al., 2011 is carried out in India, Llanos et al., 2006 is carried out in Chile, Bloemen et al., 2012 is carried out in The Netherland, Liao et al., 2012 is carried out in China.

Number of Participants

Sample sizes of reviewed studies were different. It ranges from 40 patients to 60. Petkar et al., 2011 reported the sample size 40, Bloemen et al 2012 reported 42 and 2 studies (Llanos et al., 2006, Liao et al., 2012) reported 60.

In Bloemen et al., 2012, 25% of patient loss to follow-up in control group. The reason is not mentioned. There is no patient loss in all other studies

Characteristics of participants

In all the selected studies, the participants involved are patients who are required to operate split-thickness skin grafting. The reasons that required surgery are varied. 60 patients are due to amputation wounds on limbs, 17 patients are due to orthopedic problem such as exposed fracture, degloving and trauma. 122 patients are due to burn, and 3 patients are due to other problems. 76 patients are male, 26 patients are female and 100 patients are not mentioned. Other demographic characteristics such as age, location of injury, and grafted area are comparable between intervention and control
group. All the studies had shown that the socio-demographic variable and baseline characteristics between the groups are no statistically significant differences in gender, age, other comorbidities and etiology (p-value < 0.05).

**Characteristics of wounds**

The wounds in the studies were at different sites such as limbs and trunk. The natures of injury were mainly due to burn and different orthopedic problems such as trauma, amputation and open fracture. And the wound surface area varied from 3cm²-1200cm².

**Intervention**

In two of the selected studies (Liao et al., 2012, Bloemen et al., 2012), the intervention used Vacuum-assisted closure (V.A.C) system to deliver suction force. Another two studies (Petkar et al., 2011, Llanos et al., 2006) used modified technique. They used the central aspiration system of the hospital provide suction force instead of connecting to a designated vacuum pump. In both systems, negative pressure wound therapy used a suction pump to create a controlled and localized negative pressure, which is the V.A.C machine or the central aspiration system.

After taking, meshing and fixing the graft, a single layer of dressing materials will put on the skin graft. In Petkar et al., 2011, vaseline gauze was used, while paraffin gauze was used in Llanos et al., 2006 and non-adhesive dressing was used in Bloemen et al., 2012 to put on top of the skin graft. In three of the studies (Petkar et al., 2011, Bloemen et al., 2012, Llanos et al., 2006), the polyurethane foam was cut into the shape that fits to the wound and placed over the non-adhesive dressing. A fenestrated silicone drainage tube was put inside between the foam layers. Then the tube is connected to either the V.A.C machine or the central aspiration system of hospital. The foam dressing, the suction tube and the peri-wound area were covered with a transparent adhesive dressing.

Negative pressure was set differently at -80mmhg in Petkar et al., 2011 and Llanos et al., 2006, -125mmhg in Bloemen et al., 2012 and 375-450mmHg in Liao et al., 2012. All the studies applied suction force continuously. Additional wound care
and dressing change was not used until the 4-10 postoperative day after the assessor assessed all the wounds.

Comparison

Among all the selected studies, three of them made comparison of NPWT with conventional dressing or standard treatment:

In Liao et al., 2012, it compared NPWT with direct anti-taken skin graft, and conventional dressing change, which is vaseline gauze, cotton pads, cotton bandage or elastic adhesive bandage. In Petkar et al., 2011, it compared NPWT with conventional dressing that included vaseline gauze, cotton pads, cotton bandage or elastic adhesive bandage. In Bloemen et al., 2012, it compared NPWT with Standard treatment that involved gauzes, supplement with an antibacterial substance such as povidone-iodine or fusidic acid.

One of the selected studies (Llanos et al., 2006) compared NPWT with Silicone fenestrated tube, translucent adhesive dressing, and flexible gauze. Intervention group and control group are using the same dressing materials while intervention group is connected to central aspiration system and control group does not.

Follow Up

Length of follow-up in three of the studies (Petkar et al., 2011, Petkar et al., 2011 and Liao et al., 2012) is within one week. One of the studies (Bloemen et al., 2012) has a longer follow up time with 3 to 12 months in each group.

Outcome measure

Rate of graft take or graft loss were used in all studies as outcome measurement. Two of the selected studies (Liao et al., 2012, Petkar et al., 2011) reported that there is a significantly improvement in the graft take (p=0.030, p<0.001). One study (Llanos et al., 2006) showed less graft loss (p=0.001). One of the selected studies (Bloemen et al., 2012) showed that there is no significantly differences in the rate of graft take (p=0.552).
Two of the studies (Liao et al., 2012, Bloemen et al., 2012) calculated the rate of infection and reported that wound infection rate in the intervention group were significantly lower than those in control group (p=0.044, p=0.042). Two studies (Liao et al., 2012; Llanos et al., 2006) reported that NWPT shorten the length of hospital stay after grafting.

Two of the studies reported NWPT reduced the need of second operation compare with control group ((Liao et al., 2012 p=0.038; Llanos et al., 2006 p=0.045)

2.5.2 Synthesis of Evidence

Prevention of graft loss and ensure the graft take

One of the four selected studies (Bloemen et al., 2012) reported that there is no significantly differences in the rate of graft take between intervention group and control group (p=0.552), but it did not report that there is negative effect in the graft take.

Another three studies (Liao et al., 2012, Bloemen et al., 2012, Llanos et al., 2006), the effectiveness of negative pressure wound therapy is proven statistically effective in increasing the graft take percentage and lowering the graft loss percentage (p=0.030, p<0.001, p=0.001).

Negative pressure wound therapy can achieve better wound drainage, promote good adhesion of wound and leading to cellular proliferation on the wound surface. These advantages directly help the healing of the split-thickness skin graft. The formation of blisters, hematoma of the graft and the shearing force to the graft can also be prevented when using negative pressure wound therapy. It is suggested that with the use of negative pressure wound therapy, the skin graft survival rate will improved. Also, it will decrease the need for secondary procedure and as a result in shortening the length of hospital stay.

Reduce infection rate

Two of the selected studies (Liao et al., 2012, Bloemen et al., 2012) reported that the wound infection rate in intervention groups is significantly better than those in
control groups (p=0.044, p=0.042). One study proven that NPWT improved the skin survival rate. (Liao et al., 2012 p=0.030)

**Shortening the length of hospital stay**

Two of the selected studies (Liao et al., 2012, Llano et al., 2006) reported that the days of hospital stay decreased after using negative pressure wound therapy (-6 days p=0.003, -4 days p=0.001). Therefore, it can reduce the inpatient cost and reduce the risk of patients getting nosocomial infection.

**Perform the intervention**

Physicians in the studies mainly perform the intervention. The nursing role is not mentioned.

In Hong Kong, the negative pressure wound therapy is a clinical decision of nurses. There is a difference in the western countries and in Hong Kong. In Hong Kong, the NPWT is usually done and monitor by nurses. Nurses are qualified from special training and capable to perform NPWT.

In the reviewed studies, the technique of applying NPWT is the same as the usual practice of Hong Kong nurses with NPWT training.

In the proposed program, nurse with NPWT training will implemented and applies the NPWT in operation room. With the coordination with the operation department, nurses can enter the operation room and apply the NPWT. The effect of NPWT can be transferrable from the studies to the proposed setting. The EBP guideline is needed to perform an evidence-based and high quality care for using negative pressure wound therapy for patients with split-thickness skin graft.
Chapter 3 implementation

In the previous chapters, negative pressure wound therapy is an evidence-based intervention for treating patients with split thickness skin graft. In this chapter, I will discuss the potential of implementation and develop the evidence-based protocol.

3.1 Implementation Potential

3.1.1 Target setting

This evidence-based protocol will be implemented in orthopedic and traumatology ward in acute hospital under the Hospital Authority. This ward mainly admits patients with orthopedic problems, such as acute trauma wounds, amputation, chronic diabetic ulcers, fractures and spinal injuries. Targeted patients are adults require split-thickness skin grafting with amputation wounds for limbs or other orthopedic problems. The ward admits patients with emergency conditions and the bed stat is 28.

3.1.2 Target audience

The target audience involves the wound clinic nurses and 16 ward nurses. The wound clinic nurses consists 1 nurse specialist, 1 advanced practiced nurse and 1 nursing officer who are qualified from the orthopaedics and traumatology specialty training. They will be responsible for implementation of the protocol.

And the targeted patients are adult patients who required split-thickness skin grafting. The reason of surgery mainly due to orthopedic problem such as open fracture wounds, amputation wounds, burns, infection and malignancy. The wound surface area was from 10cm² to 125cm².

3.2 Transferability of the finding

3.2.1 Comparison of setting and audience

Reviewed studies and the proposed clinical setting have similar target population and setting. 3 out of 4 selected studies are western studies, the remaining one is a Chinese study. The demographic data of such as sex, age, reason of surgery, and etiology of target setting matches greatly with all selected studies.

In the reviewed studies, surgeons did the NPWT. But in the proposed program nurse with NPWT training will implemented and applies the NPWT in operation
In Hong Kong, the NPWT is usually done and monitor by nurses. Nurses are qualified from special training and capable to perform NPWT. With the coordination with the operation department, nurses can transfer the same effect of NPWT from the studies to the proposed setting.

### 3.2.2 Philosophy of care

The philosophy of care in the reviewed studies and the proposed program are the same. Both of them share the common objectives. They are to provide high quality of care to patients, increase comfort and shorten the days of hospital stay and to promote holistic care to patients with available resource. The health care providers are trained to use advanced technologies and skills. The continuous improvement can be promoted if the evidence-based protocol is developed.

### 3.2.3 Sufficiency of client benefit from the innovation

In Hong Kong Hospital Authority Queen Mary Hospital, there were 1388 new patients and 2021 of attendances in 2012/2013 in orthopaedics and traumatology department (Hospital Authority Annual Report 2012-2013). As a leading hospital in Hong Kong HA west cluster, there are many complicated conditions such as trauma wound, chronic diabetic wound are admitted into in Queen Mary Hospital. According the admission record of orthopedic department in 2012/2013, there are around 7% may need split thickness skin grafting. The reviewed studies proved that the NPWT could reduce the days of hospital stay and increase successful rate graft taking. A hundred of patients in the proposed setting can benefit from this innovation annually.

### 3.2.4 Time Schedule for implementation and Evaluation

According the reviewed studies, in the preparation phase, surgeon did the skin grafting. In the previous session, studies reported that the surgeon performed the intervention. But in Queen Mary Hospital, the NPWT is usually done and monitor by nurses. Nurses are qualified from special training and capable to perform NPWT. Therefore nurse will able and qualified to apply the NPWT on the skin graft wound.

In the intervention phase, the most common duration was a 4-9 days treatment with NPWT. The proposed intervention will take 7 days, which is the usual practice in Queen Mary Hospital. In Queen Mary Hospital, the skin grafted wound will keep
intact with paraffin gauze, cover with gauze and bandage for 7 days.

In the evaluation phase, after completed a course of 7 days NPWT, the wound condition will be assessed and evaluated. The graft-take percentage and infection status will be evaluated and documented using Autocad software and record in the progress note. Afterward, the wound dressing will be cleaned by hibitane solution, paraffin gauze as primary dressing, covered with gauze and bandage, which is the usual practice in our department.

In the reviewed studies, they do not mention about the intervention after completed 7 days NPWT. The implementation plan after day 7 will be accorded the wound condition. If the graft is completely covered a wound bed and is well adhered and no sign of infection, no further dressing is needed. If the graft has only been partially successful in covering a wound area, it will require dressings according amount of exudate and culture results.

3.3 Feasibility

3.3.1 Freedom on implementation

Negative pressure wound therapy is a common technique in orthopaedics and traumatology department in QMH. Nurses in wound management team are well trained in NPWT. Physicians permit and encourage nurses to apply this technique right after surgery in the operation theatre.

The application of NPWT will be discussed with physicians before the operation to ensure no systematic infection and other complication. Trained nurse at orthopaedics and traumatology ward will be on-call to the operation theatre when the skin graft surgery nearly finished. The orthopaedics and traumatology nurse will enter the operation theatre and do the NPWT. This is not the usual practice. The nurses’ permission to access operation theatre will discuss with operational department.

3.3.2 Interference on Staff function

The proposed program will be started in late 2015. Originally, there is no NPWT for the split thickness skin graft patients. The implementation of the proposed intervention is likely to increase workload of the wound management team staff but reduce workload of the frontline staff in ward. It does not interfere with the current
functions of ward staff.

For wound management team staff, they have to enter operation theatre to apply NPWT during the skin graft surgery.

For the current functions of the frontline staff in ward, they have to monitor the complications of wound after surgery such as oozing, shearing of dressing. The workload of frontline staff is reduced. It is because NPWT can reduce wound exudate and the cases of graft shear as proven in two of the selected studies (Saaiq M et al., 2010 and Weinfeld et al., 2005). Thus, the frequency of changing dressing will then be decreased. Workload due to need for a 2nd coverage procedure will be significantly reduced by 23.3% with the decreased risk of infection and increased graft take (Llanos et al., 2006).

3.3.3 Support from Administration and institution

In order to propose protocol into the department, support from the orthopaedics and traumatology departmental heads and the hospital is needed for the proposed protocol put into practice. They can provide necessary supplies to fuel the protocol. Chief of Service (COS) and Department Operation Manager (DOM) in orthopaedics and traumatology department both encourage evidence-based practice into clinical setting. Queen Mary Hospital is linked hospital with The University of Hong Kong. Utilization of research finding and evidence-based practice is conducive and being encouraged in QMH. An evidence-based protocol in wound debridement by nurses has currently been implemented. In orthopaedics and traumatology department, orthopaedics and traumatology nurses and physicians have also conducted several joint replacement studies. Those protocol and studies are led by nurses and supported by administration.

3.3.4 Consensus among staff and administration

Nursing staff and medical staff want to develop new evidence-based practice into the clinical setting. They understand the importance of developing an evidence based protocol of NPWT. They have consensus that evidence-based practice can promote
beneficial effect in wound management. They also have consensus to expand to wound management service in wound management team in orthopaedics and traumatology, which provide better quality of care to patients.

3.3.5 Risk of Friction

The proposed intervention requires nurses enter the operation theatre to apply the NPWT. So the communication between physicians and nurses has to be clear. A specific Digital Enhanced Cordless Telecommunication (DECT) phone should be provided to the case in-charge nurses in order to facilitate the service. The schedules of the nurse cannot be too tight so as to prevent delaying the application of NPWT after skin grafting. The permission to access of operation theatre will be discussed with operational department to reduce the influence.

3.3.6 Skills of adopting the innovation

NPWT is a common technique in orthopaedics and traumatology department in QMH. Every nurse has to be trained to do NPWT in the orientation period. Wound management team members are experienced and knowledgeable to handle NPWT. With briefing on the implementation and updated guideline of the proposed intervention, nurses will be capable to apply NPWT. Braakenburg et al., 2009 had shown that it is sufficient to understand NPWT technique in two demonstrations. Mody et al., 2008 had shown that the time of applying NPWT was 17 minutes in average.

3.3.7 Equipment and Facilities

The NPWT is a common intervention in orthopaedics and traumatology department. So the existing equipment is adequate to facilitate the proposed intervention.

3.3.8 Staff Training

All nurses who work in orthopaedics and traumatology department after orientation program are trained and capable in applying the NPWT. For wound management team members, a training session about the choice of materials, evidence-based protocol in NPWT with skin graft is needed before the
implementation of the intervention. For ward staff, a briefing session on pressure setting, wound condition management will be held. In order to ensure the quality of the intervention, evaluation session will be held every 6 months.

3.3.9 Measuring tool for evaluation

Case review, digital photographs without flash are the measuring tools for evaluate the cases of infection and graft taking. Autocad software are used to measuring the loss of graft loss. This software can easily buy in computer shop or online purchase.

3.4 Cost-benefit Ratio of the Innovation

3.4.1 Potential Risks

From the reviewed studies, complication that occurs with NPWT is bleeding but it is rarely happened and not statistically significant compare to usual practice (Bloemen et al., 2012 p=0.303). NPWT allow minor bleeding when changing dressing. If there is any significant bleeding, NPWT should be stopped and reported.

3.4.2 Potential Benefits

At the client’s level, the proposed intervention can increase graft-take and reduce post-operation wound infection. Furthermore, it can reduce the length of hospital stay. From the reviewed studies, the length of hospital stay will decrease 4 to 6 days (Liao et al., 2012 p=0.003, Llanos et al., 2006 p= 0.001). Hence the government will gain benefit by reduce the day of subsidizes to in-patients.

At the staff’s level, nurses can make clinical decisions according to proposed evidence-based guideline. The wound infection rate and the length of hospital stay can be shorten, thus the workload of staff will decrease.

At the organization’s level, it will reduce the healthcare cost spending on inpatient care due to reduce the length of hospital stay and can have better utilization of resources, and create an image on showing respect and encourage to implement evidence-based practice to provide the most updated care.

3.4.3 Risks of Maintaining Current Practice
The current practice of the skin graft wound treatment is to assess the wound after the conventional dressing applied for 7 days. If the proposed program is not implemented, the risk of infection and percentage of graft take maybe affected. Therefore, the wound will require an additional skin graft or debridement. The risk of complications and the length of hospital stay will increase.

In Hong Kong, government subsidizes the in-patient cost of HKD 4,580 per day per patient (Hospital Authority website, 2015). If there is any infection or large graft lost, addition cost for operation is needed. Additional days of hospital stay may be needed. For an extra skin graft operation, the wound has to keep intact for another 7 days. A total cost for 7 days subsidizes will be HKD 32,060. (Appendix 4)

From the study of Llanos et al., 2006, it had shown that the need for second coverage procedure of skin graft wound with negative pressure wound therapy is 16.7% compared with usual practice 40%. As a result, there are 23.3% more patients will have another operation. Therefore, for every one hundred cases, there will be addition 23 cases are needed for an extra skin grafting due to need for second coverage procedure. In conclusion, for every one hundred cases, the total cost of managing split thickness skin graft with usual practice will be HKD1, 288,980 compare with managing split thickness skin graft with NPWT will be HKD 694,852 (Appendix 4). The department will save HKD 594,128 for every one hundred cases.

3.4.4 Material cost of implementing the Innovation

If the proposed program is implemented, additional NPWT materials have to be bought as a set up cost. Central aspiration system and modification dressings used in Llano et al., 2006 and Petkar et al., 2011 had shown statistically positive results. Therefore, there is no need to buy additional designed dressing set and pump (e.g VAC) to apply NPWT.

From the study of Dorafshar et al., 2011, it compares the cost of implementing hospital-devised and built system with the commercial system. The study was conducted at the University of Chicago Medical Center and hence the costing was in term of US$. In Hong Kong currently, the cost of implementing hospital-devised and built system is HKD 200, which is four times lower cost than a commercial system. A
commercial system required HKD 880 (Appendix 4). Therefore, the hospital-devised and built system is recommended.

The Training cost is only HKD 3,520 (Appendix 4) for one ward staff including wound management team members. The cost includes the cost of information session, training and practicing session. For whole orthopedic departments four wards staffs, it will need HKD 14,080 for the training.

<table>
<thead>
<tr>
<th>Training cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 hr information session (21 staff)</td>
</tr>
<tr>
<td>HKD 25,600/30/8*21 =HKD 2,240</td>
</tr>
<tr>
<td>15 mins training (21 staff)</td>
</tr>
<tr>
<td>HKD 25,600/30/8/4*21 =HKD 560</td>
</tr>
<tr>
<td>15 mins starting (21 staff)</td>
</tr>
<tr>
<td>HKD 25,600/30/8/4*21 =HKD 560</td>
</tr>
<tr>
<td>Teaching staff (Investigator)</td>
</tr>
<tr>
<td>HKD 25,600/30/8*1.5= HKD 160</td>
</tr>
<tr>
<td>Stationary, video</td>
</tr>
<tr>
<td>Free</td>
</tr>
<tr>
<td>Total cost on training</td>
</tr>
<tr>
<td>HKD 3,520</td>
</tr>
</tbody>
</table>

3.4.5 Material Cost of not implementing the innovation

For the cost of not implementing the intervention, the basic dressing set with bandage, paraffin gauze, bandage cost HKD30. (Appendix 4)

3.4.6 Potential Non-material Costs of Implementing the innovation

If the proposed protocol has been implemented, it may induce stress on involved staff for adapting the changes. Staff morale may alter, as they have to pay extra effort in applying NPWT according to the newly developed evidence based guideline.

3.4.7 Potential Non-material Benefits of implementing the innovation

If the proposed intervention has been implemented, it may get reputation from clients due to high quality of care. Also, nurse and doctor cooperation will increase. If the proposed intervention succeeds, specialized nurse can try to do other types of dressing in the future right after surgeon finished their operation in the operation
theatre. This may become a new direction of wound management team. Therefore it may increase our department nurse spirit and job satisfaction.

3.5 Evidence-based practice Guideline

An evidence-based guideline was developed for adult patients with split thickness skin graft to promote graft taking and reduce wound infection by NPWT and is presented in Appendix 5. The evidence levels of the selected studies were based on Scottish Intercollegiate Guideline Network (SIGN) as shown in Appendix 6. The recommendations were extracted from the five selected studies, two (Bloemen et al., 2012; Llanos et al., 2006) are graded as 1++, and the other two (Petkar et al., 2011, Liao et al., 2012) are graded as 1+. For the grading of the proposed recommendations, they were determined by the evidence level of each identified studies. These recommendations were then graded according to Grades of Recommendation (SIGN, 2012a) as shown in Appendix 7.
Chapter 4 Implementation plan

In this chapter, it will show the plan of implementation and pilot study. By a successful implementation plan, staff can change to new behavior on the management of skin graft easily. Also, a good pilot study can facilitate a smooth transitional development. The time flame of the whole session will be completed in 24 months (Appendix 6)

4.1 Communication plan

Stakeholder is the person who is affected by the proposed changes or anticipated results of the proposed innovation. The consideration and the support of the stakeholder is necessary to the initiation, sustain development and following reinforcement of the proposed guideline. A study of the stakeholders is essential to examine the feasibility and grade of impact associated to the application of the change.

The stakeholders of this guideline are:

1. Top level administrators: Chief of Service (COS), Departmental Operation Manager (DOM) and Nurse Consultant (NC)
2. Administrators: Ward Manager, Nurse Officer and Nurse Specialist
3. Care providers: Wound management team nurses and ward staff
4. Orthopedic medical officer
5. Target patients and their relatives

4.1.1 Administrators Level

Nurse specialist and ward manager will be the first group to be presented. Discussion about the development of guideline will be done with nurse specialist first. It is because he is the expert in wound management. If he agrees the proposal, a formal presentation will be done with nurse specialist and the ward manager. Nurse specialist and the ward manager are important person to start the proposal. They allocate and organize work for ward nurses and the wound management team. Also they are experienced in administration. They can provide valuable commands to
improve the proposed guideline.

Also, with a clear presentation to ward managers and nurse specialist, they can clarify any overlapping studies and protocol in department. Otherwise, it may increase disturbance and misunderstanding to the staff.

With their support, they can provide a positive manner to staff and beliefs about the suggested innovation.

4.1.2 Top level administrators

Anything cannot start without the agreement of top management level. Departmental Operation Manager can provide necessary supplies to fuel the protocol. Management Meeting will be holding on every Thursday. Presentation can be done in the meeting. The presentation will focus on the number involvement of patients, manpower control, budget plan, cost-benefit ratio and pilot study plan of the guideline.

4.1.3 Care providers

Before the initiation of the guideline, the awareness of the proposed intervention can be introduced to care providers, such as ward nurses, in monthly department meeting. There will be some obstacles, such as malpractice due to misunderstanding to implement the guideline. Question, fear and misconception can be clarified through sharing and discussion. Also, a session of expressing opinion is a good approach to express concern and clarify misunderstanding.

Formal presentation and trainings will be provided afterward. Firstly, the presentation will focus on information providing, clarifying question and misunderstanding. The potential benefits will be presented in the next section of presentation. Some clinical cases example will be shared. Finally the presentation will compare the difference between the usual practice and the new innovation. Question and answering section will be held at the end of the presentation.

Training will be held for the wound nurses and ward staff separately. It is because ward staff is focusing on the dressing monitoring process rather than the application of the dressing. For the wound nurse, the application of the dressing in the operation
theatre, the wound assessment and rundown of the proposed intervention will be explained.

In the presentation and training, the pilot study plan and evaluation plan will also be presented in details. All involved staff will gain general knowledge on the method of applying NPWT on skin graft wound and the process of monitoring the NPWT in ward according to an up-dated protocol. A pocket-sized guideline will be provided to staff for reference. A comprehensive evidence-based guideline with all listed details will be written in a resource manual and distributed to wards and keep updated.

4.1.4 Orthopedic surgeons

A meeting will be held with all surgeons in orthopaedics and traumatology department. After the meeting, recruitment criteria and their role will be established. Referring criteria to the proposed intervention will be clarified to minimize misunderstanding between staff.

Surgeons are responsible for the decision making of skin graft and the procedure of skin grafting. The timing of calling wound nurses from wards to apply NPWT in the operation theatre is critical and will be compromised in this meeting.

4.1.5 Therapist

Physiotherapists, occupational therapists will receive the education of the basic knowledge on applying NPWT in a brief presentation in ward after weekly grand round. The purpose of introducing this guideline to therapists is to let them understand how to handle the device during mobilization exercise and weight bearing exercise.

4.1.6 Clerical staff

Clerical staff will be educated about the workflow and documents handling such as wound assessment and audit forms through a briefing section.

4.1.7 End user

This evidence-based guideline of NPWT with skin graft patients is designed for a course of 7 days. Nurses will introduce the purpose and the information of NPWT before the skin grafting procedure. Information sheets and the flow chart of the
treatment will be printed and distributed to patients or their relatives.

4.2 Pilot Study

The pilot study can determine the feasibility of the proposed change in order to avoid unexpected difficulties (Polit & Beck, 2008). Through the evaluation of the pilot study, it can determine whether revision is needed before implementing the change in other clinically appropriate units.

Objectives

The objectives of the pilot study are:

1. Assessing the feasibility of recruitment process;
2. Assessing the flow of the proposed guideline;
3. Assessing the compliance of the use of assessment form;
4. Assessing the feasibility of the audit form;
5. Assessing the potential problem and solution

4.2.1 Target setting and target audience

The target setting of the pilot study will be same as the proposed guideline in the previous section. The target audience will involve whole team of wound nurses for the dressing application. Two ward nurses will be involved for the dressing monitoring. The clerk from wound nurse team will be involved for data collection. The case medical officers will contact wound nurses if there have any cases need skin grafting

4.2.2 Sampling plan

Convenience sampling method will be used to recruit the eligible participants. Inclusion and exclusion criteria will be the same as the proposed guideline in the previous section. From ward admission record, around 60 patients required skin grafting annually. Around four to five cases will be recruited monthly. Therefore, fifteen cases will be recruited in the 3-months pilot study to test the workflow feasibility.
Wound nurses should screen patients with the fulfillment of the criteria. Nurses will provide patients with the information about data collection plan, potential risks and benefits of the proposed intervention. Patients will sign consent for the participation. The right of withdraws and confidentiality will be ensured and informed to patients. (Polit & Beck, 2008)

4.2.3 Workflow of pilot study

The pilot study will take 3 months to complete. The feasibility of the flow can be assessed through this designed workflow. The audited form (Appendix 9) is provided for the audit.

![Workflow Diagram]

4.2.4 Evaluation of Pilot Study

The evaluation plan will start at the beginning of the recruitment. The result of the evaluation aims to improve the feasibility and acceptability of the proposed guideline.

Wound nurse team will evaluate the number of recruitment and compliance by using audit form (Appendix 7). Then the evaluation meeting will be held. Ward managers, nurse specialist, team of wound nurses and two pilot wards staff will be involved. The meeting aims to collect comments, questions and report problems
according to the proposed guideline.

4.3 Evaluation Plan

4.3.1 Expected Outcome

The expected outcome divided into three parts. They are patients, care providers and system level. Patient outcome is the main focus of the evaluation. Measurement of care provider and system outcomes is to prevent variation that may affect the expected result to patients.

**Patient outcome**

The primary outcome is measured at the patient level, which is the percentage of graft taken after post-operation day 7 with NPWT. This will be assessed by photo taking and calculated by computer software and determined by ward staff or wound nurses after dressing removed and will be final confirmed by the Nurse specialist with the clinical photos.

The secondary outcomes are the number of wound infection by wound swab and culture, number of the need of second operative procedure.

After skin grafting, blood vessels in the skin graft will occur inosuclation between 24-72 hours. Blood vessels in the wound bed will grow and connect with the blood vessels in skin graft. The fibrin network will act as a supportive frame. Blood flow into the graft on day 3-4 through anastomoses and the process will be slow down on day 5-6 (Converse et al., 1975). The investigator, such as wound management team nurses will evaluate the condition of the graft on day 7 after the blood vessel network of the graft is secured. Digital photographs with same camera without flash will be taken and used to evaluate the cases of graft taking. Auto-cad software is used to measure the percentage of graft take.

For secondary outcome, if the wound swab and culture shown that the graft is infected, the skin graft may not survive (Beldon 2003). Wound swab will be taken for test after the removal of dressing. The number of wound infection will be calculated.
Reviewed studies had shown that NPWT could prevent the need of second operative procedure and shorten the length of hospital stay by four to six days. Therefore, the number of patients requires undergoing second operative procedure in the study will be measured.

**Healthcare provider outcome**

According to Rosswurm & Larrabee, (1999), precision of performing each procedure from care providers may directly affect patients’ outcomes. So an audit form (Appendix 9) will be used to assess the compliance of care provider.

**System outcome**

The length of stay in hospital and the cost-benefit ratio will be considered as the system outcomes.

Cost-benefit ratio analysis will compare resource costs of the intervention with the health outcomes. The cost in dollar values will be compared. The length of stay in hospital and dressing material cost will be the quantifiable outcomes for the system.

**4.3.2 Patients involved**

**Nature of patients involved**

The characteristics of patients including gender, age, nature of injury, location of injury, grafted area, and medical history will be taken in the assessment stage. Mean, standard deviation and the percentage of these data will be calculated.

**Number of patients involved**

The number of patients needed in this study is according to the primary outcome. The study will be an after-only quasi-experimental study design with nonequivalent control group. The control group will be randomly selected by the patient file, which used the convention treatment for the skin graft wound. A two-tail t-test will be used for testing the graft taken percentage in day 7 after removal of dressing. No change in the percentage of graft taken will be the null hypothesis. The sample size was determined by Java Applets For Power and Sample Size. The power will take as 80%, the significance level will be 5%. The null value will be set at 0. The expected value
is 0.1. The sample size will be 23. Taking the highest drop out rate is 5% (Petkar et al., 2011; Bloemen et al., 2012; Llanos et al., 2006; Liao et al., 2012). Therefore, the number of patients is needed to be 25. From ward admission record, around of 60 patients required skin grafting annually. Around four to five cases will be recruited monthly. Therefore, five to six months is needed to recruit 25 patients.

4.3.3 Data collection

Demographic data of control group of the study will be collected according to the admission form in patients’ files. And the demographic data of the intervention group will be collected at the initial assessment through the nursing assessment form. Wound condition will be charted at the wound assessment form. Clinical photos will be assessed and documented in the patient’s record after the dressing removed.

The data of graft taken percentage will be calculated on day 7 by the investigator and the wound culture swab will be taken after taking clinical photo. The wound infection data will be taken on day 14 after the culture result available. The need of secondary operative procedure data will be taken on day 21.

Investigator will audit the compliance during the dressing application on day 0. Ward monitoring audit will be done randomly during day 0 to day 7.

The reason for withdrawal cases will be investigated and reviewed.

4.3.4 Data analysis

Statistical analysis will be done after data collection.

Analyzing patient outcome

The percentage of graft take in the study period will be compared with the control group. A two-tail t-test will be used to calculate the percentage changed.

The total number of second operative procedure and wound infection will be compared with the control group.

Mean score of patient acceptance cannot be compared because it has never been done according to the usual practice in department. The score of acceptance can be collected and evaluated to understanding more about patients’ feeling to the proposed
intervention.

**Analyzing care provider outcome**

Care provider outcome analysis will be calculated with the number of completed item as nominator and the total number of item in the audit form as the denominator.

**Analyzing system outcome**

Patient total length of stay in hospital will be calculates. Mean value of total length of stay in the intervention group and the control group will be compared using two-tailed t test.

The material costs will be evaluated. If there is any extra cost, it will also be evaluated and calculated.

### 4.3.5 Criteria for effectiveness

**Criteria for patient outcome**

According three of the selected studies (Petkar et al., 2011, Liao et al., 2012, Llanos et al., 2006) with high quality of methodology, they have found the graft take increase from 9.2% to 26.7% and is being considered as an effective treatment. Therefore, the proposed guideline will take more than 10% increases of graft take for the patient in the intervention group more than the control group will be considered as effective.

The guideline will also be considered as effective when the wound infection rate is decreased by 17% or higher. It is because 16.7% in Liao et al., 2012 and 43% in Bloemen et al., 2012 of decreased percentage of wound infection while two studies had high level of evidence.

The need for second operative procedure rate is lower than in the control group.

The mean of acceptance score should rated higher than 2 out of 5. It will be considered patients accept and understand the benefit of the proposed guideline.

**Criteria for care provider outcome**
The effectiveness of the proposed guideline will be affected by non-compliance and misunderstanding of the intervention. A minimum of 80% compliance is required to consider as effective.

**Criteria for system outcome**

The guideline will be considered effective if the length of stay in hospital is reduced. The dressing material cost will increase but the risk of maintaining current practice cost will decrease as previous session mentioned.
Chapter 5 Conclusion

In this dissertation, split-thickness skin grafting with negative pressure wound therapy proved as an effective measure to increase the percentage of graft take and reduce the infection rate. Studies selected in the dissertation provide high level of evidence. Evidence are concluded and combined to develop an evidence-based guideline for using negative pressure wound therapy in split-thickness skin grafting.

By using this guideline in the hospital, it aims to promote higher successful rate of skin grafting and better patient outcome.
Reference:


Hospital Authority Annual Report 2012-2013 (2013). Retrieved August 17, 2015 from The Hospital Authority, Web site:


Hospital Authority (2015). Retrieved August 17, 2015 from The Hospital Authority, Web site:

https://www.ha.org.hk/visitor/ha_visitor_text_index.asp?Content_ID=10045


comparing negative pressure dressing and conventional dressing methods on
split-thickness skin grafts in burned patients. Burns, 37(6), 925-929.

dressing and paraffin gauze dressing in skin-grafted sites. Burns, 22(7),
543-545.


Saaiq M, Hameed UdD, Khan MI, et al. Vacuum-assisted closure therapy as a

Alonso, J. E. (2006). Negative pressure wound therapy to treat hematomas and
surgical incisions following high-energy trauma. Journal of Trauma and Acute
Care Surgery, 60(6), 1301-1306


Appendix

Appendix 1 Searching result with Prisma Flow Diagram

Inclusion criteria:
1. Randomized controlled trials
2. Adult patient in ward setting
3. NPWT compared with usual practice in managing split thickness skin graft
4. Included wound healing and cost
5. In English or Chinese

Exclusion criteria:
1. Pediatric case
2. Animals cases
3. Setting outside hospital
4. Intervention of the studies not only NPWT

545 Non-Duplicate Citations Screened

540 Articles Excluded After Title/Abstract Screen

5 Articles Retrieved

Inclusion/Exclusion Criteria Applied

1 Articles Excluded After Full Text Screen

Articles Excluded During Data Extraction

4 Articles Included
<table>
<thead>
<tr>
<th>Bibliographic citation</th>
<th>Study type</th>
<th>Patient Characteristics</th>
<th>Intervention</th>
<th>Comparison</th>
<th>Length of follow up</th>
<th>Outcome measures</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisidis et al., (2004)</td>
<td>Prospective, Controlled clinical trial</td>
<td>Patients with skin graft wound (n=22)</td>
<td>Negative-pressure wound therapy (n=22)</td>
<td>Standard bolster dressings (n=22)</td>
<td>2 weeks</td>
<td>(1) Wound epithelialization (%)</td>
<td>(1) No significantly different</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(2) Rate (poor, satisfactory, good, or excellent)</td>
<td>(2) Graft takes: Better= 50% Equivalent= 35% Worse= 15% (P &lt; 0.05)</td>
</tr>
<tr>
<td>Bloemen et al., (2012)</td>
<td>Four-armed, multicenter randomized controlled trial</td>
<td>Patients with deep dermal or full-thickness burn wounds requiring skin transplantation (n=20)</td>
<td>Split skin graft with Negative-pressure wound therapy (n=22)</td>
<td>Standard treatment (Gauzes, supplement with an antibacterial substance such as povidone-iodine or fusidic acid) (n=20)</td>
<td>3 months+12 months</td>
<td>(1) Graft take (%) (2) Wound epithelialization (%) (3) Post-op Contaminated wounds (%)</td>
<td>(1) No significantly different (2) No significant different (3) -43% (p=0.042)</td>
</tr>
<tr>
<td>Petkar et al., (2013)</td>
<td>Randomized controlled trial</td>
<td>Patients with acute or old burn required skin grafting in a burnt area (n=19)</td>
<td>Split skin graft with Negative-pressure wound therapy (n=21)</td>
<td>Conventional dressing (Vaseline gauze, cotton pads and cotton bandage or elastic adhesive bandage) (n=19)</td>
<td>9 days</td>
<td>(1) Graft takes. (%) (2) Duration of dressing (Day)</td>
<td>(1) +9.2% (p&lt;0.001) (2) -1.11 (p&lt;0.001)</td>
</tr>
<tr>
<td>Liao et al., (2012)</td>
<td>Randomized, Single-Blinded, controlled trial</td>
<td>Patients with amputation wounds for limbs open fractures required anti-taken skin graft.</td>
<td>Anti-taken skin graft. With vacuum sealing drainage (n=30)</td>
<td>Conventional dressing (n=30)</td>
<td>8 days</td>
<td>(1) Survival rate of skin graft (%) (2) Infection rate (%) (3) Re-amputation rate (%) (4) Dressing change (Time) (5) Hospitalization time (Day)</td>
<td>(1) +26.7% (p=0.030) (2) -16.7% (p=0.044) (3) -13.3% (p=0.038) (4) -b (p=0.003) (5) -6 (p=0.041)</td>
</tr>
<tr>
<td>Llanos et al., (2006)</td>
<td>Randomized, double-masked, controlled trial</td>
<td>Patients having wounds with skin loss which hindered primary closure (n=30)</td>
<td>Split skin graft with Negative-pressure wound therapy (n=30)</td>
<td>Silicone fenestrated tube, translucent adhesive dressing, and flexible gauze, (n=30)</td>
<td>4 days</td>
<td>(1) Loss of grafted area (%) (2) From grafting to discharge (Day) (3) Need for a 2nd coverage procedure (%)</td>
<td>(1) -12.8% (p=0.001) (2) -4 (p=0.001) (3) -23.3% (p=0.045)</td>
</tr>
</tbody>
</table>
Appendix 3: Critical Appraisals and Quality Assessment

<table>
<thead>
<tr>
<th>Study Identification (include author, title, year of publication, journal title, pages)</th>
<th>A Prospective, Blinded, Randomized, Controlled Clinical Trial of Topical Negative Pressure Use in Skin Grafting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guideline topic: The use of negative pressure wound therapy for adult in-patient with split thickness skin grafts</td>
<td>Key Question No: 1</td>
</tr>
</tbody>
</table>

### SECTION 1: INTERNAL VALIDITY

<table>
<thead>
<tr>
<th>In a well conducted RCT study...</th>
<th>Does this study do it?</th>
</tr>
</thead>
</table>
| 1.1 The study addresses an appropriate and clearly focused question.\(^1\) | Yes ☑  
Can't say ☐  
No ☐ |
| 1.2 The assignment of subjects to treatment groups is randomised.\(^4\) | Yes ☑  
Can't say ☐  
No ☐ |
| 1.3 An adequate concealment method is used.\(^3\) | Yes ☑  
Can't say ☐  
No ☐ |
| 1.4 Subjects and investigators are kept ‘blind’ about treatment allocation.\(^7\) | Yes ☑  
Can't say ☐  
No ☐ |
| 1.5 The treatment and control groups are similar at the start of the trial.\(^6\) | Yes ☑  
Can't say ☐  
No ☐ |
| 1.6 The only difference between groups is the treatment under investigation.\(^8\) | Yes ☑  
Can't say ☐  
No ☐ |
| 1.7 All relevant outcomes are measured in a standard, valid and reliable way.\(^9\) | Yes ☑  
Can't say ☐  
No ☐ |
| 1.8 What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed?\(^8\) | Yes ☑  
Can't say ☐  
No ☐ |
| 1.9 All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis).\(^8\) | Yes ☑  
Can't say ☐  
No ☐ |
| 1.10 Where the study is carried out at more than one site, results are comparable for all sites.\(^8\) | Yes ☑  
Can't say ☐  
No ☐ |

### SECTION 2: OVERALL ASSESSMENT OF THE STUDY

| 2.1 How well was the study done to minimise bias? Code as follows:\(^7\) | High quality (++): ☑  
Acceptable (+): ☐  
Unacceptable – reject: ☐ |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2 Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention?</td>
<td>Yes</td>
</tr>
<tr>
<td>2.3 Are the results of this study directly applicable to the patient group targeted by this guideline?</td>
<td>Yes. The patient population of my proposed guideline is the same as the study.</td>
</tr>
</tbody>
</table>
### SECTION 1: INTERNAL VALIDITY

#### In a well conducted RCT study...

<table>
<thead>
<tr>
<th>Question</th>
<th>Does this do it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 The study addresses an appropriate and clearly focused question.</td>
<td>Yes ☒ No ☐</td>
</tr>
<tr>
<td>1.2 The assignment of subjects to treatment groups is randomised.</td>
<td>Yes ☐ Can't say ☐</td>
</tr>
<tr>
<td>1.3 An adequate concealment method is used.</td>
<td>Yes ☐ Can't say ☐</td>
</tr>
<tr>
<td>1.4 Subjects and investigators are kept 'blind' about treatment allocation.</td>
<td>Yes ☐ Can't say ☐</td>
</tr>
<tr>
<td>1.5 The treatment and control groups are similar at the start of the trial.</td>
<td>Yes ☐ Can't say ☐</td>
</tr>
<tr>
<td>1.6 The only difference between groups is the treatment under investigation.</td>
<td>Yes ☐ Can't say ☐</td>
</tr>
<tr>
<td>1.7 All relevant outcomes are measured in a standard, valid and reliable way.</td>
<td>Yes ☐ Can't say ☐</td>
</tr>
<tr>
<td>1.8 What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed?</td>
<td>Control group 25% drop out rate</td>
</tr>
<tr>
<td>1.9 All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis).</td>
<td>Yes ☒ No ☐</td>
</tr>
<tr>
<td>1.10 Where the study is carried out at more than one site, results are comparable for all sites.</td>
<td>Yes ☒ Can't say ☐ Does not apply ☐</td>
</tr>
</tbody>
</table>

### SECTION 2: OVERALL ASSESSMENT OF THE STUDY

<table>
<thead>
<tr>
<th>Question</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 How well was the study done to minimise bias? Code as follows:</td>
<td>High quality (+++)</td>
</tr>
<tr>
<td></td>
<td>Acceptable (+)</td>
</tr>
<tr>
<td></td>
<td>Unacceptable - reject 0</td>
</tr>
<tr>
<td>2.2 Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention?</td>
<td>Yes</td>
</tr>
<tr>
<td>2.3 Are the results of this study directly applicable to the patient group targeted by this guideline?</td>
<td>Yes, The patient population of my proposed guideline is the same in the study.</td>
</tr>
</tbody>
</table>
## SECTION 1: INTERNAL VALIDITY

**In a well conducted RCT study...**

<table>
<thead>
<tr>
<th>Key Question No. 1</th>
<th>Reviewer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does this study do it?</td>
<td>-----------</td>
</tr>
<tr>
<td>1.1 The study addresses an appropriate and clearly focused question.</td>
<td>Yes ☑</td>
</tr>
<tr>
<td>Can’t say ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>1.2 The assignment of subjects to treatment groups is randomised</td>
<td>Yes ☑</td>
</tr>
<tr>
<td>Can’t say ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>1.3 An adequate concealment method is used</td>
<td>Yes ☑</td>
</tr>
<tr>
<td>Can’t say ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>1.4 Subjects and investigators are kept blind about treatment allocation</td>
<td>Yes ☑</td>
</tr>
<tr>
<td>Can’t say ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>1.5 The treatment and control groups are similar at the start of the trial</td>
<td>Yes ☑</td>
</tr>
<tr>
<td>Can’t say ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>1.6 The only difference between groups is the treatment under investigation</td>
<td>Yes ☑</td>
</tr>
<tr>
<td>Can’t say ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>1.7 All relevant outcomes are measured in a standard, valid and reliable way</td>
<td>Yes ☑</td>
</tr>
<tr>
<td>Can’t say ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>1.8 What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed?</td>
<td>0%</td>
</tr>
<tr>
<td>1.9 All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis)</td>
<td>Yes ☑</td>
</tr>
<tr>
<td>Can’t say ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>Does not apply ☐</td>
<td></td>
</tr>
<tr>
<td>1.10 Where the study is carried out at more than one site, results are comparable for all sites</td>
<td>Yes ☑</td>
</tr>
<tr>
<td>Can’t say ☐</td>
<td>No ☐</td>
</tr>
<tr>
<td>Does not apply ☐</td>
<td></td>
</tr>
</tbody>
</table>

## SECTION 2: OVERALL ASSESSMENT OF THE STUDY

<table>
<thead>
<tr>
<th>Key Question No. 1</th>
<th>Reviewer</th>
</tr>
</thead>
<tbody>
<tr>
<td>How well was the study done to minimise bias?</td>
<td>High quality (+++)</td>
</tr>
<tr>
<td>Code as follows:</td>
<td>Acceptable (+) ☑</td>
</tr>
<tr>
<td>Unacceptable – reject 0 ☐</td>
<td></td>
</tr>
<tr>
<td>2.2 Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention?</td>
<td>Yes</td>
</tr>
<tr>
<td>2.3 Are the results of this study directly applicable to the patient group targeted by this guideline?</td>
<td>Yes. The patient population of my proposed guideline is the same in the study.</td>
</tr>
</tbody>
</table>
### SECTION 1: INTERNAL VALIDITY

<table>
<thead>
<tr>
<th>Total</th>
<th>Does this study do it?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Yes □ Can't say □</td>
</tr>
<tr>
<td>1.2</td>
<td>Yes □ Can't say □</td>
</tr>
<tr>
<td>1.3</td>
<td>Yes □ Can't say □</td>
</tr>
<tr>
<td>1.4</td>
<td>Yes □ Can't say □</td>
</tr>
<tr>
<td>1.5</td>
<td>Yes □ Can't say □</td>
</tr>
<tr>
<td>1.6</td>
<td>Yes □ Can't say □</td>
</tr>
<tr>
<td>1.7</td>
<td>Yes □ Can't say □</td>
</tr>
<tr>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>1.9</td>
<td>Yes □ Can't say □</td>
</tr>
<tr>
<td>1.10</td>
<td>Yes □ Can't say □</td>
</tr>
</tbody>
</table>

### SECTION 2: OVERALL ASSESSMENT OF THE STUDY

<table>
<thead>
<tr>
<th>Question</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>High quality (++□)</td>
</tr>
<tr>
<td></td>
<td>Acceptable (+□)</td>
</tr>
<tr>
<td></td>
<td>Unacceptable – reject 0 □</td>
</tr>
<tr>
<td>2.2</td>
<td>Yes</td>
</tr>
<tr>
<td>2.3</td>
<td>Yes. The patient population of any proposed guideline is the same in the study.</td>
</tr>
</tbody>
</table>
### SECTION 1: INTERNAL VALIDITY

| 1.1 | The study addresses an appropriate and clearly focused question. | Yes ☑️ |
| 1.2 | The assignment of subjects to treatment groups is randomised. | Yes ☑️ |
| 1.3 | An adequate concealment method is used. | Yes ☑️ |
| 1.4 | Subjects and investigators are kept ‘blind’ about treatment allocation. | Yes ☑️ |
| 1.5 | The treatment and control groups are similar at the start of the trial. | Yes ☑️ |
| 1.6 | The only difference between groups is the treatment under investigation. | Yes ☑️ |
| 1.7 | All relevant outcomes are measured in a standard, valid and reliable way. | Yes ☑️ |
| 1.8 | What percentage of the individuals or clusters recruited into each treatment arm of the study dropped out before the study was completed? | 0% |
| 1.9 | All the subjects are analysed in the groups to which they were randomly allocated (often referred to as intention to treat analysis). | Yes ☑️ |
| 1.10 | Where the study is carried out at more than one site, results are comparable for all sites. | Yes ☑️ |

### SECTION 2: OVERALL ASSESSMENT OF THE STUDY

| 2.1 | How well was the study done to minimise bias? | High-quality (+++) |
| 2.2 | Taking into account clinical considerations, your evaluation of the methodology used, and the statistical power of the study, are you certain that the overall effect is due to the study intervention? | Yes |
| 2.3 | Are the results of this study directly applicable to the patient group targeted by this guideline? | Yes. The patient population of my proposed guideline is the same in the study. |
## Appendix 4 Cost-Benefit Ratio of the innovation

<table>
<thead>
<tr>
<th></th>
<th>Usual Practice</th>
<th>With NPWT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Materials cost</strong></td>
<td>Dressing Set HKD10/pack</td>
<td>Hospital-devised and built system:</td>
</tr>
<tr>
<td></td>
<td>Hibitane HKD 4/pack Additional gauze and</td>
<td>HKD 200/day*7=HKD 1,400</td>
</tr>
<tr>
<td></td>
<td>Bandage HKD16/time = 10+4+16= Total HKD 30</td>
<td>Commercial system</td>
</tr>
<tr>
<td></td>
<td>10+4+16= Total HKD 30</td>
<td>HKD 800/day*7=HKD 5,600</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Dorafshar et al., 2011)</td>
</tr>
<tr>
<td><strong>Non-materials cost</strong></td>
<td>1 RN to implement HKD 179/hour</td>
<td>1 RN to implement HKD 179/hour</td>
</tr>
<tr>
<td></td>
<td>10 minutes for perform usual practice</td>
<td>20 minutes for perform NPWT</td>
</tr>
<tr>
<td></td>
<td>Total= 179*0.2=HKD 35.8</td>
<td>Total= 179*0.3=HKD 53.7</td>
</tr>
<tr>
<td><strong>Risks of Maintaining Current Practice</strong></td>
<td>1 days hospital stay HKD 4580</td>
<td>Total cost on training for one ward with 21 staffs including wound management team</td>
</tr>
<tr>
<td></td>
<td>7 day hospital stay= 4580 * 7= HKD 32,060</td>
<td>For one orthopedic department with four wards:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>=HKD 3,520</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For one orthopedic department with four wards:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>=HKD 3,520*4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>=HKD 14,080</td>
</tr>
<tr>
<td><strong>Training cost</strong></td>
<td>Free</td>
<td>Total cost on training for one ward with 21 staffs including wound management team</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For one orthopedic department with four wards:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>=HKD 3,520</td>
</tr>
<tr>
<td></td>
<td></td>
<td>For one orthopedic department with four wards:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>=HKD 3,520*4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>=HKD 14,080</td>
</tr>
<tr>
<td><strong>Need for second coverage procedure and cost</strong></td>
<td>40% of cases need second coverage procedure</td>
<td>16.7% of cases need second coverage procedure</td>
</tr>
<tr>
<td>(Llanos et al., 2006 p=0.045)</td>
<td>For every 100 patients, around 40 patients need second coverage procedure, for 7 day more hospital stay, government subsidizes:</td>
<td>For every 100 patients, around 16.7 patients need second coverage procedure, for 7 day more hospital stay, government subsidizes:</td>
</tr>
<tr>
<td></td>
<td>4,580<em>7</em>40= HKD 1,282,400</td>
<td>4,580<em>7</em>16.7= HKD 535,402</td>
</tr>
<tr>
<td><strong>Total Cost (every 100 cases)</strong></td>
<td>Usual practice: (30+35.8)<em>100+32,060</em>40=6,580+1,282,400 = HKD 1,288,980</td>
<td>Hospital-devised and built system:</td>
</tr>
<tr>
<td></td>
<td>(1,400+53.7)<em>100+32,060</em>16.7+14,080</td>
<td>= HKD 694,852</td>
</tr>
<tr>
<td></td>
<td>= HKD 1,288,980</td>
<td>Commercial system:</td>
</tr>
<tr>
<td></td>
<td>(5,600+53.7)<em>100+32,060</em>16.7+14,080</td>
<td>=HKD 1,114,852</td>
</tr>
</tbody>
</table>
Appendix 5: Evidence-based guideline for the use of negative pressure wound therapy for adult patients with split thickness skin graft

An Evidence-based guideline for the use of negative pressure wound therapy for adult patients with split thickness skin graft

June 2
Aim:

To provide an evidence-based guideline for using negative pressure wound therapy for adult patients with split thickness skin graft in orthopedic and traumatology.

Objectives:

To promote graft taking and reduce wound infection for adult patient with split thickness skin graft by NPWT

Target Users of the protocol

The wound management team and nurses in the orthopaedic and traumatology unit

Target Group

The targeted patients are adult patients required split-thickness skin grafting. The reason of surgery mainly due to orthopedic problem such as open fracture wounds, amputation wounds, burns, infection and malignancy. The wound surface area was from 10cm$^2$ to 125cm$^2$ from the reviewed studies.

Recommendation: Assessment

1. Split thickness skin graft cannot be done if there is Infected wound or patient with systematic infection. (Grade A) (Llanos et al., 2006, Bloemen et al., 2012) (1++) (Liao et al., 2011, Petkar et al., 2011)(1+)

   Infected wound or patients with systematic infection were excluded from the reviewed studies. A review, assessment and wound culture of the wound before skin grafting by are recommended If the skin grafting is done on a infected wound or patient with systematic infection, nurses should not apply NPWT on it.

2. Wound surface area before skin graft is ranged from 10cm$^2$ to 125cm$^2$

   (Grade A) (Llanos et al., 2006, Bloemen et al., 2012) (1++) (Liao et al., 2011, Petkar et al., 2011)(1+)
From the reviewed studies, the wound surface area was mainly from 10cm$^2$ to 125cm$^2$. Therefore, before the application of NPWT, a review, assessment and wound size measurement before skin grafting by nurses are recommended.

**Recommendation: Procedures**

1. The skin grafted wound should be covered with a single layer of paraffin gauze first. *(Grade A)* (Bloemen et al., 2012, Llanos et al., 2006)(1++) (Petkar et al., 2011)(1+)

   Using paraffin gauze dressing could reduce the problem of patient discomfort during dressing changes for newly grafted wound.

2. 1 to 2 layers of polyurethane foam cut into the shape of the wound and placed over the non-adhesive dressing. *(Grade A)* (Bloemen et al., 2012, Llanos et al., 2006)(1++) (Petkar et al., 2011)(1+) One layer of polyurethane foam is enough if there is no risk of pressure ulcers under the suction tube. *(Grade A)* (Llanos et al., 2006)(1++)

3. Then, a fenestrated silicone suction tube put on top of the polyurethane foam and cover with another polyurethane foam *(Grade A)* (Bloemen et al., 2012, Llanos et al., 2006)(1++) (Petkar et al., 2011)(1+)

4. Using transparent adhesive dressings cover the foam, the tube and the peri-wound area *(Grade A)* (Bloemen et al., 2012, Llanos et al., 2006)(1++) (Petkar et al., 2011)(1+)

5. Connect the tube to the V.A.C machine (Bloemen et al., 2012) (1++) or connect to the central aspiration system of hospital *(Grade A)* (Llanos et al., 2006)(1++) (Petkar et al., 2011)(1+) *(Grade A)*

   Reviewed studies *(Grade A)* (Llanos et al., 2006)(1++) (Petkar et al., 2011)(1+) shown that the modified NPWT provide the same effect compared with designed dressing and vacuum pump *(e.g V.A.C)*.

6. Using pressure from -80mmHg continuously *(Grade A)* (Llanos et al., 2006)(1++) (Petkar et al., 2011)(1+)
Reviewed studies shown that -80mmHg continuously demonstrated the best healing effect.

7. In postoperative day 0 to day 7, patients should keep bed rest, allowing limited movement only for personal hygiene. No extended wound care is needed until the 7th postoperative day. (Grade A) (Bloemen et al., 2012)(1++)(Petkar et al., 2011, Liao et al., 2012)(1+)

Recommendation: evaluation

1. Evaluate wound condition when the wound is uncovered. Assess the area loss of the skin graft, and any wound infection. (Grade A) (Bloemen et al., 2012, Llanos et al., 2006)(1++)(Petkar et al., 2011, Liao 2012)(1+)

If there are any problems, such as, pus or slough is noted, report to physicians immediately and consider further treatment such as debridement or re-grafting. Otherwise, dress the wound with usual practice (hibitane lotion, paraffin gauzes, cover with gauze and bandage) if no complication shown.
Reference:


## Appendix 6: Level of Evidence Developed by the SIGN

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1++</td>
<td>High-quality meta-analyses, systematic reviews of RCTs, or RCTs with very low risk of bias.</td>
</tr>
<tr>
<td>1+</td>
<td>Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with low risk of bias.</td>
</tr>
<tr>
<td>1-</td>
<td>Meta analyses, systematic reviews of RCTs, or RCTs with a high risk of bias.</td>
</tr>
<tr>
<td>2++</td>
<td>High quality systematic reviews of case-control or cohort studies. High quality case-control or cohort studies with a very low risk of confounding, bias, or chance and a high probability that the relationship is causal.</td>
</tr>
<tr>
<td>2+</td>
<td>Well-conducted case control or cohort studies with a low risk of confounding, bias, or chance and a moderate probability that the relationship is causal.</td>
</tr>
<tr>
<td>2-</td>
<td>Case control or cohort studies with a high risk of confounding, bias, or chance and a significant risk that the relationship is not causal.</td>
</tr>
<tr>
<td>3</td>
<td>Non-analytic studies, e.g. case reports, case series</td>
</tr>
<tr>
<td>4</td>
<td>Expert opinion</td>
</tr>
</tbody>
</table>

**RCT**: randomized, controlled trial
## Appendix 7 SIGN-Grading of recommendations

Scottish Intercollegiate Guidelines Network (SIGN) (2012)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At least one meta-analysis, systematic review, or RCT rated as 1++, and directly applicable to the target population; <em>or</em> A body of evidence consisting principally of studies rated as 1+, directly applicable to the target population, and demonstrating overall consistency of results.</td>
</tr>
<tr>
<td>B</td>
<td>A body of evidence including studies rated as 2++, directly applicable to the target population, and demonstrating overall consistency of results; <em>or</em> Extrapolated evidence from studies rated as 1++ or 1+.</td>
</tr>
<tr>
<td>C</td>
<td>A body of evidence including studies rated as 2+, directly applicable to the target population and demonstrating overall consistency of results; <em>or</em> Extrapolated evidence from studies rated as 2++.</td>
</tr>
<tr>
<td>D</td>
<td>Evidence level 3 or 4; <em>or</em> Extrapolated evidence from studies rated as 2+.</td>
</tr>
<tr>
<td>D</td>
<td>Recommended best practice based on the clinical experience of the guideline development group</td>
</tr>
</tbody>
</table>

* GPP: good practice points (Recommended best practice based on the clinical experience of the guideline development group)
### Appendix 8 Gantt chart Of Negative Pressure Wound Therapy In Split-Thickness Skin Graft Patients

| Event                                      | 1 | 2   | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21| 22| 23| 24 |
| Preparation of the proposal and guideline  |   |     |   |   |   | 1 | 2 |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Approval seeking                           |   |     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Training session to program team           |   |     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Pilot Study                                |   |     |   |   |   |   |   |   |   |   |   | 1 | 2 | 3 | 4 |   |   |   |   |   |   |   |   |   |   |
| Evaluation of Pilot Study                  |   |     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Actual Implementation                      |   |     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Evaluation                                 |   |     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
### Appendix 9 Nursing Procedure Audit Form

Department of Orthopaedic and Traumatology

Audit on Evidence-based practice on using negative pressure wound therapy in Split-thickness skin graft patient.

Please circle the appropriate source of information and tick the appropriate column

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Source of information</th>
<th>Yes</th>
<th>No</th>
<th>N</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Assess for risk and contraindication</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1  All patients needed skin graft are referred to the wound management team</td>
<td>N/F/O/CR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2  Assess the reason of surgery mainly due to orthopedic problem</td>
<td>N/F/O/CR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3  Assess the wound surface area</td>
<td>N/F/O/CR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4  Assess the infection status (Wound or systematic)</td>
<td>N/F/O/CR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5  All recruitment criteria fulfilled</td>
<td>N/F/O/CR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6  Obtaining informed consent</td>
<td>N/F/O/CR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intervention (Item 7-10 for wound management team nurse)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7  Skin grafted wound covered with a single layer of paraffin gauze first</td>
<td>N/F/O/CR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8  1 to 2 layers of polyurethane foam cut into shape of the wound and placed over the non-adhesive dressing 1 layer of polyurethane foam is enough if there is no risk of pressure ulcers at the bed of suction tube</td>
<td>N/F/O/CR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>N/F/O/CR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>A fenestrated silicone suction tube put on top the polyurethane foam and cover with another polyurethane foam</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Using transparent adhesive dressing cover the foam, the tube and the peri-wound area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Connect the tube to the V.A.C machine or connect to the central aspiration system of hospital</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Using pressure from ~80mmHg continuously</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Clinical photo with wound size measurement and date</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Documentation on reason for unplanned dressing change</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Clear documentation on number of dressing packed into the wound</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Documentation**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>N/F/O/CR</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Complete all items in assessment form</td>
<td></td>
</tr>
</tbody>
</table>

NA: not applicable; N: ask nurse; F: ask family; O: observation; CR: Check record

Compliance percentage: _____________________________

Auditor: _____________________________

Signature: _____________________________

Date: _____________________________