An-Najah National University
Faculty of Graduate Studies

Effect of Surgical Site Infection Bundles in Cardiac Surgery: Incidence, Microbiology, and Risk Factors

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This Thesis is Submitted in Partial Fulfillment of the Requirements For the Degree of Master of Critical Care Nursing, Faculty of Graduate Studies, An-Najah National University, Nablus - Palestine.

2021

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الاهداء

لأن وراء طريق طويل تملؤه العثرات كما النجاحات حلم لا بد أن يتحقق، فلولاكم أنتم من كنتم بجانبي لحظه بلحظه، من ساندني طيله سنوات من التعب والسهر والدراسة لم يكن عملي هذا سيظهر للنور.

إلى مناره العلم والامام المصطفى، الى سيد الخلق

الى رسولنا الكريم (ص)

إلى من جرع الكأس فارغا ليسقيني قطره حب، الى من حصد الاشواك من دربي ليمهد لي طريق العلم، الى القلب الكبير

(والدي العزيز)

إلى الينبوع الذي لا يمل العطاء، الى من حاكت سعادتي بخيوطٍ منسوجةً من قلبها

(والدتي العزيزة)

إلى رايحين حياتي، أنتم سندي وانتم من دعمني لأصل الى هنا، شكرا لكم اخوتي واخواتي.

الى من أشرقت شمسك في سماء حياتي. . وكنت نوراً قد غطى على أحزاني وبدلها

أفراح... كم هي رائعة عيناك التي أرى بهما الحياة. . حفظك اللـه لـي ومتعك بالصحة والعافية ... ودمت لــي.... (زوجتي العزيزة)

الى من أصبحت الحياة جميلة بوجودهم معي فيها. . بابتسامتهم التي ترتسم على

محياك الجميل. (ابني وابنتي)

الى من علمونا حروفاً من ذهب، وعبارات من اسمى واجلى عبارات في العلم (معلميني الافاضل)

الى من تعبنا وسهرنا وسرنا نحو احلامنا معاً ،شكراً لكل من ساعدني منكم لأصل الى هنا

(الى اصدقائي)

Acknowledgment

First, all praise is to Allah who has enabled me to complete this thesis on time.

Without faculty and colleagues this scientific study would not have been possible. Although it would be impossible to name individually all of the people and the events that contributed to the success of this project and the accomplishment of a remarkable educational and experiential milestone, we know and value and appreciate each and every one.

Next, to express my deepest appreciation to Dr. Jamal Al-Qadomi for his diligent supervision, clear guidance and thoughtful mentoring throughout the whole of this thesis, You were for me a leader, advisor, teacher, and seminar supervisor, and our role model. Thank you.

For all Doctors in the Critical care nursing program, you provide me intellectually challenge and helped me grow professionally. I have learned a lot from each of you and consider our self extremely fortunate to have worked with you

My warm appreciations are expressed to My families, respectful parents and brothers, sisters, who have continually supported me during our entire educational journey, what a pleasant it has been. I also wish to. Special thanks go to my friends– for their supportive and patient attitude, it was most truly welcome.

I would like to thanks the MOH of enable us to study in their facilities.

Last but not least, our deepest gratitude for everyone who contributed to this works & appreciates their efforts.

الاقرار

أنا الموقع أدناه، مقدّم الرسالة التي تحمل العنوان:

Effect of Surgical Site Infection bundles in Cardiac Surgery: Incidence, Microbiology, and risk factors

أقر بأن ما اشتملت عليه هذه الأطروحة إنما هو نتاج جهدي الخاص، باستثناء ما تمت الاشارة إليه حيثما ورد. وأن هذه الرسالة كاملة، أو اي جزء منها لم يقدم من قبل لنيل اي درجة او لقب علمي او بحثي لدى أي مؤسسة تعليمية أو بحثية أخرى.

Declaration

The work provided in this Thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

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Date: 2/3/2021 **التاريخ:**

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List of Abbreviation

AVR	Aortic Valve Replacement
BSI	BloodStream Infection
CABG	Coronary Artery Bypass Grafting
CDC	Centers for Disease Control and Prevention
DM	Diabetes Mellitus
DSWIs	Deep Sternal Wound Infections
HAIs	Hospital Acquired Infections
ICU	Intensive Care Unit
IRB	Institutional Review Board
MRSA	Methicillin-resistant Staphylococcus aureus
MSSA	Methicillin-Sensitive Staphylococcus Aureus
MVR	Mitral Valve Repair
PHMB	Polyhexamethylene Biguanide
SCFs	Stern Cutaneous Fistulas
SCIP	Surgical Care Improvement Project
SSI	Surgical Site Infection
SSIB	Surgical Site Infection Bundle
SVG	Saphenous Vein Graft
VAP	Ventilator-Associated Pneumonia

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Abstract

Introduction: Surgical site infections (SSI), defined by the Centers for Disease Control and Prevention (CDC) as “an infection that occurs after surgery in the area of the body where the surgery took place…” (CDC, 2016), are the second most common type of healthcare associated infection.

Aim: The overall aim of this study is to find out the incidence and associated risk factors of surgical site infection after implemented SSI bundles in cardiac surgery include both sternal and leg wound.

Data collection: Quasi-experimental research design method was used including retrospective analysis incidence and SSI followed cardiac surgery and prospective experimental use Surgical Site Bundles approach compared with routine care in retrospective assess at governmental and private Hospitals in West Bank. A total of 222 cardiac surgery patients included in this study in which 110 for control and 112 for experimental.

The result: among patients underwent cardiac surgery 70% underwent CABG, and most of them (90.5%) aged above 45 years. Furthermore, male was prevailing (70.3%), and 45% of them either overweight or obese. Hypertension was the higher prevalent (72.5%) chronic disease. The incidence rate of SSI in our study was 7.2%.

adherence to surgical prophylaxis protocol (Bundle) was associated with a reduction in SSI rates, the incidence of SSI was higher among conventional group compared with SSI bundle group (10.9% vs. 3.6%). The MRSA, Enterbacter Coccai, Staph Aureus, and A-Hemolytic Strep were the SSI type of bacteria.

Conclusion: adherence to surgical prophylaxis protocol (Bundle) was associated with a reduction in SSI rates. The incidence of SSI was higher among conventional group compared with SSI bundle group (10.9% vs. 3.6%). The MRSA, Enterbacter Coccai, Staph Aureus, and A-Hemolytic Strep were the SSI type of bacteria.

higher mean level of glucose, high BMI, and having respiratory chronic disease were independent factors associated with SSI in patients who underwent cardiac surgery procedures.

Age, gender, diabetes, and chronic renal failure had no statistically significant, but all had a risk on developing SSI.

Key words: Care Bundle, Cardiac Surgery, Surgical Site Infection, Pathogens, Sternal and Leg Wound.

Chapter One

Introduction

1.1 Background

The second most common type of healthcare-related infection is surgical site infections (SSI), described by the Centers for Disease Control and Prevention (CDC) as "an infection that happens after surgery in the part of the body where the surgery occurred (CDC, 2016). The second most common type of healthcare-related infection is surgical site infections (SSI). The United States conducts nearly 140,000 vascular surgery procedures annually (Calderwood, et al, 2014; AHRQ-HCUPnet, 2016). Patient-related, surgical (procedure)-related, and/or environment-related risk factors for vascular SSIs can include: nasal colonization of methicillin-sensitive Staphylococcus aureus (MSSA) or staphylococcus aureus (MRSA) immune to methicillin, obesity, end-stage renal disease, old age, diabetes, and smoking (Inui & Bandyk, 2015). Environmental variables that raise the risk include the amount of ventilation in the operating room, surface cleaning in the environment, surgical attire, surgical instrument, and implant sterility, and sterile operative technique (Inui & Bandyk, 2015). Vascular procedures that are open / infrainguinal (infra-aortic) and those with prosthetic implantation are associated with the highest infection rates, and highest morbidity, respectively (Tatterton & Homer-Vanniasinkam, 2011; Vogel, et al., 2010; Stone, et al., 2010; Ryan, et al., 2004). When compared to total SSI ratios of 1-5%, vascular surgery patients are at higher risk of contracting surgery-related infections. (Tatterton & Homer-Vanniasinkam, 2011).

A surgical site infection, such as a sternal infection following open-heart surgery, can range from a spontaneously minimal wound discharge within 7-10 days of an operation to a life-threatening postoperative complication. Many infections at the surgical site are induced during surgery by penetration of an incision with microorganisms from the patient's own body. Infection from an external source caused by microorganisms after surgery is less likely. The bulk of infections at the surgery site are preventable. Measures should be taken to minimize infection risk in the pre-, intra-, and postoperative periods of treatment (Berg, et al . 2011).

Infections at the surgery site may have a direct impact on the patient's quality of life. They are linked with severe morbidity and sustained hospitalization. Moreover, surgical site infections contribute to a major financial burden on healthcare providers. Advances in medicine and anesthesia have resulted in medicine being considered in patients who are at higher risk of surgical site infections. In comparison, greater rates of infections are now found in primary care when patients are encouraged to go home early after the case of the day and fast-track surgery (Woods, 2015).

The cause of pathogens for most surgical site infections is the patient's endogenous skin flora, mucous membranes, or hollow viscera. Staphylococcus aureus, coagulase-negative staphylococci, Enterococcus spp., and Escherichia coli are also the most commonly isolated pathogens in the distribution of pathogens isolated from SSIs (Alexiou, et al., 2017). Surgical staff (especially members of the surgical team), the operating room atmosphere (including air), and all equipment, instruments, and materials brought to the sterile field during the procedure are exogenous sources of SSI pathogens. Infection happens within 30 days of treatment if no implant is left in place or if the implant is in place within one year and the infection tends to be connected to the treatment, and some portion of the body (e.g., organs or spaces) other than the incision is involved in the infection (Albrich & Harbath, 2008).

Diabetes, smoking, steroid use, obesity, malnutrition, extended preoperative stay, and perioperative transfusion are causes that expose patients to elevated risk for SSIs. Other preoperative and intraoperative risk factors for SSIs include inadequate use of antimicrobial prophylaxis, remote site infection not treated before the operation, site shaving vs. clipping, long procedure duration, improper skin preparation, improper hand preparation of the surgical staff, operating room environment (ventilation, sterilization), surgical wear and drapes, asepsis, sterile field, Surgical technique: hemostasis, foreign bodies (NICE, 2013).

1.2 Cardiac surgeries

One of the most common surgical operations performed in developing countries is open heart surgery; the most common procedures are coronary artery bypass grafting (CABG), mitral valve repair (MVR), and aortic valve replacement (AVR) (Swedeheart, 2012; Yuh et al., 2007). Cardiopulmonary bypass (CPB) is typically used and the heart is arrested, but a pumping heart (off-pump, OPCAB) may also be carried out with coronary revascularization. Entry to the heart is normally achieved by sternotomy for open heart surgery, separating the manubrium and sternum longitudinally with a saw. However, some valvular and coronary bypass operations have been gradually performed through partial upper or lower sternotomy in later years (Tabata, et al., 2008), right or left thoracotomy (Wang et al., 2009). These procedures are also technically complex, but the reason is to minimize discomfort and other sternotomy-related risks, such as surgical site infections (SSIs) and the need for reoperation due to bleeding (Modi, et al., 2008). Infections are among the most important risks linked to open heart surgery, along with atrial fibrillation, renal failure, stroke, and bleeding, and frequently result in high mortality and morbidity (Sjögren, et al., 2011).

Almost 5% of patients suffer significant infection following heart surgery, considering advancements in medical treatment and the growing focus on clinical management measures to eliminate postoperative infections (Gelijns, et al., 2014). Latest studies from a prospective multiinstitutional cohort analysis of cardiac surgery-related infections have shown large changes in morbidity, mortality, and costs associated with these cases (Greco, et al., 2017). However, one infection of concern not reviewed in this initial study was secondary surgical site infections in patients undergoing coronary artery bypass grafting (CABG) with saphenous vein graft (SVG) harvesting. The SVG harvest site's surgical site infections (SSI) after CABG affect 1-4% of patients and are associated with major morbidity and expense (Williams, et al., 2012). These infections can also result in limb loss in rare cases (Paletta, et al., 2000). Although multiple outcome studies have been reported after saphenous vein harvesting, few concentrate on infection as the primary endpoint and those that also lack past discharge follow-up or 30 days postoperatively are non-adjudicated and are often single-center retrospective evaluations (Zenati, et al . , 2018).

1.3 Sternal wound infections

A 24-year-old man who had a heart laceration after a stab wound was identified in the first published account of a surgical human heart operation undertaken in Norway in 1895. The wound was sutured; the patient, however, died three days later from a serious wound site infection (Baksaas & Solberg, 2003; Cappelen, 1896). Sternotomy was first described in 1897 by Milton, but did not achieve mainstream acceptance until this technique for open heart surgery was described by Julian et al. (1957) and began to be used by surgeons worldwide (Dalton et al . , 1992).

Today, the most common surgical procedure used in medicine to obtain entry to the heart and other thoracic organs is a midline sternotomy.

A debilitating, and often deadly, complication is sternal wound infection, an SSI of the sternotomy incision. Depending on the extent of the infection in the wound, sternal wound infections can be broken into superficial infections and deep infections. Both superficial infections that enter the dermis and subcutaneous tissue and deep sternal wound infections (DSWIs) that enter beneath the sternum and anterior mediastinum are early infections. A DSWI is also sometimes referred to as postoperative mediastinitis, and may occur either early, more regularly, or as a late infection.

A mixture of superficial and deep infections is frequently a late infection, like osteomyelitis, subcutaneous abscess, and stern cutaneous fistulas (SCFs). Within 30 days of the surgical operation, an early superficial infection occurs and affects only the skin and subcutaneous incision tissue (Horan et al., 2008). Furthermore, the patient should have at least one of the following evidence of infection: I purulent discharge from the superficial wound; (ii) microbes isolated from an aseptic culture of fluid or tissue from the superficial wound; (iii) at least one of the following symptoms and signs of infection: discomfort or tenderness, local swelling, heat or redness; intentionally opened superficial incision; a superficial incision is deliberately opened by the surgeon and is culture-positive or not cultured (a culture-negative finding does not meet this criterion), and/or iv) diagnosis of a superficial incision surgical site infection by the surgeon or attending physician. A DSWI is clearly defined as an infection that is deeper than the sternum, touching the mediastinum.

CDC criteria for the diagnosis of deep sternal wound infections (DSWI) (Horan et al., 2008).

- Organisms developed from mediastinal tissue or fluid collected through surgery or needle aspiration
- Signs of mediastin it is seen in the process of surgery or histopathological review
- At least one of the following signs or symptoms of no other identifiable cause: fever (> 38 ° C), sternal instability or chest pain, and at least 1 of the following: (a) purulent mediastinal discharge; (b) blood-grown organisms; or mediastinal discharge; (c) mediastinal x-ray expansion.

1.4 Surgical Site Bundles

surgical site Bundles consisted of a group of evidence-based practice strategies that can have a significant effect on patient care when conducted together (Lowman, et al., 2016).

One of the most avoidable sources of hospital-acquired infections is surgical site infection (Koek, et al., 2017). Data shows that the perioperative team's treatment bundles will reduce the occurrence of certain infections whilst still providing extra benefits. Through their evidence-based practice, surgical site infection intervention bundles will help staff, lead to continued career growth and facilitate collaboration and coordination. Bundles are easy to introduce, can be individualized by each hospital and can use a scale-up approach to promote cultural transformation with long-term benefits for the health care agencies. Care bundles have been introduced globally in operating theatres and are accepted as a combination of evidence-based approaches to minimize surgical site infection (Anderson, et al., 2014). However, while they provide advantages to health care organizations, nurses and patients as well as being able to be incorporated as a quality improvement project on a clinical level, the uptake of these packages in Australian health care is not optimal. Using a collaborative, educational approach that promotes evidence-based approaches in reducing surgical site infection, treatment packages can be developed and implemented by perioperative team members. Bundles not only encourage best nursing practice for improved patient outcomes and achieve organizational objectives, through implementing bundles, nurses may meet educational requirements, inspire one another with a shared goal, and become individual change agents in the department to facilitate a scale-up practice change plan for long-term benefits. They encourage the professional growth of individual nursing staff members. In 2001, the Center for Health Care Reform first suggested the concept of the care bundle to promote coordination and collaboration and strengthen the quality and safety of the delivery of patient care (Resar, et al., 2012). Bundles directly targeting harm and cost areas were split into three to five evidence-based approaches that met expectations to enhance patient outcomes. In order to simplify decisions and minimize mistakes, these standardized procedures are based on existing guidelines (Camporota & Brett, 2011). The Centre for Medicare and Medicaid Services (CMS) later launched similar programs directly addressing surgical site infection in 2003 across the United States of America and later by the Department of Health in the United Kingdom (Department of Health (UK), 2011).

The Institute for Healthcare Improvement first proposed the potential for the use of care bundles in 2001 to maximize performance in critical care (Institute for Healthcare Improvement, 2002). A minimum of three stable, evidence-based measures are collectively and regularly introduced with the package strategy such that there is a potential overview of their results to minimize complications or adverse events. The first bundles of care were aimed at minimizing ventilator-associated pneumonia (VAP) and bloodstream-associated central line infections (CLABSIs); these showed great results (Pronovost, et al., 2006). The focus and selection of packages was expanded to resolve other clinical issues, including surgical site infections (SSIs), following these achievements. A bundle approach has the potential to reduce SSIs because there are many related risk factors to be targeted and there are a large number of robust, evidence-based interventions (Resar, et al., 2005).

At national levels, care bundles to minimize SSIs have been initiated, such as the Surgical Care Improvement Project (SCIP) in the US and the

High Impact Intervention Department of Health (DH HII) in England (Weston, et al., 2013). In 2006, SCIP was introduced with core antibiotic prophylaxis measures and effective preoperative hair removal, as well as additional normothermia maintenance measures in colorectal patients and diabetic management in cardiac patients. A US surgical care alliance coordinated the project and 95% compliance with interventions is needed to obtain full coverage from Medicaid. Mixed reports of its efficacy have been produced (Hawn, et al., 2011).

A seven-step strategy was designed and included in the Care Bundles:

#1 Safe Operating Room

- Traffic management, number of staff in-room
- Systems for air handling, ventilation, grills
- SCIP: hair cutting, skin warmers, oxygenation.
- Therapeutic prophylaxis, removal of the foley catheter within 48 hours
- turnover Between case room and regular terminal cleaning
- Surgical procedure and tissue handling, use of wound protector / retractor to avoid contamination of the field
- Method for instrument cleaning / sterilization, biological indicators
- Supply storage, clean supply containers, carts, tables, stationary devices

#2 Screening for MRSA and MSSA

Staph aureus SSIs are more likely to occur in patients who hold Staph aureus and MRSA in their nostrils or on their skin.

- An important tool for Staph aureus eradication is short-term nasal mupirocin (4-7 days)
- 90% efficiency in one week
- 1% develop resistance to mupirocin

#3 Shower pre-op

Research shows that frequent use of CHG soap improves CHG 's capacity before surgery to minimize bacterial counts on the skin. Patients should be advised to use either CHG solution or CHG wash cloths to clean the body the night before and morning of the operation.

#4 Skin prep – dual combined antiseptics

Two types of preoperative skin preparations combining alcohol (which has an immediate and significant killing effect on skin pathogens) with long-acting antimicrobial agents seem to be more efficient than povidone-iodine (iodophor) alone in preventing SSI:

- Alcohol plus chlorhexidine
- Iodophor mixed with alcohol

 # 5 Antimicrobial

- Like all foreign objects, bacteria will colonize sutures:
- Implants include bacteria nidus for attachment.
- Bacterial colonization can lead to the formation of biofilms
- On an implant, such as a suture, it takes just 100 staphylococci per gram of tissue for an SSI to grow.
- Biofilm formation increases the difficulty of treating an infection.

#6 Solution to pollution is dilution

Latest CHG surgical follows American College of Emergency Physicians (ACEP) volume and pressure requirements for wound irrigation. Splatter Guard Patented protects healthcare staff, patients and the environment from contamination by biohazards. Chlorhexidine Gluconate has shown antimicrobial efficacy and persistence in laboratory testing at a low concentration of 0.05%. In compound fractures and tissues, the mechanical action loosens and eliminates wound debris efficiently. FDA-approved to be Safe for mucous membranes.

#7 Skin adhesive or antimicrobial gauze dressings

Wounds in the first 48-72 hours are more vulnerable to infection. 1 until the epithelial barrier is complete (commonly around 48 hours), to preserve integrity, wounds are solely reliant on the wound closure unit. The level of microbial protection depends on the integrity of the barrier. 1 For the first 48 hours, effective barriers must preserve their integrity. A strong microbial barrier that prevents bacteria from entering the incision site is provided by the incisional adhesive.

Seven days of power for wound healing in less than one minute of application

Immediately wash • Wash

• Outstanding cosmesis

• Reduced follow-up

Less pain and anxiety Antimicrobial dressings Antimicrobial dressings are wound covers that produce the effects of agents to maintain efficacy against common infectious bacteria, such as silver and polyhexamethylene biguanide (PHMB). Indicated to help minimize the risk of infection, over percutaneous line sites and surgical incisions, in partial and full thickness wounds.

1.5 Statement of problem

During my work in infection control committee, I noticed the effectiveness of SSI care bundle in decreasing SSI among patients, so I decide to implementing this bundle to cardiac surgery in other Palestinian hospitals that not use this bundle in their routine care.

An infection that can occur post-surgery (CDC, 2010) is a postoperative wound infection. SSIs appear to occur during surgical procedures despite introducing best practice interventions during pre- and intraoperative periods (Manian, 2014). Therefore, to prevent hospital-acquired infections, adherence to effective perioperative infection control procedures when providing treatment for surgical patients is important. Every year, 1.7 million HCAIs are expected to occur, while SSIs alone account for 290,000 of the total HCAIs and around 8,000 deaths (Tsai and Caterson 2014). Infections linked to surgical procedures are clearly a universal concern, and SSI is one of the most common health-care-related infections (Allegranzi et al,. 2011). Historically, until the early nineteenth century, surgical results were low, with SSIs being the main risk factor (Humes and Lobo, 2009). An SSI is projected to be gained by 3% to 5% of all patients undergoing surgery (Anderson et al. 2010; Singh et al. 2014).

The development of surgical wounds interferes with the integrity and protective role of the skin. Deep body tissue exposure to bacteria in the atmosphere puts the patient at risk of surgical site infection, a potentially life-threatening complication. Surgical site infections are the most common nosocomial infection in post-operative patients, with 67 percent of these infections occurring within the incision and 33 percent occurring around the surgical site in the organ or space (Smyth et al., 2008).

In the United States, postoperative surgical site infections (SSIs) are a significant cause of morbidity. Approximately 500,000 of the 27 million individuals undergoing surgery annually will develop nosocomial surgical site infections (Lissovoy et al., 2009).

The third most often recorded nosocomial infection is surgical site infections. Analysis of these infections found that each infection at the surgical site lasted seven to nine days and resulted in an additional cost per infection of more than $3,000 (Gudmundsdóttir, et al., 2012).

The studies conducted in India show a 4.04 to 30 percent overall rate of infection for clean surgeries and 10% to 45% for clean polluted surgeries.

A research conducted in Germany to assess the reduction in deep sternal surgical site infection rates by a robust infection management program after cardiac surgery showed a substantial reduction in deep sternal surgical site infection from 3.61% to 1.83% with a package of interdisciplinary infection control interventions such as methicillin-resistant Staphylococcus aureus (MRSA)

There is no study in Palestine conducted to identify effectiveness of implementing of SSI care bundle.

1.6 Significant of study

SSI is a severe postoperative complication following heart surgery that causes patients to suffer and can lead to morbidity and even death. Species previously considered to be harmful to the skin can now cause SSI.

Because of the multiple causes of infection and the interacting routes of transmission, the growth of a surgical site infection is very complicated in some conditions and bacterial antibiotic resistance complicates more therapy. In this context, the focus of this thesis for incidence and risk factors of SSI post cardiac surgery.

For **Practice**: This study may assist in identifying the clinical practice role of surgical team members in prevention measurement of SSI.

For Research: This study may assist in identifying possible areas of future research to provide evidence-based solutions for clinical practice, education and policy development.

For Policy development: Policy development and changes to existing policies arise from the identification of areas of concern within clinical practice. Once concerns have been substantiated by research, evidence-based policy can be developed in order to effect changes in the practice. This study may provide information to assist in policy development within the cardiac surgery.

1.7 Aim of study

The overall aim of this study is to find out the incidence and associated risk factors of surgical site infection before and after implemented SSI bundles in cardiac surgery include both sternal and leg wound.

1.7.1 Objectives of the study

- To identify the rate and severity and microbiology of surgical site infection followed open heart surgery before implemented SSI bundles

- To find out pathogens that cause SSI

- To identify preoperative and postoperative risk factors and incidence of SSI before implement SSI Bundles

- To identify the effect of implement SSI Bundles on SSI rate and severity among open heart surgery pts

1.8 Operational definitions

Surgical Site Infection*:* Refers to a type of healthcare-associated infection in which a wound infection occurs after an invasive (surgical) procedure followed cardiac surgery.

Obesity: BMI was calculated in each patient. Those with BMI > 30 were regarded as obese.

Malnutrition: Those with BMI < 18.5 were regarded as suffering from malnutrition.

Jaundice: Those with S. bilirubin > 1.2 mg/ dl were recorded as jaundiced.

COPD: Suspected patients were diagnosed with the help of CXR.

Diabetes: Those known as diabetic from history and those with RBS more than 11 mmol/ l were included as diabetic.

Duration of operations: Duration of operation was recorded during each operation.

Types of incisions: were recorded during each operation

Chapter Two

Review of Literature

2.1 Introduction

An important element of scientific study is the review of literature. One of the key functions of literature review is to assess what is already understood about the topic of interest, and this will help to build a broad conceptual framework within which a research issue will fit.

2.2 Hospital Acquired Infections

Hospital Acquired Infections (HAIs) are a significant cause of a large number of deaths in the U.S. Surgical site infection (SSI), urinary tract infection (UTI), bloodstream infection (BSI) and pneumonia, such as ventilator-associated pneumonia (VAP), are the most common forms of HAIs triggered by bacterial, viral and fungal infections (CDC, 2010).

The leading causes of major morbidity and mortality in the US are healthcare-associated infections (HAIs). More than 75% of all HAIs in hospitals account for four types of infections: UTI, 34 percent; SSI, 17%; BSI, 14%; and, finally, Pneumonia is at 13% (CDC, 2010).

The Emerging Infections Program Healthcare-Associated Infections-Community Interface (EIP HAIC) and the National Healthcare Safety Network (NHSN) are two complementary HAI monitoring programs that regularly publish reports that are used to monitor progress and target the areas that require assistance (CDC, 2010). Nationally, in acute care hospitals in the U.S. between 2015 and 2016, there was a 2-11% decline in unique HAI forms (CDC, 2010). The 2016 state performance shows that 38 states improved performance on at least two types of HAI over the same period, with only 10 states doing worse on two types of infections. While considerable progress has been made in preventing some of these HIAs over the years, much more work still needs to be done. The costs incurred for the treatment of HAI are not reimbursed to the healthcare institution concerned and the financial security of the hospital must always be taken into account, since they can run into thousands of dollars.

2.3 Pathogenesis of Surgical Site Infections

During the perioperative period, contamination occurs as the hematogenous spread of microbes occurs after perioperative treatment and is associated at the incision site with primary bacteremia or infection (Greene 2012). Pathogens that may cause wound infection have been found in the literature to be acquired either endogenously from the patient's own flora on the skin or from open viscus or exogenously from interaction with operative room staff or the environment (Singh et al. 2014). In this context, it is known that at the time of the operative procedures, SSI is triggered by microorganisms introduced into the incision site (Kirby and Mazuski 2009). Most SSIs, like Staphylococcus Pyogenes, Methicillin Resistant Staphylococcus Aureus (hereinafter abbreviated as MRSA), Enterococcus and gram-negative species such as Pseudomonas Aeruginosa, Enterobacter and Klebsiella are found to be associated with gram-positive organisms that are part of natural skin flora (Greene 2012; Rubin 2006; Joyce and Lakshmidevi 2009; Spy 2013). In the pathogenesis of post-surgery SSIs, the existence of a biofilm also plays a key role (Greene 2012; Lepelletier et al . 2013; Quinn et al. 2009).

2.4 Mode of Transmission and Pathophysiology of Surgical Site Infections

In a health care system, a compromised host and a chain of transmission, SSIs result from an interaction of microorganisms (Spy 2013). This infection occurs when, as a consequence of bacteria or fungi migrating from the skin or gastrointestinal tract (hereinafter abbreviated as GI) of the patient, microorganisms are transmitted via the surgical incision such as microflora (endogenous infection) or direct transfer from surgical instruments, hands of healthcare professionals through the airborne route (exogenous infection) (Harrington 2014). The incision site becomes infected as microbes enter the wound and SSI evolves (Harrington, 2014). Bacteria can invade the body and pass through the bloodstream in other instances, or deposits on prosthesis implants can also be the cause of infection (Harrington 2014).

2.5 The Impact of Surgical Site Infections on patient outcomes

Postoperative infectious complications such as SSI can adversely affect the quality of life associated with patient health (hereinafter abbreviated as HRQoL) (Badia et al. 2017). There is some evidence to support that SSIs, associated with prolonged duration of postoperative hospital stays, higher care costs, and threatened health outcomes, are a significant cause of morbidity and mortality (Anderson 2014; Diaz and Newman 2015; Junker et al . 2012; Lipke and Hyott 2010; Nabor et al . 2015). In addition, if the patient is admitted to the hospital for a long time, discomfort can also be caused by the surgical patient and family members (Badia et al. 2017). Similar findings have been reported by other studies, which showed that patients who developed SSI are twice as likely to die, 60% more likely to spend time in an intensive care unit (hereafter abbreviated as ICU), and up to five times more likely to be re-admitted to hospital (Kirkland et al. 1999). SSIs occur during surgical operations at the surgical site and have a negative impact on the subsequent care of patients. Indeed, SSI is established by around 5 % of patients undergoing open surgery (Leaper et al . 2013; Good 2008). The effect of SSIs should therefore not be underestimated (Kirkland et al. 1999; Nessim et al. 2012), since they ultimately have a substantial impact on the postoperative outcomes of a patient (NICE 2008). SSIs can, therefore, present life-threatening complications after surgery, and patients who experience an SSI are more likely to spend an estimated 7 to 10 days in hospital (NICE 2008). In postoperative patients, SSI remains a substantially complex issue (Al Maqbali 2016). In certain cases of elective surgery, however, SSIs are preventable if evidence-based recommendations are strictly followed. It is also recommended that, as part of a crucial move towards preventing SSIs, HCWs should adhere to effective perioperative infection control steps.

2.6 Categories of Surgical Site Infections

Four classes consisting of clean (class I), clean polluted (class II), polluted (class III) and dirty procedures (class IV) (Philips et al . 2014) are categorized into surgical wounds. There are clean surgical procedures where no infection or inflammation is present. The probability of developing an SSI is below 2% (Zinn 2013) in this class. Those procedures in which the gastrointestinal (GI), respiratory and urinary tracts are entered under controlled circumstances and no infection is detected (Zinn 2013) are characterized by the second class of clean/ contaminated surgical procedures. In surgeries involving this sort of wound class, the risk of SSI varies from 5% to 15% (Zinn 2013). Surgical procedures that are open, accidental fresh wounds or a severe break in sterile technique can all lead to the presentation of acute inflammation in the contaminated class. In surgeries covered in the contaminated class, the risk of SSI is greater than 15% (Zinn 2013). Old traumatic wounds are included in the final dirty / infected class 11, and the possibility of SSI in this form of surgery accounts for up to 30% of all HCAIs (Zinn 2013).

2.7 Contributing Risk Factors for Surgical Site Infections

In surgical patients, the literature illustrates manifold risk factors for SSIs. Surgical procedure factors are classified into two groups: risk factors related to patients and risk factors related to surgical procedures. Several patient-related risk factors, such as pre-existing infections, malignant disease, diabetes mellitus (DM), trauma, shock, hypothermia, hyperglycaemia, obesity, malnutrition, hypoxia, immune deficiency, old age, smoking, and respiratory failure, have been associated with the onset of SSI (Reyes et al. 2011). Similarly, factors for surgical procedures include steps such as minimizing the duration of preoperative hospital stay, the use of personal protective equipment (hereinafter abbreviated as PPE), diligent prepping and draping for surgical procedures, preventing the removal of patient hair or, if absolutely necessary, using clippers outside the OR, washing with antiseptic agents, adequate preoperative medication (Barnes 2015; Harrop et al. 2012; Lepelletier et al. 2013; McHugh et al. 2014).

2.8 Evidence-Based Guidelines to Prevent Surgical Site Infections

For evidence-based medicine and eventually practice with an emphasis on wound care, the highest-level evidence is required (Maurya and Mendhe, 2014). The use of evidence-based recommendations in wound care has been proposed to have the potential to enhance patient outcomes and minimize the cost of hospital wound care (Gillespie et al., 2014). Proof-based wound management was described as the combination of best scientific evidence with clinical expertise and patient values by David Sackett (2000) Maurya and Mendhe, 2014, according to Maurya and Mendhe (2014). Gillespie et al. (2014) carried out an audit in the United Kingdom in relation to the subject; it revealed that nursing time spent on dressing modifications was 88.5 full-time equivalents over 1 year, while patients' wound-related costs were found to be between 19,000-31,000 bed days per year. Economic figures in the United Kingdom indicate that wound-related costs account for around 4% of all health costs and that ratio is increasing (Gillespie et al., 2014). In the systematic compilation of Umscheid, et al. (2011) performed with hospitals in the United States, according to Ding et al . (2017), 55% of the SSIs can be prevented by current evidence-based recommendations (Umscheid et al., 2011; Ding et al., 2017). Educators trained in wound care taught nurses about new evidence-based wound care practices in a study by Maurya and Mendhe (2014) on the prevention of post-operative wound infection according to evidence-based practice. Before and after the class, the awareness, attitudes and behaviors of nurses in the study were assessed. The awareness, skills and attitude of wound care by nurses was found to be 58.57% while 100% established and that patients were pleased with this practice (Maurya and Mendhe, 2014).

2.9 Role of Nurse in Surgical Site Infections

Prevention and Successful Wound Care Nurses working every day are in a perfect position to take part in initiatives aimed at ensuring the standard of care, thereby increasing patient protection, like SSI prevention, or to become the leader (Teshager, Engeda, Worku, 2015). Nurses should have knowledge of high-quality nursing care, and SSI guidelines based on causes, consequences, management and evidence (Han and Choi-Kwon, 2011; Harrington, 2014; Qasem and Hweidi, 2017). Nurses should be aware of surgical site infections, classifications, risk factors and at-risk populations, signs and symptoms of surgical site infection, prophylactic use of antibiotics, preoperative skin preparations, field treatment for postoperative surgery, guidelines for infection management and strategies for prevention of surgical site infection. In any event, nurses must also protect their patients (Gould, 2012; Yao, Bae, Yew, 2013; Qasem and Hweidi, 2017). For successful wound treatment, nurses need evidence-based guidance. Evidence-based recommendations for clinical practice are an efficient communication tool for health care practitioners and can help them make choices (Han and Choi-Kwon, 2011). Healthcare professionals' preparation will boost the level of awareness, thereby encouraging the adoption of anti-infection recommendations that lead directly to the reduction of health-related infections (Belowska, Panczyk, Gotlib, 2014). A large number of studies have shown, however, that health professionals do not have adequate awareness to avoid surgical site infections, evidence-based guidelines and recommendations are not being correctly enforced, and health professionals need information (El-Sayed, et al., 2015; Teshager, Engeda, Worku, 2015; Qasem and Hweidi, 2017).

In Belgium, Labeau et al. (2010) conducted a study to assess the level of awareness of nurses about evidence-based recommendations for SSI prevention to determine their particular educational needs. They found that male nurses were more informed about the application of the preventive guidelines for SSIs than their female colleagues (Labeau et al., 2010).

Awad (2012) found that in two distinct county hospitals, compliance with SSI prevention guidelines was low. The adherence of clinicians to surgical care kit interventions such as the 'Improvement Initiative for Surgical Care' for SSI prevention was inadequate (Awad, 2012).

Another Australian study found that there was a positive relationship between the number of years of clinical experience and the level of awareness of nurses on SSI prevention (Qasem and Hweidi, 2017).

In a descriptive study conducted by Surme (2014) with 311 nurses working in surgical services to assess the expertise and practice levels of wound healing nurses at the incision site, it was found that half of the nurses do not perform wound healing activities, and more than half of them do not regularly perform wound care discharge training and that nurses need to learn.

The education of the patient, family and friends of the patient is another important issue about efficient wound treatment. In the preoperative and postoperative periods, nurses who offer treatment play an important role in counseling on the risks associated with SSIs and how to treat the infection (Harrington 2014). The NICE (2017) and AWMA (2010) recommendations provide consideration of patient training, which states that nurses should provide patients and caregivers with knowledge and advice in all phases of treatment. The risks of developing SSIs, how to minimize the risks and how to handle SSIs should be covered by information (AWMA, 2010; NICE, 2017). The guidelines propose that clinicians advise the patient and/or their caregivers about the results of the assessment and education that is acceptable for their age and cognitive status (Ding et al., 2017).

Ding et al. (2017) study, which analyzed nursing practices to avoid postoperative wound infections, found that more than one-third of surgical nurses did not use clean gloves properly, one-fifth of nurses did not use sterile gloves properly, more than half of them did not train patients to treat postoperative wounds, and the recommended and enforced wound care practices vary.

In order to ensure optimum patient outcomes, nurses are responsible for ensuring that all SSI requirements are met and that evidence-based guideline principles are implemented (Harrington, 2014). Effective implementation of infection control strategies, in particular SSI prevention measures, and well-structured continuing education programs are seen as a significant element that would improve the awareness of evidence-based recommendations for the prevention of SSIs by nurses and eventually contribute to positive effects on surgical patients admitted to acute care in the sense of patients' qq Hospital administrators and all other relevant parties should therefore continue to emphasize the educational needs of nurses, particularly nurses employed in acute care environments, in order not to compensate for the level of care given in acute care environments (Qasem and Hweidi, 2017).

2.10 Previous studies

2.10.1 Section A: -literature related to incidence and risk factors of surgical site infections

A research on pre-educational intervention in cardiothoracic surgery by healthcare practitioners complying with infection prevention measures was conducted in Malta. The standardized observational approach was used to gather data on infection management activities among surgeons, anesthetists, nurses, cardiopulmonary bypass technicians and orderlies practicing during open heart surgery in the cardiac operating theatre and assessed the 30-day surgical site infection rate among surviving open heart surgery patients by post-discharge telephone surveillance Practices were observed during 30 randomly selected operations and identified higher levels of insufficient practices related to environmental disinfection, hand hygiene, operating room flow, and non-scrubbed workers (anesthesiologists and cardiopulmonary bypass technicians) surgical wear. 140 out of 155 patients who underwent open heart surgery were followed up in total, achieving a 91.5 percent response rate. Superficial and deep Surgical Site Infection rates, for both sternal and harvest site infections, were 16.4% and 4.3% respectively. We found insufficient compliance by non-scrubbed workers engaged in cardiac surgery with infection management procedures and reported a high incidence of infection at the surgical site, the majority being leg wound infections after saphenous vein harvesting (Tartari, et al., 2016).

In Finland, a study was conducted to determine the frequency and risk factors of surgical wound infections (SWI) after infrarenal aortic and lower limb vascular surgery, a cohort of 184 consecutive patients in the study. There have been postoperative complications reported. 84 (46%) patients had critical ischaemia, 81 (45%) patients had infrainguinal bypass surgery, and 64 (35%) received vascular prothesis or prosthetic patch. Forty-nine patients developed surgical wound infections (27%). The leading pathogen cultured from the wound was Staphylococcus aureus. With the treatment, 47 of the 49 infected wounds responded and healed. The causes of one major amputation were surgical wound infections. The study indicated that there is a high incidence of surgical wound infections following vascular surgery (Turtiainen, 2014).

A research on infectious complications following elective vascular surgery was performed in the USA to assess and compare the rates of postoperative infectious complications and deaths following elective vascular surgery. International Classification of Diseases, 9th Clinical Modification (ICD-9-CM) codes were used to classify major vascular procedures in the National Inpatient Study. Pneumonia, urinary tract infections (UTI), postoperative sepsis, and surgical site infections (SSI) were included in the infectious complications reported. Case-mix-adjusted rates for infectious complications or death were estimated using a multivariate logistic regression model as an endpoint and indirect standardization. With an average postoperative infection rate of 3.70%, a total of 870,778 elective vascular surgical procedures were estimated and evaluated. Open abdominal aortic surgery, accompanied by open thoracic operations and aorta-iliac-femoral bypass, had the highest rate of postoperative infections. After open aortic surgery, pneumonia was the most common infectious complication (6.63). There were greater infectious risks in females and blacks. After elective vascular surgery, nosocomial infections dramatically increased the duration of stay in the hospital and overall hospital costs were registered. Infectious complications in the hospital were found to significantly increase the use of health care services. There could be substantial potential cost savings in strategies that reduce nosocomial complications and prioritize high-risk procedures (Vogel, et al., 2010).

In Spain, a study was conducted to determine surgical site infection rates and to evaluate the implementation of protocols for pre-surgical preparation and antimicrobial prophylaxis in 14 public hospitals in the Madrid region. It was a prospective surveillance analysis by Multi-centre. From 1 January 2009 until 31 December 2009, all patients undergoing surgery with a hospital stay of more than 48 hours were tracked from the time of surgery until discharge from the hospital. The most common health care-associated infections were surgical site infections (superficial incisional surgical site infection = 1.7%; deep incisional surgical site infection = 2%; organ-space surgical site infection = 1.7%). Surgical complications, duration of stay, antimicrobial prophylaxis, mortality, readmission due to infection or other complications and revision surgery are additional quality measures reported (Pérez, et al., 2011).

In Brazil, a study was conducted to determine the association between the risk index score for surgical-site infection on the 1st day postoperatively and the development of surgical site infection up to 30 days postoperatively. For the period from June 2007 to August 2008, the patients prospectively followed were those who underwent elective, clean or polluted surgery, conducted through traditional approach at a university hospital. The mean patient age was 55.5 years, 133 (65.5%) were male, 120 (59.1%) underwent clean surgery, and 83 (40.9%) were polluted. The global surgical site infection index was 10.3%; in clean procedures, 10 (8.3%) and in infected ones, 111(3.2%). At the time of hospitalization, four (19.1%) of the surgical site infections were diagnosed, and 17 (80.9%) at post-discharge follow-up. Of the surgical site infections, twelve (57.1%) were superficial, 2 (9.5%) deep and 7 (33.3%) at a particular site. The global index of infections at the surgical site and its occurrence among contaminated procedures are within the limits predicted. On the other side, according to SIRI, both for clean and infected procedures, the surgical site infection indexes are beyond the anticipated standards (Santos, 2017).

2.10.2 Section B: SSI followed cardiac surgery

Abuzaid, et al, (2015) carried out a retrospective analysis on possible risk factors for surgical site infection, found that patients with comorbidities of impaired renal function and/or impaired left ventricular systolic function are at high risk of developing SSI. An association between SSIs in CABG patients and impaired renal or LV function (low fraction of ejection) appears to exist. Even in diabetics, CABG could be safely done with BIMA grafting. Further scrutiny of these and other variables in relation to SSIs in a broader surgical population should be considered in future studies.

Cheng, et al, Research (2015) was carried out in a teaching hospital in China on risk factors for surgical site infection. The study involved 1,138 patients, with findings showing that 38 of the 1,138 patients suffered from SSI, giving an incidence of 3.34%. During hospitalization, thirty-six of the SSI cases occurred and two took place after discharge. Of the 38 cases, 30 were superficial incisional infections, six were deep incisional infections, and six were two infections of the organ / space. Twenty bacterial species, including Escherichia coli, Staphylococcus aureus, and Pseudomonas aeruginosa, have been isolated from the contaminated surgical incision sites.

Da Silva and Barbosa (2012) carried out a study to assess the incidence of surgical site infection (SSI) between July 2005 and July 2010 in patients undergoing cardiac surgery. In a public teaching hospital, the approach was a quantitative, historical cohort analysis that analyzed 384 patients. For data analysis, the Social Sciences Software Statistical Kit was used, and for descriptive analysis, correlation tests were used in contingency tables and logistic regression. The findings showed that 36 (9.4%) patients developed SSI and 14 (38.9%) developed mortality. The prevalent microorganism (12, 27.3%) was Staphylococcus aureus. The risk factors reported as predictors of SSI in the multivariate study were male gender, intubation for more than 24 hours, and reintubation. The study concluded that the risk factors predicting the incidence of SSI ($p<0.05$) for more than 24 hours were: male sex, reintubation, and intubation.

2.10.3 Surgical Site Bundles on cardiac surgery

Schweizer, et al., (2015) conducted a study to determine whether the introduction of an evidence-based bundle in patients undergoing cardiac operations or hip or knee arthroplasty is correlated with a lower risk of S aureus SSIs. Patients whose preoperative narrowing screens were positive for methicillin-resistant S aureus (MRSA) or methicillin-susceptible S aureus (MSSA) were asked to take up to 5 days of intranasal mupirocin twice daily and to bathe with chlorhexidine gluconate (CHG) daily for up to 5 days prior to surgery. For perioperative prophylaxis, the MRSA carriers received vancomycin and cefazolin or cefuroxime; all the others received cefazolin or cefuroxime. The night before and morning after surgery, patients who were MRSA-negative and MSSA-negative bathed with CHG. If screening outcomes were uncertain, patients were treated as MRSA-positive. The results showed that package adherence was 83% (39% absolute adhesion; 44% partial adherence) after a 3-month phase-in duration. Overall, 101 complex S aureus SSIs occurred during the pre-intervention period after 28,218 operations, and 29 occurred during the intervention period after 14,316 operations (mean rate per 10,000 operations, 36 for pre-intervention period vs 21 for intervention period, difference, -15 [95 % CI, -35 to -2]; rate ratio [RR], 0.58 [95 % CI, 0.37 to 0.92]). For hip or knee arthroplasty (difference per 10 000 operations, −17 [95 % CI, −39 to 0]; RR, 0.48 [95 % CI, 0.29 to 0.80]) and for cardiac operations (difference per 10 000 operations, −6 [95 % CI, −48 to 8]; RR, 0.86 [95 % CI, 0.47 to 1.57]), the rates of complex S aureus SSIs decreased. The study conclude that In this multicenter study, a bundle comprising *S aureus* screening, decolonization, and targeted prophylaxis was associated with a modest, statistically significant decrease in complex *S aureus* SSIs.

Crolla, et al., (2012) performed a prospective, quasi-experimental, cohort study aimed at introducing a package of vascular surgery treatment and evaluating the impact on the rates of overall and deep-SSI. From 2009 to 2011, vascular surgery was carried out at the Amphia hospital in Breda. In total, during the study period, 720 vascular procedures were performed and 75 (10.4%) SSI were observed. In 25 (3.5%) patients, deep SSI occurred. The hospital stay after surgery was substantially longer in patients with SSI (28.5±29.3 vs 10.8±11.3, $p<0.001$) and deep-SSI (48.3±39.4 vs 11.4±11.8, $p<0.001$) than in patients without an infection. In patients who developed deep SSI, substantially higher mortality was observed (Adjusted OR: 2.96; 95% confidence interval 1.32-6.63). Multivariate analysis showed a significant and independent decrease of the SSI-rate over time that paralleled the introduction of the bundle. The SSI-rate was 51% lower in 2011 compared to 2009. The implementation of the bundle was associated with improved compliance over time and a 51%

reduction of the SSI-rate in vascular procedures. The bundle did not require expensive or potentially harmful interventions and is therefore an important tool to improve patient safety and reduce SSI's in patients undergoing vascular surgery.

Gillespie, et al., (2015) published a study to define and explain the techniques and procedures used to minimize surgical site infections (SSIs) by multidisciplinary teams of health care professionals. An integrative study of the literature of the research was conducted. In April 2015, searches were performed. Data were abstracted using summary tables after review of the included studies and the methodological quality of each study was evaluated by two reviewers using the Criteria for Quality Assurance Reporting Excellence Guidelines. Discrepancies have been resolved by consensus. The techniques used by multidisciplinary health care teams to prevent SSI were identified and explained using inductive content analysis. The findings showed that 13 studies met the requirements for inclusion in total. In these, 12 studies used quantitative approaches, while qualitative interviews were used in a single sample. The majority of the studies were conducted in North America. All quantitative studies evaluated multifaceted quality-improvement interventions aimed at preventing SSI in patients undergoing surgery. Across the 13 studies reviewed, the following multidisciplinary team-based approaches were enacted: using a bundled approach, sharing responsibility, and, adhering to best practice. The majority of studies described team collaborations that were circumscribed by role. None of the reviewed studies used strategies that included the input of allied health professionals or patient participation in SSI prevention.

Wassef et al . (2020) conducted a study in the urgent surgical intensive care unit of the Emergency Hospital of Cairo University to test a bundle-based approach to minimizing SSI. The research was performed between March 2018 and February 2019 and used risk assessment. The findings showed that Phase I contained 177 patients, while 93 patients were included in Phase III. A substantial decrease in colonization was observed, from 24% to 15% ($p < 0.001$). Similarly, a decrease in SSI from 27% to 15% was observed ($p=0.02$). In the implementation of the package, a logistic regression was conducted to compensate for confounding and we observed a 70% decrease in the SSI odd's ratio (OR ratio = 0.3) confidence interval (95% CI 0.14 – 0.6) with substantial Apache II ($p = 0.04$), wound type; type II ($p = 0.002$), type III ($p = 0.001$) and surgery length ($p = 0.04$) as independent risk factors for SSI. Klebsiella pneumoniae was the most prevalent organism during phase I (34.7%). On the other hand, A. baumannii was the commonest organism to be isolated during phase III with (38.5%) preceding K. pneumoniae (30%). The study concluded that the implementation of a multidisciplinary bundle containing evidence-based interventions was associated with a significant reduction of colonization and SSIs and was met with staff approval and acceptable compliance.

2.11 Conclusion of literature review

Surgical care bundles are made up of a group of evidence-based practice interventions which when performed together can have a positive outcome on patient care. The ACORN Standards for Perioperative Nursing in Australia outline practices that should be adhered to in Australia; however, practices can be further refined clinically to ensure best practice. Surgical site infection is one of the most preventable causes of hospital-acquired infections in Australia. Research suggests that care bundles implemented by the perioperative team can reduce the incidence of such infections while also offering additional benefits.Surgical site infection intervention bundles can support nurses in their evidence-based practice, contribute to continuing professional development and encourage communication and teamwork. Bundles are simple to implement, can be individualised to each facility and can support culture change using a scale-up approach with long-term benefits for the health care organisation.

Chapter Three

The Method

3.1 Study design

Quasi-experimental research design method was used including retrospective analysis incidence and SSI followed cardiac surgery and prospective Quasi-experimental implementing of Surgical Site Bundles approach compared with routine care in retrospective assess at governmental and private Hospitals in West Bank. Within this study, patients classified into two groups— experiment group with implemented bundles groups and control group retrospective patient with routine care without care bundles.

3.2 Study population

Patients who had underwent cardiac surgery invited to enroll in the study during the study period. Patients underwent cardiac surgery were usually admitted a few days before the surgical procedure for completion of physical and laboratory examinations to determine whether cardiac surgery was needed.

3.3 Sample size

A total of 222 cardiac surgery patients included in this study in which 110 for control and 112 for experimental

3.4 Inclusion criteria

All patients underwent cardiac surgery are eligible to participate above 18 years.

1.5 exclusion criteria

- patients underwent cardiac surgery under 18 years.

- laparoscopic cardiac surgery

3.6 Setting of the study

The study was conducted in 3 districts in West Bank – Palestine including Jerusalem, Ramallah, Hebron. The included hospital was

Al-Makased Sociaty Hospital in Jerusalem

East Jerusalem operates under the auspices of the Makassed Islamic Charitable Society. Founded in 1968 and starting as a 60-bed unit, the Hospital has expanded during its life to its current size, licensed for 250 beds. It is one of the main referral hospitals for the Palestinian community of Jerusalem, West Bank, and Gaza Strip providing a range of specialties.

Palestine Medical complex (PMC)– Governmental hospital in Ramallah

The PMC includes 214 beds. It provides a wide range of services, including neonatal care, maternity care, internal medicine, pediatrics, general surgery, and cardiovascular surgery.

Al-Ahli Hospital in Hebron district

Al-Ahli Hospital operates with a capacity of 250 beds that can be easily raised to 500 beds in emergency cases. Al-Ahli Hospital currently employs more than (600) male and female employees in all its medical, auxiliary and administrative departments.

Al-Ahli Hospital contains all the medical and auxiliary departments, as well as facilities, medical departments and other devices such as the unit for treating electrical heart problems, cerebral catheters, and the only unit licensed in Palestine for nuclear medicine.

The hospital includes several departments: ambulance and emergency, outpatient clinics, operations, surgery, obstetrics and gynecology, prematurity, children, internal diseases, intensive care, daily cases, lithotripsy departments, teeth, nuclear medicine, radiology, pharmacy, laboratory and blood bank, Physiotherapy, sterilization.

3.7 Field work

3.7.1 For retrospective sample

The study participant who was underwent cardiovascular surgery, a researcher started to collect data from patients' files including his or her risk factors, demographic data, occurrence of SSI, and selected data according to data collection sheet.

3.7.2 For prospective sample

The researcher make training for nurses in each intensive cardiac care unit in selected hospitals to collect the data from participants.

After the study participant admitted to the cardiovascular surgery units prior to cardiac surgery, a trained nurse started to apply Surgical Site Bundles including Surgical Site Bundles (Annex 1) then collect data on the risk factors. The trained nurses then continued to collect data throughout hospitalization period from the patients.

Sternal SSI was defined according to the SSI criteria of the US Centers for Disease Control and Prevention (2009). Infection occurs within 30 days after surgery and can include the following types: 1) superficial incisional (infection above the sternum with no bony involvement);2) deep incisional (infection involving the sternum); and3) organ/space (site-specific infection, such as mediastinitis).

Leg SSI was defined as redness, swelling, increased pain, excessive bleeding, or discharge at the incision site among the patients who had undergone coronary artery bypass grafting. All SSI cases were diagnosed by attending physicians and confirmed by the nosocomial infection control committee. Patients who did not have any SSI formed the control group.

3.7.3 Time of study

The study conducted between June to December 2019

From June to September for retrospective group (control group)

From October to December for prospective (Experiment group)

3.8 Tools of the study

A seven-step strategy was designed and included in the Care Bundles:

#1 Safe Operating Room

- Traffic management, number of staff in-room
- Systems for air handling, ventilation, grills
- SCIP: hair cutting, skin warmers, oxygenation.
- Therapeutic prophylaxis, removal of the foley catheter within 48 hours
- turnover Between case room and regular terminal cleaning
- Surgical procedure and tissue handling, use of wound protector / retractor to avoid contamination of the field
- Method for instrument cleaning / sterilization, biological indicators
- Supply storage, clean supply containers, carts, tables, stationary devices

#2 Screening for MRSA and MSSA

Staph aureus SSIs are more likely to occur in patients who hold Staph aureus and MRSA in their nostrils or on their skin.

- An important tool for Staph aureus eradication is short-term nasal mupirocin (4-7 days)
- 90% efficiency in one week
- 1% develop resistance to mupirocin

#3 Shower pre-op

Research shows that frequent use of CHG soap improves CHG 's capacity before surgery to minimize bacterial counts on the skin. Patients should be advised to use either CHG solution or CHG wash cloths to clean the body the night before and morning of the operation.

#4 Skin prep – dual combined antiseptics

Two types of preoperative skin preparations combining alcohol (which has an immediate and significant killing effect on skin pathogens) with long-acting antimicrobial agents seem to be more efficient than povidone-iodine (iodophor) alone in preventing SSI:

- Alcohol plus chlorhexidine
- Iodophor mixed with alcohol

 # 5 Antimicrobial

- Like all foreign objects, bacteria will colonize sutures:
- Implants include bacteria nidus for attachment.
- Bacterial colonization can lead to the formation of biofilms
- On an implant, such as a suture, it takes just 100 staphylococci per gram of tissue for an SSI to grow.
- Biofilm formation increases the difficulty of treating an infection.

#6 Solution to pollution is dilution

Latest CHG surgical follows American College of Emergency Physicians (ACEP) volume and pressure requirements for wound irrigation. Splatter Guard Patented protects healthcare staff, patients and the environment from contamination by biohazards. Chlorhexidine Gluconate has shown antimicrobial efficacy and persistence in laboratory testing at a low concentration of 0.05%. In compound fractures and tissues, the mechanical action loosens and eliminates wound debris efficiently. FDA-approved to be Safe for mucous membranes.

#7 Skin adhesive or antimicrobial gauze dressings

Wounds in the first 48-72 hours are more vulnerable to infection. 1 until the epithelial barrier is complete (commonly around 48 hours), to preserve integrity, wounds are solely reliant on the wound closure unit. The level of microbial protection depends on the integrity of the barrier. 1 For the first 48 hours, effective barriers must preserve their integrity. A strong microbial barrier that prevents bacteria from entering the incision site is provided by the incisional adhesive.

Seven days of power for wound healing in less than one minute of application

Immediately wash • Wash

• Outstanding cosmesis

• Reduced follow-up

Less pain and anxiety Antimicrobial dressings Antimicrobial dressings are wound covers that produce the effects of agents to maintain efficacy against common infectious bacteria, such as silver and polyhexamethylene biguanide (PHMB). Indicated to help minimize the risk of infection, over percutaneous line sites and surgical incisions, in partial and full thickness wounds.

3.8.1 Risk factors (Questionnaire)

Potential risk factors for sternal SSI classified into two groups according to stage (preoperative, and postoperative). Preoperative potential risk factors

included demographic factors (age, gender, weight, height, body mass index, and smoking) (table 1) and factors pertaining to medical history (diabetes, hypertension, use of antibiotics, chronic obstructive pulmonary disease, peripheral arterial occlusive disease, previous cardiac surgery, and obesity (body mass index)).

Post hospitalization parameters included Length of hospital stay before the operation including Length of hospital stay post the operation, Admission to ICU before surgery, Length of time in ICU before surgery, Duration of intubation, Re-intubation, and Use of steroids.

3.8.2 Postoperative potential risk factors included

duration of intermittent positive pressure ventilation and length of stay in the ICU after cardiac surgery

Study variables

Control variable

Use of surgical care bundle

Dependent variables

Occurrence of SSI

Severity of SSI

Pathogenesis of SSI

Independent variables

Past medical History

Demographic variables

Type of surgery

Duration of surgery

Vital signs and lab test

3.9 Validity

Content validity of the questionnaire for verifying the validity of the tool and knowing if the questionnaire with its sections really measures what they were designed to, for this study the questionnaire items generated from previous studies then its presented to 3 arbitrators having PhD, the items adopted after being accepted by arbitrators, and as well as acceptance of the modifications made by the researcher on the questionnaire.

3.10 Ethical consideration:

Ethics refers to a system of moral values that is concerned with the degree to which research procedures adhere to professional, legal and social obligations to the study participants (Polit & Beck 2018). To ensure that ethical issues were taken into consideration, various steps will follow by the researcher.

The researcher is cognisant that the issue of research is a sensitive and private matter and as such will has an ethical responsibility to adhere to key ethical principles such as respect, informed consent, beneficence, non-maleficence, veracity and justice, explain to the nurse, IRB.

Before commencement of data collection, approval for this study obtained from the institutional review board (IRB).

No participation risks were identified for this study.

3.11 Data analysis:

The survey collected data analyzed by (statistical package for the social sciences (SPSS) and entering the data in the program.

The description and correlation statistics used to analyze the collected data.

1. Frequencies and percentages.
2. Mean and Standard Deviation.
3. Pearson chi square.
4. chronbach alpha coefficient.
5. Crosstabulation

Chapter Four

The Results

4.1 Introduction

In this chapter the results of the thesis are presented as an answer for research questions that investigate the effectiveness of utilization of Surgical Site Infection Bundle (SSIB) in reducing the post-operative open-heart surgery wound infection occurrence.

The demographic and other characteristics of patient underwent open heart surgery is presented first then these variables are presented for each one of the two groups to decide if they are comparable.

Univariate statistical analysis followed by multivariate analysis to figure out the effectiveness and predictors of these factors on the SSI occurrence.

4.2 Demographic, medical history, and characteristics of open-heart surgery in Palestine

As seen in table 1, nearly half of subjects were involved in the SSI bundle group (112, 50.2%), 70% underwent CABG, and most of them (90.5%) aged above 45 years as seen in figure 1. Furthermore, male was prevailing (70.3%), and 45% of them either overweight or obese. For more details see table1 and figure 1.

Table 1: Demographic of patients undergoing coronary artery bypass graft (CABG) procedures, 2017-2018

		Frequency	Percent
Group	**1.00**	110	49.5
	2.00	112	50.5
Type of surgery/surgical procedure	**CABG**	157	70.7
	MVR/ AVR/both	55	24.8
	CABG+valve	7	3.2
Age (years)	**18-25**	1	0.5
	26-34	5	2.3
	43-44	15	6.8
	45-54	66	29.7
	55-64	92	41.4
	>65	43	19.4
Gender	**Male**	156	70.3
	Female	66	29.7
BMI	**<18.4**	4	1.8
	18.5-24.9	118	53.2
	>25	100	45.0

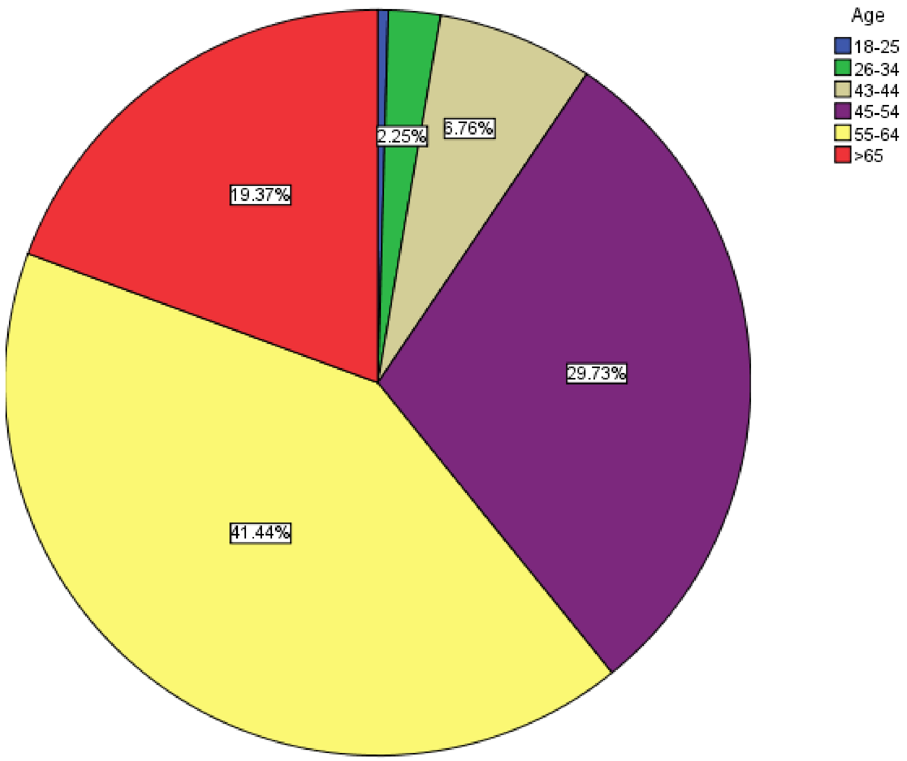

Figure 1: distribution of participants according to their age.

Hypertension was the higher prevalent (72.5%) chronic disease among open heart surgery in Palestine followed by diabetes mellitus (30.6%). On the other hand, few patients had Chronic Respiratory disease (9.5%), renal failure (4.5%), hypercholesterolemia (4.5%), Previous CABG surgery (4.1%), congestive heart failure (0.9%), and peripheral vascular disease (0.5%). For more details see table 2.

Table 2: past medical history of patients undergoing coronary artery bypass graft (CABG) procedures, 2017-2018.

		Frequency	Percent
Hypertension	**No**	61	27.5
	Yes	161	72.5
Diabetic	**No**	154	69.4
	Yes	68	30.6
Renal Failure	**No**	212	95.5
	Yes	10	4.5
Chronic Respiratory disease	**None**	201	90.5
	COPD	14	6.3
	Asthma	7	3.2
congestive heart failure	**No**	220	99.1
	Yes	2	0.9
Hypercholesterolemia	**No**	212	95.5
	Yes	10	4.5
peripheral vascular disease	**No**	221	99.5
	Yes	1	.5
Previous CABG surgery	**No**	213	95.9
	Yes	9	4.1

Only one patient had history of alcohol consumption but, unfortunately, 43.7 % of patients were smoker. Most of patients (80.6%) were admitted 1 to 3 days to before surgery and 61.7% of them stayed 8-15 days post-surgery. Regarding ETT, most of them (86.5%) of them intubated either to more than 24 hours (12.6%) or less than 24 hours (74.8%) and few patients (2.7%) were re intubated and 5.4% were given steroid. For more details see table 3.

Table 3 clinical characteristics of patients undergoing coronary artery bypass graft (CABG) procedures, 2017-2018

		Frequency	Percent
Alcohol	**No**	221	99.5
	Yes	1	.5
Smoking	**No**	125	56.3
	Yes	97	43.7
Length of hospital stay before the operation	**1-3 Days**	179	80.6
	4-7 days	29	13.1
	8-15 days	14	6.3
Length of hospital stay post the operation	**1-7 Days**	71	32.0
	8-15 days	137	61.7
	15-20 days	11	5.0
	More 20 days	3	1.4
Admission to the ICU before surgery	**No**	10	4.8
	Yes	212	95.5
Length of time in the ICU before surgery	**.00**	10	4.5
	1-3 Days	172	77.5
	4-7 days	34	15.3
	8-15 days	6	2.7
Patient on ETT	**NO**	29	13.1
	YES	192	86.5
Duration of intubation	**.00**	27	12.2
	< 24 hours	166	74.8
	> 24 hours	28	12.6
Reintubation	**NO**	216	97.3
	YES	6	2.7
	Total	210	100.0
Use of steroids	**No**	210	94.6
	Yes	12	5.4

4.3 Comparison between the two groups (conventional and SSI bundle) regarding their demographic, medical history, and characteristics:

Both groups (conventional and SSI bundle) were comparable regarding all demographic and medical history except BMI. There were no statistically significant differences between the two groups regarding their age and gender (p= 0.34 & 0.61 respectively). Unfortunately, there was a statistically significant difference (P= 0.028) between the two groups regarding their BMI. Furthermore, there were no statistically significant differences between the two groups regarding their history of hypertension, diabetes, and renal failure (*p*= 0.50 & 0.33, 0.97 respectively).

Table 4 comparison between groups regarding demographic and past medical history

		Group		
		Conventional	**SSI bundle**	
		n (%)	**n (%)**	**Sig.**
Age	**18-25**	0(.0%)	1(0.9%)	0.24
	26-34	0(.0%)	5(4.5%)	
	43-44	8(7.3%)	8(7.1%)	
	45-54	33(30.0)	33(29.5%)	
	55-64	45(40.9%)	47(42.0%)	
	>65	24(21.8%)	19(17.0%)	
Gender	**Male**	79(71.8%)	77(68.8%)	0.61
	Female	31(28.2%)	35(31.2%)	
BMI	**<18.4**	3(2.7%)	1(0.9%)	0.028
	18.5-24.9	67(60.9%)	51(45.5%)	
	>25	40(36.4%)	60(53.6%)	
Hypertension	**No**	28(25.5%)	33(29.5%)	0.50
	Yes	82(74.5%)	79(70.5%)	
Diabetic	**No**	73(66.4%)	81(72.3%)	0.33
	Yes	37(33.6%)	31(27.7%)	
Renal Failure	**No**	105(95.5%)	107(95.5%)	0.97
	Yes	5(4.5%)	5(4.5%)	

Although there was a statistically significant difference between the two groups regarding their BMI, the BMI and age were approximately the same between male and female as seen in figure 2.

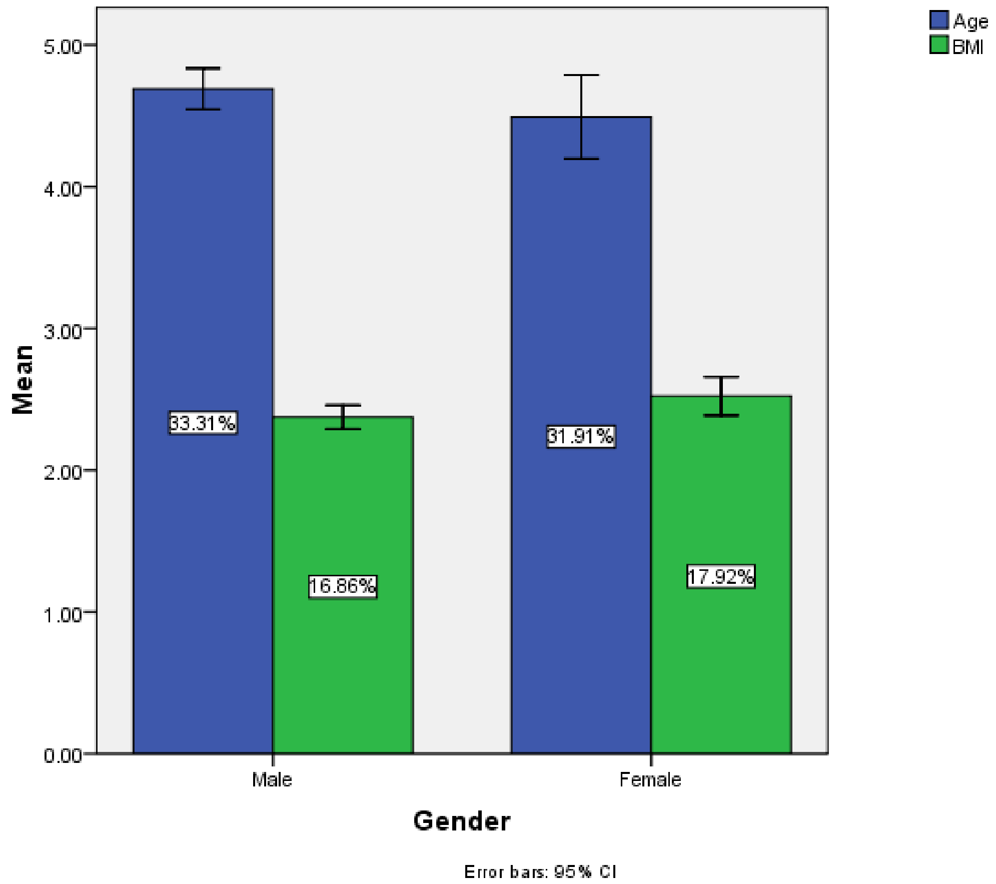

Figure 2: distribution of BMI and age according to gender**.**

Although there was a statistically significant difference between the two groups regarding their history of hypertension, both male and female were approximately the same regarding their history of hypertension, diabetes, renal failure, chronic respiratory disease, and congestive heart failure as seen in figure 3.

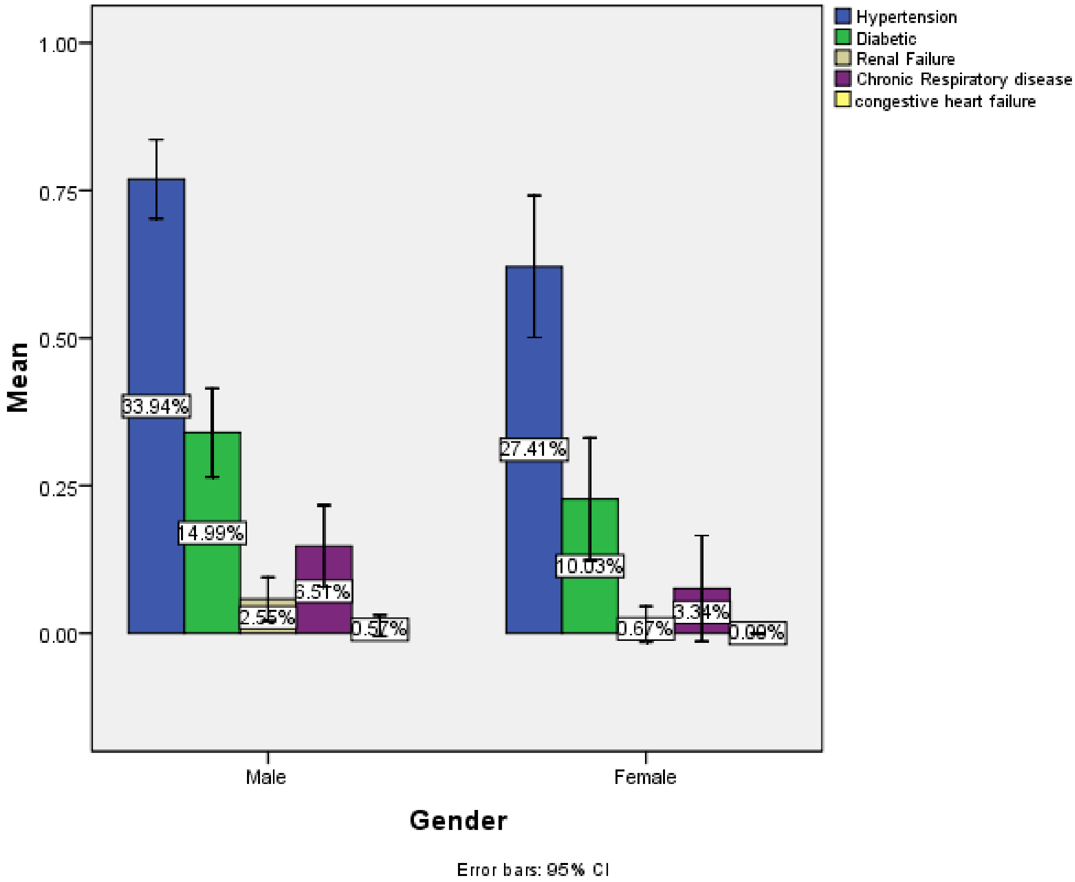

Figure 3: distribution of history of hypertension, diabetes, renal failure, chronic respiratory disease, and congestive heart failure according to participants' gender.

4.4 Surgical site infection description:

Both participants' who developed SSI and who did not were approximately the same regarding their history of hypertension, diabetes, renal failure, chronic respiratory disease, and congestive heart failure as seen in figure 4.

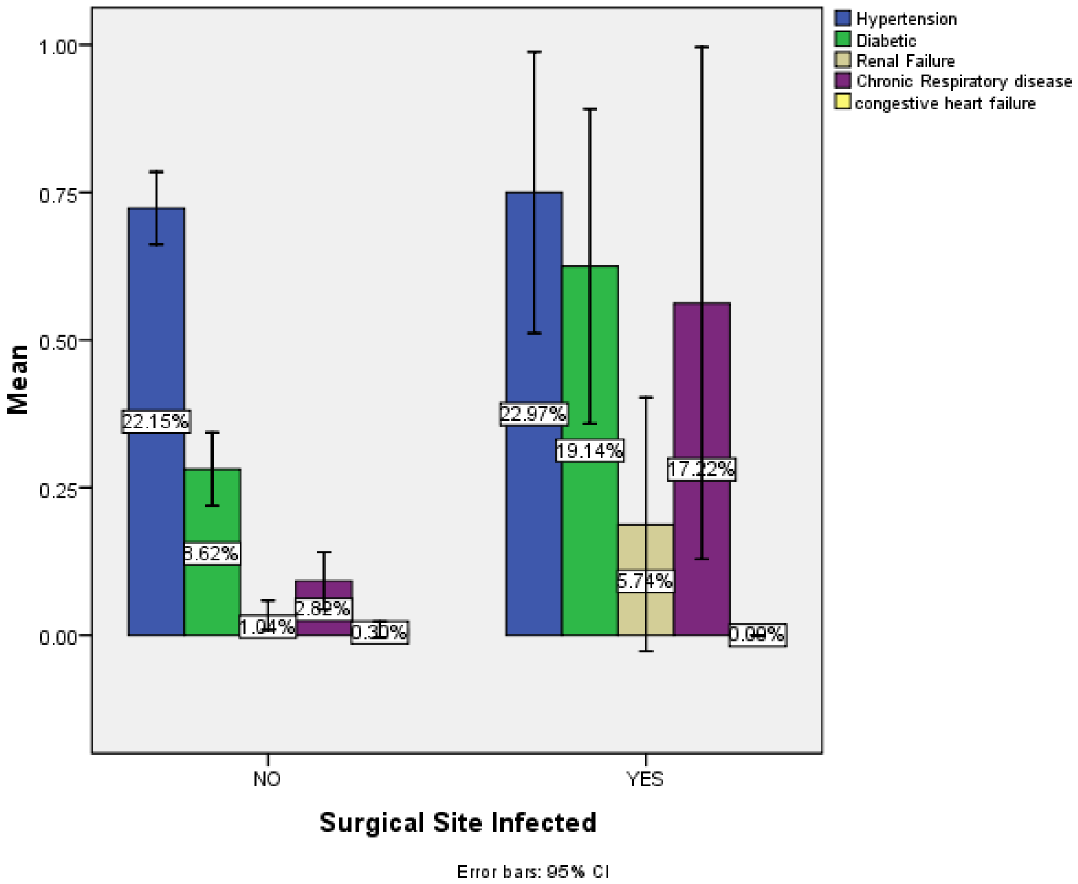

Figure 4: distribution of history of hypertension, diabetes, renal failure, chronic respiratory disease, and congestive heart failure according to SSI development**.**

Out of 222 participants, 16 (7.2%) developed SSI. The incidence of SSI was higher among conventional group compared with SSI bundle group (10.9% vs. 3.6%). Most of SSI was superficial and developed in sterna incision and just two cases developed SSI in the leg and 5 cases developed deep incisional in the conventional group. Furthermore, Klebsila Pneumonia, MRSA, and Enterbacter Coccai were the most common type of bacteria in conventional group followed by Staph Aureus while in the SSI bundle group, the MRSA, Enterbacter Coccai, Staph Aureus, and A-Hemolytic Strep were the SSI type of bacteria. There were statistically significant differences between Surgical Site Infected, Type of infection, and Microbiological culture (p = 0.035, 0.043, 0.035 respectively)

Table 5: comparison between groups regarding surgical site infection

			Group		
		Total	**Conventional**	**SSI bundle**	
		n (%)	**n (%)**	**n (%)**	**Sig.**
Surgical Site Infected	No	206 (92.8)	98(89.1%)	108(96.4%)	0.035
	Yes	16 (7.2)	12(10.9%)	4(3.6%)	
Infection Site	None	206 (92.8)	98(89.1%)	108(96.4%)	0.080
	Sternal	14 (6.3)	10(9.1%)	4(3.6%)	
	Leg	2 (.9)	2(1.8%)	0(.0%)	
Type of infection	None	206 (92.8)	98(89.1%)	108(96.4%)	0.043
	Superficial	11 (5.0)	7(6.4%)	4(3.6%)	
	Deep Incisional	5 (2.3)	5(4.5%)	0(.0%)	
Microbiological culture	No	206 (92.8)	98(89.1%)	108(96.4%)	0.035
	Yes	16 (7.2)	12(10.9%)	4(3.6%)	
Name of bacteria	None	206 (92.8)	98(89.1%)	108(96.4%)	0.168
	Klebsila Pneumonia	4 (1.8)	4(3.6%)	0(.0%)	
	Staph Aureus	3 (1.4)	2(1.8%)	1(.9%)	
	MRSA	4 (1.8)	3(2.7%)	1(.9%)	
	Enterbacter Coccai	4 (1.8)	3(2.7%)	1(.9%)	
	A-Hemolytic Strep	1 (.5)	0(.0%)	1(.9%)	

There were statistically significant differences in the level of glucose between those who developed SSI and those who did not at the three time points (admission, day 1post operative, and discharge day). Those patients who developed SSI had higher mean level of glucose at the three time points (admission [p= 0.043], post-operative day 1[p= 0.001], and discharge [p= 0.001]). For more details see table 6 and figure 5.

Table 6: comparison between groups regarding the relation between the surgical site infection and patients' sugar level during admission, post op day 1, and discharge .

Time	Surgical Site Infected	N	Mean	Std. Deviation	Sig.
Admission	No	74	197.93	77.8	0.043
	Yes	12	247.75	79.1	
Post op 1	No	74	143.95	41.4	0.001
	Yes	12	226.25	68.8	
Discharge	No	73	144.19	51.1	0.001
	Yes	12	202.00	55.6	

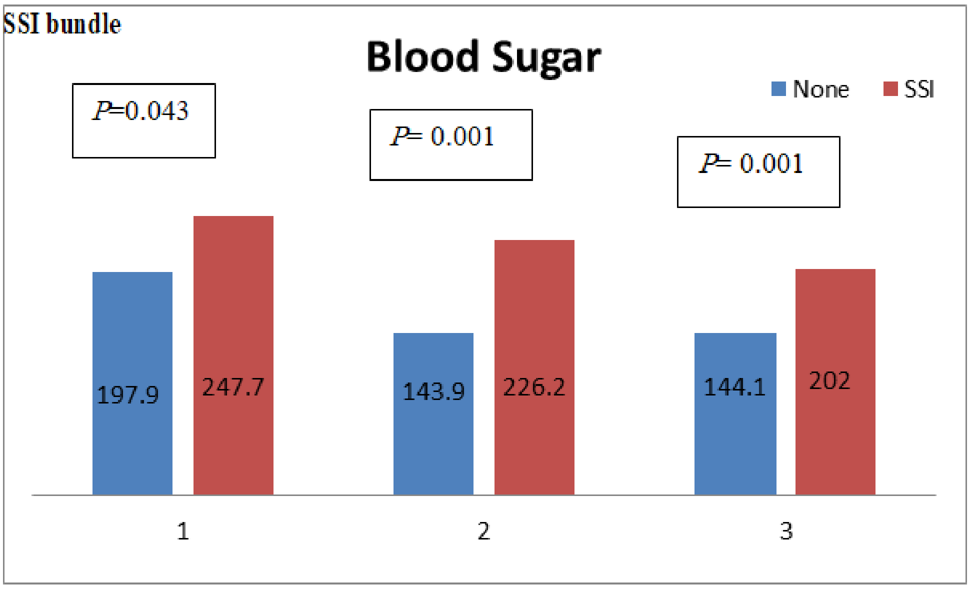

Figure 5: surgical site infection and patients' sugar level during admission (1), day 1post op (2), and discharge day (3).

The length of stay post-operative, intubation, and the length period of intubation were the variables that had statistically significant difference between conventional and SSI bundle group. The latter group had a higher post-operative period and a higher period of intubation. On the other hand, other variables were not statistically significant between the two groups.

Length of stay before operation, admission to ICU, length of stay in ICU, and the use of steroids were the same in both groups. For more details see table 7.

Table 7 cross tabulation comparison between groups regarding their pre and post-operative periods

		Group			
Variables		**Conventional**	**SSI bundle**	**Total**	**Sig.**
Length of hospital stay before the operation	1-3 Days	92(83.6%)	87(77.7%)	179(80.6%)	0.20
	4-7 Days	10(9.1%)	19(17.0%)	29(13.1%)	
	8-15 Days	8(7.3%)	6(5.4%)	14(6.3%)	
Length of hospital stay post the operation	1-7 Days	50(45.5%)	21(18.8%)	71(32.0%)	
	8-15 Days	54(49.1%)	83(74.1%)	137(61.7%)	<0.001
	15-20 Days	5(4.5%)	6(5.4%)	11(5.0%)	
	> 20 Days	1(.9%)	2(1.8%)	3(1.4%)	
Admission to ICU before surgery	None	6(5.5%)	4(3.6%)	10(4.5%)	0.49
	Yes	104(94.5%)	108(96.4%)	212(95.5%)	
Length of time in ICU before surgery	None	6(5.5%)	4(3.6%)	10(4.5%)	0.22
	1-3 Days	89(80.9%)	83(74.1%)	172(77.5%)	
	4-7 Days	14(12.7%)	20(17.9%)	34(30.6%)	
	8-15 Days	1 (.9%)	5(4.5%)	6(5.4%)	
Pt on ETT	No	24(22.0%)	5(4.5%)	29(13.1%)	<0.001
	Yes	85(78.0%)	107(95.5%)	192(86.9%)	
Duration of intubation	None	22(20.2%)	5(4.5%)	27(12.2%)	0.001
	< 24 Hours	76(69.7%)	90(80.4%)	166(75.1%)	
	> 24 Hours	11(10.1%)	17(15.2%)	28(12.7%)	
Re-intubation	No	107(97.3%)	109(97.3%)	216(97.3%)	0.98
	Yes	3(2.7%)	3(2.7%)	6(2.7%)	
Use of steroids	No	105(95.5%)	105(93.8%)	210(94.6%)	0.57
	Yes	5(4.5%)	7(6.2%)	12(5.4%)	

The statistically significant predictors of SSI were group, BMI, and history of respiratory chronic disease. Participants in the conventional group, with high BMI, and having respiratory chronic disease were at a higher risk of developing surgical site wound comparing with participants in SSI bundle group, normal BMI, or did not have any respiratory chronic disease. Participant in SSI bundle group had 0.21 less risk to develop SSI compare with conventional group. Overweight and obese participant had a 5.7 higher risk than normal weight participants to develop SSI. Participants with chronic respiratory disease had a 6.9 higher risk to develop SSI than those without history of respiratory disease.

Furthermore, although the age, gender, diabetes, and chronic renal failure had no statistically significant, but all had a risk on developing SSI. Elderly people participants had 1.5 higher risks compare with younger participants. Participants with history of hypertension, diabetes, and chronic renal failure had a higher risk to develop SSI than those who had not (2.6 and 6.8). Finally, participants with history of hypertension had a 0.59 lower risk than those who did not have.

Table 8: The statistically significant predictors of SSI

					95.0% C.I. for EXP(B)	
Variables	**B**	**Wald**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
Group	-1.527	4.804	.028	.217	.055	.851
Age	.440	1.022	.312	1.552	.662	3.639
Gender	-.179	.065	.798	.837	.213	3.292
BMI	1.746	6.322	.012	5.733	1.470	22.362
Hypertension	-.514	.440	.507	.598	.131	2.728
Diabetic	.960	2.025	.155	2.612	.696	9.803
RF	1.923	2.891	.089	6.843	.746	62.815
CRD	1.943	11.797	.001	6.982	2.303	21.166
CHF	-21.776	.000	.999	.000	.000	.

Group: conventional vs intervention, **BMI**: body mass index, **RF**: renal failure, **CRD**: chronic respiratory disease, **CHF**: congestive heart failure.

The pre- and post-operative length of stay were statistically significant predictors of SSI. The higher the length of stay in hospital pre-operative and the higher the length of stay post-operative, the higher the risk of participants to develop SSI. Admission to ICU pre-operative was statistically significant (p=0.011) predictor of SSI occurrence. Steroid was also statistically significant (p=0.001) predictor of SSI occurrence. On contrast ETT was not statistically significant (p=0.86) predictor but increase the risk by 1.2 of SSI occurrence.

					95.0% C.I. for EXP(B)	
Variables	**B**	**Wald**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
Pre LOS	2.768	4.820	.028	15.921	1.346	188.343
Post-op LOS	3.905	20.409	.000	49.652	9.123	270.225
ICU pre-op	14.175	6.427	.011	1.432E	24.929	8.228E10
ETT	.246	.030	.862	1.279	.080	20.475
Steroids	3.411	13.845	.000	30.290	5.024	182.621
Constant	-21.067	16.555	.000	.000		

Pre LOS: pre operation length of stay in hospital, **post-op LOS**: post operation length of stay, **ICU pre-op**: pre operation length of stay in ICU, **ETT**: endotracheal tube.

Glucose level at admission and on the first day post-operative was statistically significant (p=0.022 & 0.008 respectively) predictor of SSI occurrence. On contrast, glucose level at discharge day post-operative was not statistically significant (p=0.20) predictor of SSI occurrence. Operative status, surgery duration, and blood transfusions had no statistically significant, but all had a risk on developing SSI (9.3, 4.6, and 2.4 respectively). Both bypass time and clamp time neither had statistically significant nor risk on developing SSI

					95.0% C.I. for EXP(B)	
Variables	**B**	**Wald**	**Sig.**	**Exp(B)**	**Lower**	**Upper**
Admission RBS	-.053	5.253	.022	.949	.907	.992
post op day 1RBS	.083	7.035	.008	1.087	1.022	1.155
Discharge RBS	.012	1.579	.209	1.013	.993	1.032
Operative Status	2.234	2.026	.155	9.336	.431	202.34
Surgery Duration	1.539	1.433	.231	4.661	.375	57.938
Bypass Time	.055	2.129	.145	1.056	.981	1.136
Clamp Time	.018	.185	.667	1.018	.938	1.104
Blood Transfusions	.879	.425	.514	2.408	.172	33.782
Constant	-20.979	7.984	.005	.000		

Chapter Five

The Discussion

5.1 introduction

This chapter explains the key results and the discussion in terms of goals and hypotheses, and contrasts are made with other results of the analysis. The findings of the report have been drawn and their implications for nursing and health care have been clarified. During the study period, the limitations encountered are presented. The chapter concludes with proposals and recommendations for future field studies.

As care bundle contain a group of best practice procedures, it would be assumed that several components of a bundle would already be standard practice in perioperative care (such as effective and timely antibiotic prophylaxis or preservation of normothermia). As a result, all studies evaluating care bundles, especially cohort studies with historical controls, should include compliance data for pre- and post-bundle implementation interventions so that compliance with the bundle in full can be evaluated.

Having too many elements in a care bundle can present an inherent weakness in its execution and the ability to comply. Likewise, as the DH HII SSI care bundle is distributed over pre, intra and postoperative phases, many clinical teams are involved, which may also restrict compliance and efficacy. The bundle could not be broken down into its constituent parts.

The need to include composite compliance data is also illustrated in this report. The Institute for Healthcare Improvement notes that it is based on the clear and systematic implementation of all elements in a package to effectively execute a bundle. This was seen in a report on the implementation of a VAP bundle that produced a substantial reduction in VAP that was not produced with earlier ad hoc recommendations for VAP prevention (Morris, et al., 2011). Therefore, compliance with the complete bundle and SSI rates for patients who have received the entire bundle must be recorded.

5.2 Demographic characteristics

Results showed in (Table 1) that 70% underwent CABG, and most of them (90.5%) aged above 45 years as seen in figure 1. Furthermore, male were prevailing (70.3%), and 45% of them either overweight or obese. This consistent with study of Wang, et al., (2014) in which 88.8% of patients under went cardiac surgery where age above 50 years old, and 73% of them under went CABG, and male 75.8% of them were male and mean of BMI was 29.6.

5.3 Patients history

In our study Hypertension was the higher prevalent (72.5%) chronic disease among open heart surgery in Palestine followed by diabetes mellitus (30.6%). On the other hand, few patients had Chronic Respiratory disease (9.5%), renal failure (4.5%), hypercholesterolemia (4.5%), Previous CABG surgery (4.1%), congestive heart failure (0.9%), and peripheral vascular disease (0.5%). This consistent with Wang, et al., (2014) in which 69.9% of patients had Hypertension, and 31% of them with diabetes mellitus. On other hand smoker represent 43.7% in our study contradict with Ji, et al., (2015) in which 58% of patient underwent cardiac surgery were smoker.

For Both groups (conventional and SSI bundle) were comparable regarding all demographic and medical history except BMI. There were no statistically significant differences between the two groups regarding their age and gender. Unfortunately, there was a statistically significant difference (*P*= 0.028) between the two groups regarding their BMI in which BMI higher in SSI bundle group.

5.4 Discussion related to SSI

The SSI rate in our study was 7.2%. In developed countries, the SSI rate varies from 1.2% to 5.2%, whereas, in developing countries, it may be as high as 11.8%. Our rate was, therefore, higher than the general SSI rate in developed countries (1.2-5.2%), but lower than the rate in developing countries (11.8%) (WHO, 2018).

In our study, adherence to surgical prophylaxis protocol (Bundle) was associated with a reduction in SSI rates. The incidence of SSI was higher among conventional group compared with SSI bundle group (10.9% vs. 3.6%). Most of SSI was superficial and developed in sterna incision and just two cases developed SSI in the leg and 5 cases developed deep incisional in the conventional group. Surgical procedure studies suggest that antimicrobial use has been associated with a decreased infection rate within 60 minutes before the procedure (WHO, 2018). Care bundle are often regularly guided by best-practice guidelines and usually consist of three to five practice elements that are carried out as a full operation in which all defined components are faithfully implemented (Clarkson, 2013). Since they encourage structured treatment, care bundle decreases the risk for care omissions that could otherwise lead to adverse events. The rapid adoption of care bundle with a specific emphasis on clinical practice as a way of minimizing or even preventing adverse outcomes, such as SSI, has spawned a shift in the thinking that adverse events are inevitable (Rello, et al., 2011).

According to a study by (Gillespie, et al., 2015), care bundle have the opportunity to improve team participation, so team members may appreciate individual and mutual contributions to patient care and outcomes. As a consequence, this multidisciplinary coordination mechanism has an energizing effect within the team, because priorities can be clearly defined and implemented and changes in patient care are expressed in improved staff morale. Care bundles often strengthen the notion of mutual accountability within the team, because individual components are not perceived to be unique accountability. The SSI prevention techniques included in care bundles also mirrored the "big three" best-practice guide lines in SSI prevention (i.e., antibiotic administration, normo-thermia, and skin antisepsis), according to (Anderson, et al., 2014).

There were statistically significant variations between contaminated surgical sites in which the reduction of pathogenic microorganisms can be assured by less in the SSI bundle community for form of infection and microbiological culture due to adequate choice of antimicrobial prophylaxis. In addition, an appropriate antimicrobial prophylaxis with broad spectrum efficacy is inexpensive, qualified and germicidal (Anderson, et al., 2014).

Our results showed The MRSA, Enterbacter Coccai, Staph Aureus, and A-Hemolytic Strep were the SSI type of bacteria. This consistent with (Ranjbar & Behzadi, 2015).

Also, the study results showed that there were statistically significant differences in the level of glucose between those who developed SSI and those who did not. This consistent with study of Anderson, et al., (2014) who showed that high blood sugar has contributed to a significant rise in SSIs. The findings also support the consideration of diabetes as an independent predictor for SSIs for several forms of surgical procedures in the analysis by Martin, et al. (2016).

Also the study results showed that participants in the conventional group, with high BMI, and having respiratory chronic disease were at a higher risk of developing surgical site infection comparing with participants in SSI bundle group, normal BMI, or did not have any respiratory chronic disease. This consistent with many studies, Haas, et al., (2015) Smoking and body mass index were predictors of SSI in patients undergoing cardiac surgery. Silva et al . (2012) reported that differences such as male sex, intubation period greater than 24 hours and reintubation were risk factors of SSI in patients undergoing cardiac surgery. Obesity, age, postoperative mechanical ventilation, and early surgical re-exploration were reported by Lucet, J. (2016). In accordance with the most recent World Health Organization study (WHO, 2016), diabetes mellitus, blood glucose level, obesity, and surgical risk index are factors associated with SSI.

5.5 The Recommendations

Although the importance of these measures is well documented in extant literature and current international and national recommendations, very few studies address actual implementation of EBP in ORs in Palestine. Therefore, it is necessary to conduct further studies examining perioperative procedures and evaluating adherence to preventive measures for SSI, so as to gather richer insights into the perspectives and experiences of HCWs. Finally, the data collected as part of this study derived only from three hospitals, and thus it would be instructive to expand the number of hospitals and obtain data from a larger sample in future research.

5.6 The Limitations

The duration of the implementation phase of the study was comparatively short (six months), and compliance may have increased had the study continued for a longer period and included more patients. Furthermore, although some of the elements of the DH HII bundle (hair removal, antibiotic prophylaxis and maintenance of normothermia) have a level I evidence base, other elements have varying grades of supporting evidence.

5.7 Conclusion

higher mean level of glucose, high BMI, and having respiratory chronic disease were independent factors associated with SSI in patients who underwent cardiac surgery procedures.

Age, gender, diabetes, and chronic renal failure had no statistically significant, but all had a risk on developing SSI.

Deep sternal wound infections and stern cutaneous fistulas are serious complications of open-heart surgery. Despite the great advances in prevention and treatment, many patients suffer from great morbidity and even mortality due to these infections. It is therefore important to prevent them, but also to improve the outcome of treatment

Surgical care bundles have been implemented in health care facilities internationally for nearly two decades and offer many benefits to health care organizations, clinical staff and hospital patients. The risk of infection is reduced when all interventions that make up care bundles are performed every time and for every patient. Although health care facilities abide by guidelines and recommendations, new and improved practices are constantly being researched and nurses need the support, tools and confidence to integrate these into their practice. Surgical care bundles can facilitate improved practices; support continuing professional development, communication and teamwork; improve morale; and inspire nurses to share a vision of an improved health care service for patients. Care bundles empower nurses to make changes for the better through a scale-up approach that supports cultural change with long-term benefits for all involved. These small interventions aligned with hospital policies and the ACORN standards can make a significant difference to the quality of life for patients through reducing their risk of developing a surgical site infection with an extended hospital stay and through lowering morbidity and mortality. Surgical care bundles are simple to implement and can make an enormous difference to rates of hospital-acquired infection in health care facilities.

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Annex

Annex I: The questionnaire

اخي /اختي المشارك /ة ...

أنا الباحث الطالب **ساري طالب ابو هنية** تخصص ماجستير تمريض عنايه مكثفه جامعة النجاح الوطنية يسرني ان أدعوك للمشاركة في بحثي المتعلق بدراسة

تطبيق معايير الوقاية من الالتهابات بعد العمليات الجراحية لمرضى عمليات القلب المفتوح

لك كامل الحرية والارادة في المشاركة في هذا البحث ولك الحق في اخذ الوقت الكافي للتفكير في المشاركة من عدمها وسؤال الباحث عما تراه مناسبا والتحدث لاي شخص او جهة عن هذا البحث.

كما يمكنك الاستفسار عن اي جزء يتعلق في البحث الان او فيما بعد واذا كانت هناك كلمات او اجزاء غير مفهومة بإمكانك سؤال الباحث وستجد/ين الوقت والاجابة الكافيتين.

نؤكد بان كافة المعلومات التي سوف يتم جمعها منك سوف تستخدم فقط لأغراض البحث العلمي, وسوف يتم الحفاظ على السرية التامة وعدم استخدام هذه المعلومات لأغراض أخرى

للاستفسار: ساري طالب ابو هنيه

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Annex II

Application of Surgical Site Bundles

Pre operation Topics				
Topics	**YES**	**NO**	**N/A**	**NOTE**
1-Hair has been removed if all possible ,by clipper machine if possible				
2-The patient has showered (pr bathed /washes if unable to shower)on the day or before surgery using chlorhexadine soap				
4-If diabetic ,the patient remained normoglycaemic pre and during the operation				

Day of operation and post operation Topics				
Topics	**YES**	**NO**	**N/A**	**NOTE**
1-prophylactic antibiotics were prescribe as per the local antibiotic policy for the operation category				
2-The antibiotic was administered 60 minutes prior to the start of the operation				
3- the patients body temperature was normal (36-37.5) orally throughout the operation				
4- protect the incision with a sterile dressing for 24 hours to 48 hours postoperatively that has been closed primary				
5-Use aseptic technique when an incision dressing must be changed				
6-Educate the patients and family regarding proper incision care symptoms of surgical site infection and the need to report such symptoms to their doctors .				

In ours research I will used the Questionnaire as tools to collect data .The questioner is divided to three chapters contained many variables according to stage (preoperative, intraoperative, and postoperative).

Chapter one

A-demographic data (Age, gender ,BMI.)

B-Medical History (DM. HTN. etc)

C-post Hospitalization parameters

Chapter two

D-Intraoperative potential Risk factors

E- post operative potential risk factors

Chapter three

1-Surgical site infection details

2-Management

- Patient data collection sheet

1. Patient code:……………
2. Telephone No:…………………….
3. Type of surgery/surgical procedure:……………….

Date of admission:

Date of discharge:

Date of operation:

Chapter 1

A- Demographic data :

1. Age :□ 18-25 □26-34 □43-44 □45-54 □55-64□>65

2.Gender : □ Male □ Female

3.Wight(Kg) : Height :

4- **BMI** :□<18.4 □ 18.5-24.9 □>25BMI:

B-Medical History

1- Hypertension : □Yes □No

2-Diabetic :□Yes □No

3-Renal Failure:□Yes □No

4-**Chronic Respiratory disease**:□COPD □Asthma □ARDS □None

5-congestive heart failure :□Yes □No

6- hypercholesterolemia :□Yes □No

7-peripheral vascular disease :□Yes □No

9- Alcohol use :□Yes □No

10.Previous CABG surgery : □Yes □ No

11-Smoking :□Yes □No

C-Post Hospitalization parameter

1.length of hospital stay before the operation:

□1-3 Days □ 4-7 days □ 8-15 days□More 15 days

3.length of hospital stay post the operation :

□1-7 Days □ 8-15 days □ 15-20 days□More 20 days

4.Admission to the ICU before surgery :□Yes □ No

If YES :

length of time (hours) in the ICU before surgery:

NO	Vital signs /lab test	on admission	day one post-surgery	on discharge
1	Temperature			
2	Pulse			
3	Blood Pressure			
4	Saturation			
5	Hemoglobin(g/dl)			
6	White blood cell (1000/micro)			
7	Serum Creatinine (mg/dl)			
8	Albumin concentration			
9	Random blood sugar (mg/dl)			

□1-3 Days □ 4-7 days □ 8-15 days□More 15 days

5.Pt on ETT : □Yes □ No

If YES :

Duration of intubation :

□≤ 24 hours □> 24 hours

6.Reintubation : □Yes □ No

7-Use of steroids : □Yes □ NO

-Vital signs and lab test

Chapter 2

D-intraoperative potential Risk factors :

1.Operative status: ☐ Elective ☐ Urgent

2.Duration of surgery: ☐1- <3 hours ☐ 3-6 hours ☐more 6 hours

3. **Use of IABP (intra-aortic balloon plumb)** : ☐Yes ☐ No

IF YES **IABP TIME :……**

4.Type of blood vessel use

Right internal mammary artery: ☐Yes ☐ No

left internal mammary artery: ☐Yes ☐ No

Saphenous vein: ☐Yes ☐ No

5**.Use of inotropic drugs** : ☐Yes ☐ No

6. Use of left ventricular assist devices : ☐Yes ☐ No

7.Total bypass time :

8.aortic clamp time :

9. blood transfusions received during and after the operation: ☐Yes ☐ No

Type: ………….. Num of unit :……….

10.blood loss amount : ☐ >1000 ml ☐ < 1000 ml

11. Need of cardiac massage : ☐Yes ☐ No

D-postoperative potential Risk factors :

1.Duration of intermittent positive pressure ventilation :

☐hours ☐ days

2.length of stay in ICU after cardiac surgery :

☐1-3 Days ☐ 4-7 days ☐ 8-15 days☐More 15 days

Chapter 3:

1. Surgical site infection details

1. Surgical Site Infected:□Yes □No

2. Date infection was detected:

3. Type of infection:

□ **-Sternal** □**-Leg**

A. superficial □ **B**. Deep incisional □

C. organ space □ **D**. unknown □

Culture and sensitivity done: Yes □ No □

Name of bacteria:……………….

Annex III

Facilitating Litter

An- Najah
National University
Faculty of Medicine & Health Sciences
Department of Nursing

بسم الله الرحمن الرحيم

جامعة النجاح الوطنية
كلية الطب وعلوم الصحة
دائرة التمريض

التاريخ: 26/08/2019

حضرة د. حسن فتيان المحترم، رئيس قسم الدراسات العليا للعلوم الطبية والصحيه،

<u>الموضوع: تسهيل مهمة الطالب ساري ابو هنية / ماجستير تمريض العناية المكثفه</u>

تحية طيبة وبعد،

تهديكم دائرة التمريض والقباله في كلية الطب وعلوم الصحة/ جامعة النجاح الوطنية أجمل التحيات ونشكر لكم حسن تعاونكم المستمر معنا، أرجو من حضرتكم التكرم بالموافقة للطالب ساري ابو هنية بإجراء الدراسة البحثية حيث أنه يدرس في برنامج ماجستير تمريض العناية المكثفة وكمتطلب للتخرج يجب أن ينهي رسالة الماجستير تحت عنوان:

"Effect of Surgical Site Infection bundles in Cardiac Surgery: Incidence, Microbiology, and risk factors "

لذا نرجو التكرم بالموافقة بالإيعاز الى المدير الطبي في المجمع الطبي/رام الله بتسهيل مهمة الطالب المذكور أعلاه وذلك بالسماح له بإجراء دراسته وجمع المعلومات اللازمة له وذلك بغرض البحث العلمي واستكمالا لمتطلبات الحصول على شهادة الماجستير في تمريض العناية المكثفة.

- مرفق Proposal /Data Sheet /IRB

وتفضلو بقبول وافر الاحترام والتقدير

د.عائدة القيسي

منسقة برنامج ماجستير تمريض العناية المكثفه

بسم الله الرحمن الرحيم

An- Najah
National University
Faculty of Medicine & Health Sciences
Department of Nursing

جامعة النجاح
الوطنية
كلية الطب وعلوم الصحة
دائرة التمريض

التاريخ: 26/08/2019

حضرة د. حسن فتيان المحترم، رئيس قسم الدراسات العليا للعلوم الطبية والصحيه،

الموضوع: تسهيل مهمة الطالب ساري ابو هنية / ماجستير تمريض العناية المكثفه

تحية طيبة وبعد،

تهديكم دائرة التمريض والقبالـه فـي كلية الطـب وعلـوم الصـحه/ جامعـة النجـاح الوطنيـة أجمـل التحيـات ونشـكر لكـم حسـن تعـاونكم المسـتمر معنـا، أرجـو مـن حضـرتكم التكـرم بالموافقـه للطالـب سـاري ابـو هنيـةبإجراء الدراسـة البحثيـه حيـث أنـه يـدرس فـي برنـامج ماجسـتير تمـريض العنايـة المكثفـه وكمتطلـب للتخـرج يجـب أن ينهـي رسـالة الماجسـتير تحـت عنوان:

"Effect of Surgical Site Infection bundles in Cardiac Surgery: Incidence, Microbiology, and risk factors "

لـذا نرجـو التكـرم بالموافقـة بالإيعـاز الـى المـدير الطبـي فـي مستشـفى المقاصـد/القدس بتسـهيل مهمـة الطالـب المـذكور أعـلاه وذلـك بالسـماح لـه بـإجراء دراسـته وجمـع المعلومـات اللازمـة لـه وذلـك بغـرض البحـث العلمـي واسـتكمالا لمتطلبـات الحصـول علـى شـهادة الماجسـتير فـي تمريض العناية المكثفة.

- مرفق Proposal /Data Sheet /IRB

وتفضلو بقبول وافر الاحترام والتقدير

د.عائدة القيسي

منسقة برنامج ماجستير تمريض العناية المكثفه

بسم الله الرحمن الرحيم

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جامعة النجاح
الوطنية
كلية الطب وعلوم الصحة
دائرة التمريض

التاريخ: 26/08/2019

حضرة د.حسن فتيان المحترم، رئيس قسم الدراسات العليا للعلوم الطبية والصحيه، ،

الموضوع: تسهيل مهمة الطالب ساري ابو هنية / ماجستير تمريض العناية المكثفه

تحية طيبة وبعد،

تهديكم دائرة التمريض والقباله في كلية الطب وعلوم الصحه/ جامعة النجاح الوطنية أجمل التحيات ونشكر لكم حسن تعاونكم المستمر معنا، أرجو من حضرتكم التكرم بالموافقه للطالب ساري ابو هنيةبإجراء الدراسة البحثيه حيث أنه يدرس في برنامج ماجستير تمريض العناية المكثفه وكمتطلب للتخرج يجب أن ينهي رسالة الماجستير تحت عنوان:

"Effect of Surgical Site Infection bundles in Cardiac Surgery: Incidence, Microbiology, and risk factors "

لذا نرجو التكرم بالموافقه بالايعاز الى المدير الطبي في المستشفى الاهلي/الخليل بتسهيل مهمة الطالب المذكور أعلاه وذلك بالسماح له باجراء دراسته وجمع المعلومات اللازمه له وذلك بغرض البحث العلمي واستكمالا لمتطلبات الحصول على شهادة الماجستير في تمريض العناية المكثفه.

- مرفق Proposal /Data Sheet /IRB

وتفضلو بقبول وافر الاحترام والتقدير

د.عائدة القيسي

منسقة برنامج ماجستير تمريض العناية المكثفه

جامعة النجاح الوطنية

كلية الدراسات العليا

تطبيق معايير الوقاية من الالتهابات بعد العمليات الجراحية لمرضى عمليات القلب المفتوح

إعداد

ساري طالب ابو هنية

إشراف

د. جمال القدومي

قدمت هذه الاطروحة استكمالاً لمتطلبات الحصول على درجة الماجستير في برنامج تمريض العناية المكثفة، بكلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس– فلسطين.

2021

تطبيق معايير الوقاية من الالتهابات بعد العمليات الجراحية لمرضى عمليات القلب المفتوح

إعداد

ساري طالب ابو هنية

إشراف

د. جمال القدومي

الملخص

مقدمة: التهابات الموقع الجراحية، التي حددتها مراكز السيطرة على الأمراض والوقاية منها على أنها "عدوى تحدث بعد الجراحة في منطقة الجسم التي أجريت فيها الجراحة، هي ثاني أكثر أنواع العدوى المرتبطة بالرعاية الصحية شيوعًا.

الهدف: الهدف العام من هذه الدراسة هو معرفة مدى الإصابة وعوامل الخطر المرتبطة بعدوى الموقع الجراحي بعد تطبيق معايير الوقاية من الالتهابات بعد العمليات الجراحية بعد الجراحة القلبية التي تشمل الجرح القصي والساق.

جمع البيانات: الأسلوب الوصفي الكمي بما في ذلك التحليل بأثر رجعي والمتابعة لمرضى جراحة القلب والاستخدام التجريبي المحتمل لنهج حزم المواقع الجراحية مقارنة بالرعاية الروتينية في التقييم بأثر رجعي في المستشفيات الحكومية والخاصة في الضفة الغربية. شمل ما مجموعه 222 مريض جراحة القلب في هذه الدراسة، 110 منها للمراقبة و112 للتجربة.

النتيجة: من بين المرضى الذين خضعوا لعملية جراحية في القلب 70٪ خضعوا لعملية تحويل مسار الشريان التاجي، ومعظمهم (90.5٪) تزيد أعمارهم عن 45 عامًا. علاوة على ذلك، كان الذكور سائدين (70.3٪)، و45٪ منهم إما يعانون من زيادة الوزن أو السمنة. كان ارتفاع ضغط الدم هو الأكثر انتشاراً (72.5٪) من الأمراض المزمنة. كان معدل حدوث التهاب الموقع الجراحي في دراستنا 7.2٪.

ارتبط التقيد ببروتوكول الوقاية الجراحية (الحزمة) بانخفاض في معدلات الالتهابات للموقع الجراحي، وكان معدل حدوثها أعلى بين المجموعة التقليدية مقارنة بمجموعة التجريبية لحزمة الوقاية (10.9٪ مقابل 3.6٪). كانت اكثر انواع البكتيريا المسببة للعدوى هي المكورات العنقودية الذهبية المقاومة للميثيسيلين والمكورات العنقودية الذهبية والمكورة العقدية المقيحة.

خاتمة: ارتبط التقيد ببروتوكول الوقاية الجراحية (الحزمة) بانخفاض معدلات مباحث أمن الدولة. كان معدل حدوث SSI أعلى بين المجموعة التقليدية مقارنة بمجموعة حزمة SSI (10.9٪ مقابل 3.6٪). كانت اكثر انواع البكتيريا المسببة للعدوى هي المكورات العنقودية الذهبية المقاومة للميثيسيلين والمكورات العنقودية الذهبية والمكورة العقدية المقيحة.

كان متوسط مستوى الجلوكوز المرتفع، وارتفاع مؤشر كتلة الجسم، والإصابة بأمراض الجهاز التنفسي المزمنة عوامل مستقلة مرتبطة بحدوث الالتهابات في الموقع الجراحي في المرضى الذين خضعوا لإجراءات جراحة القلب.

لم يكن للعمر والجنس والسكري والفشل الكلوي المزمن أي دلالة إحصائية، ولكن جميعها كانت معرضة لخطر تطوير مباحث أمن الدولة.

الكلمات المفتاحية: حزمة الرعاية، جراحة القلب، عدوى الموقع الجراحي، مسببات الأمراض، الجروح القصية والساق.