Surgical Site Wound Care: Focus on High BMI Patients

OVERVIEW

The primary goal of the perioperative team for surgical patients is the prevention of postoperative surgical site infections (SSI). SSIs in wounds are a major source of clinical complications and economic consequences for both patients and healthcare providers. Wound closure and healing are essential for achieving optimal outcomes for surgical patients. This is especially important and complex in obese patients. This educational activity will provide perioperative nurses with a review of the basic principles of wound healing and provide the knowledge of how to identify patients at risk for SSIs and delayed wound healing. Key wound assessment factors will be outlined and interventions will be identified.

LEARNER OBJECTIVES

After completing this activity, the participant should be able to:

1. Identify risk factors for wound contamination and surgical site infections (SSIs).
2. Understand the basic principles of wound care and recognize their importance.
3. Understand the relationship between high body mass index (BMI) and wound healing.
4. Discuss obesity trends in the United States.
5. Describe comorbidities that accompany obesity.
6. Discuss traditional and new interventional concepts for wound healing and SSI prevention.

INTENDED AUDIENCE/EDUCATIONAL NEED

TEACHING METHODOLOGIES

This educational activity is governed by principles of adult learning. A supportive study guide with content and references is provided to each participant. Participants have an active role in this self-paced activity and can evaluate knowledge by completing post-test questions and answers section. Answers provided to participants for self-evaluation of activity content, while incorrectly answered questions offer participants opportunity to review related content in study guide.

COMMERCIAL SUPPORT

Health care organizations engaged in continuing medical, nursing and allied health education have adopted standards to promote balanced and evidence-based content. This course is supported by commercial funds and complies with the intent of these standards. Pfiedler Enterprises gratefully acknowledges educational grants provided by: **GSquared Medical.**

DISCLAIMER

Pfiedler Enterprises does not endorse or promote any commercial product that may be discussed in this activity.

ACTIVITY PLANNING COMMITTEE

Jennifer Hamrick, MSN, RN, CNOR
Senior Clinical Program Manager
Pfiedler Enterprises
Denver, CO
No conflict of interest

Judith A. Pins, RN, BSN, MBA
President
Pfiedler Enterprises
Denver, CO
No conflict of interest

AUTHOR

Dondra Tolerson, BS, MA
Medical Writer
Woodstock, GA
No conflict of interest

Disclosure of Relationships with Commercial Entities for Those in a Position to Control Content for this Activity

Pfiedler Enterprises has a policy in place for identifying and resolving conflicts of interest for individuals who control content for a Nursing or Allied Health Professional activity. Information is provided to participants, so that a determination can be made if identified external interests or influences pose potential bias in content, recommendations or conclusions. The intent is full disclosure of those in a position to control content, with a goal of objectivity, balance, and scientific rigor in the activity. For additional information regarding Pfiedler Enterprises' disclosure process, visit our website at: http://www.pfiedlerenterprises.com/disclosure

Disclosure includes relevant financial relationships with commercial interests related to the subject matter that may be presented in this educational activity. "Relevant financial relationships" are those in any amount, occurring within the past 12 months that create a conflict of interest. A commercial interest is any entity producing, marketing, reselling, or distributing health care goods or services consumed by, or used on, patients.

HIPAA COMPLIANCE

Pfiedler Enterprises makes every effort to be in compliance with HIPAA. To protect patient privacy, faculty and participants have been requested to de-identify patient related material.

INTRODUCTION

Surgical site infections (SSIs) are a commonly-occurring healthcare-associated infection (HAI). It is a significant healthcare quality issue, resulting in increased morbidity, disability, length of stay, resource utilization and costs. SSIs are diagnosed by a collection of clinical findings occurring within 30 or 90 days after the operative procedure where day one is the procedure date.[1] Despite improvements in surgical practice and infection control techniques, they remain a significant patient safety issue. SSIs are an important target for the surveillance of HAIs, which is an official priority in several European countries[2] and the United States (US). All members of the perioperative team share the responsibility for reducing surgical patients risk for SSI through optimal wound healing and infection prevention. Proper wound and incision site care pre-, intra- and postoperatively are critical factors in achieving this goal.

PRINCIPLES OF WOUND HEALING

A general understanding of the anatomy of the skin is important in order for perioperative nurses to effectively care for wounds (see Figure 1). As the largest organ of the body, the skin serves as the first line of defense in preventing infection.[3] Skin provides protection and sensation, regulates fluid balance, temperature and components of the immune system. Any wound or disruption of the integrity of the skin can provide an entryway for bacteria and possible infection. The primary layers of the skin are discussed below.

Epidermis Layer

This is the outermost layer of the skin that is composed of lipids and keratin. Keratin is the substance that hardens hair and nails and also protects the body from fluid loss and pathogen invasion.

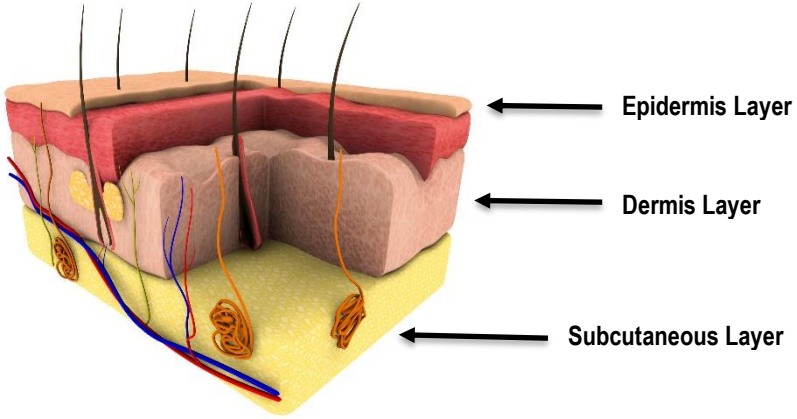
Dermis Layer

This layer is supported by the dermis and is composed of collagen. It is the largest portion of the skin and provides strength and structure. It is vascularized, innervated and contains blood vessels, lymph ducts, hair roots, sebaceous and sweat glands.

Subcutaneous Layer

This is the innermost layer of the skin and is composed of adipose tissue that joins with the deepest layer of the dermis to provide insulation, shape and support.

Figure 1- Skin Cross Section



Knowledge of the underlying physiology of the wound healing process is essential for effective wound management. It enables perioperative nurses to distinguish healthy and unhealthy tissue and thereby assess the wound for proper healing or the potential development of complications. Wound healing refers to the body's replacement of destroyed tissue by living tissue through regeneration and repair. Healing of wounds is a complex biological process that occurs in three intersecting phases: reactive, regenerative and maturation phases (see Table 1 and Figure 2).[4]

Phase 1-Reactive

Inflammation is a requirement for wound healing. It is the vascular and cellular response to disposing of bacteria and other foreign material. This phase begins within minutes after trauma to the skin and is necessary to establish hemostasis and begin mobilization of the immune system. Increased blood flow to the area causes the wound to begin to clot and, as the blood supply increases, the basic inflammatory process begins. The increase in the number of leukocytes in the blood helps to fight bacteria in the wound area and through phagocytosis assist in removing damaged tissue.

In this phase, an exudate containing blood, lymph and fibrin begins to clot and loosely bind the severed edges of the wound to form a scab. The scab assists in preventing fluid loss and bacterial invasion. However, in the first few days of the wound healing process, the scab has little tensile strength. The inflammatory phase usually lasts between one and four days. During this period, the edges of the skin may appear mildly swollen and slightly red due to the inflammatory process.

Phase 2-Regeneration

This phase begins within hours of trauma to the skin and allows for new epithelium to cover the wound. Epithelial cells migrate to and proliferate in the area of the wound, covering the surface of the wound in order to close the epithelial defect. This also provides a protective barrier, which serves as a mechanism to prevent fluid and electrolyte loss and prevent the introduction of bacteria into the wound, thus reducing the incidence of infection. As re-epithelialization occurs, collagen synthesis and wound contraction begin taking place. Collagen synthesis produces fiber molecules that link to

strengthen the wound. Epithelial migration is limited to approximately three cm from the point of origin, which is why larger wounds may require skin grafting. Approximately five days after the onset of a wound, contraction begins; it peaks at 2 weeks and gradually shrinks the entire wound. With a surgical wound, granulation tissue will form underneath the edges of the incision and are palpated as a hard ridge; this eventually resolves in the remodeling phase.

Phase 3-Maturation

During this final stage, scar tissue has formed. As the scar ages, fibers and fiber bundles are more closely packed in a crisscross pattern, ultimately forming the final shape of the wound. At most, the tensile strength of scar tissue is never higher than 80% of that of non-wounded tissue. This phase begins after approximately two to four weeks, depending on both the size and nature of the wound; it may last one year or more.

Table 1 – Phases of Wound Healing

PHASES OF WOUND HEALING		
PHASE	**TIME PERIOD**	**RESULT**

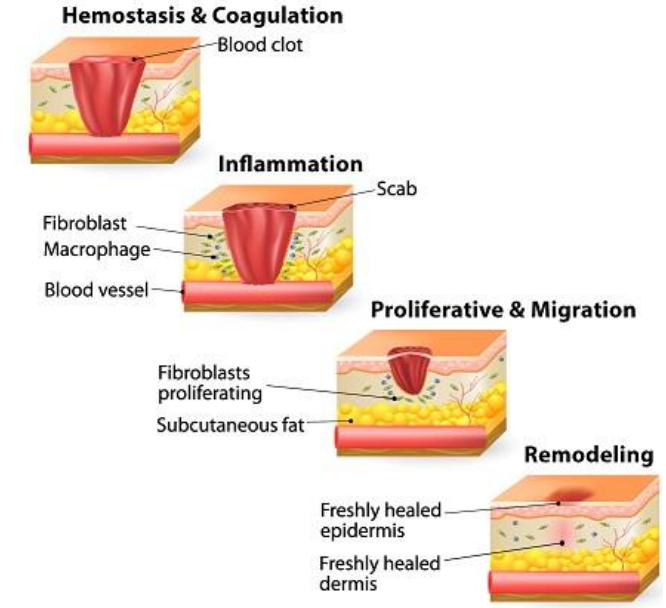
Reactive	One to four days	• Inflammation
		  ○ Formation of seal to assist in preventing fluid loss and bacterial infiltration
		  ○ Phagocytosis
		  ○ Vasodilation

Regenerative	Five days to two weeks	• Collagen synthesis • Re-epithelialization • Wound contraction

Maturation	Two weeks to one year+	• Collagen remodeling
		  ○ Collagen production and breakdown are balanced
		  ○ Randomly deposited connective tissue is arranged in linear and lateral orientation

Source: Clark RA, editor. The molecular and cellular biology of wound repair. Springer Science & Business Media; 2013 Nov 11.

Figure 2 – Wound Healing



INTERRUPTION OF THE WOUND HEALING PROCESS

There are several factors that may impair or interrupt tissue repair and healing, such as the patient's nutritional status, oxygenation level, surgical technique and overall recuperative power, all of which are critical in tissue repair and healing.[3] Both the inflammatory response and oxygen tension are dependent upon microcirculation to deliver vital components to the wound. A decrease in oxygen tension to the wound area inhibits fibroblast migration and collagen synthesis, thereby resulting in a reduction in the tensile strength of the wound.

Nutritional status is an important consideration in the wound healing process because of the need for an adequate supply of protein, which is necessary for growth of new tissue. Protein is also required for the regulation of the osmotic pressure of the blood and other body fluids and the formation of prothrombin, enzymes, hormones and antibodies. Other required nutritional elements include water; vitamins A, C, B6, and B12; iron, calcium, zinc and an adequate calorie intake.

Another important factor for the surgical patient is to maintain normothermia in the operating room (OR), because hypothermia contributes to vasoconstriction, which can have an adverse effect on wound healing.

Poor surgical technique (ie, roughly handling tissue causing trauma) can lead to bleeding and other conditions that may promote infection.[3] Examples of surgical techniques that facilitate wound healing are: achieving and maintaining adequate hemostasis; utilizing precise cutting and suturing techniques; using time efficiently in order to minimize wound

exposure to air; eliminating dead spaces; and exerting minimal pressure with the use of retractors and other instruments.

Impaired wound healing is a side effect of many drugs and herbal supplements, because many of them interact with certain phases of the healing process.[5] Herbal supplements should be taken into consideration preoperatively since many of them can inhibit platelet activity, increase blood pressure or exacerbate the effects of anticoagulant medications. Because many patients do not consider herbal supplements to be "medications," it is important that the patient is asked specifically about these products.

SSI is the most common cause of delayed wound healing in the surgical patient. There are various potential causes of SSIs, such as the patient's susceptibility to and the severity of illness, microbial contamination by the patient's own (endogenous) microflora and exogenous wound contamination from the OR environment and/or personnel.[3]

OVERVIEW OF SURGICAL SITE INFECTIONS

There are more than 40 million inpatient and 31 million outpatient surgeries performed annually in the US. At least 2% of these patients develop complications from SSIs with a severity ranging from superficial skin infection to life-threatening conditions such as severe sepsis.[6] *Staphylococcus aureus*(*S. aureus*) is a commonly-isolated organism for SSI. Methicillin-resistant *S. aureus* SSI incidence is increasing, causing more than 50% of HAIs globally and presents challenges to treatment due to multiple antibiotic resistance.[7] Other organisms regularly isolated from SSIs include:[6]

- Gram-negative bacilli,
- Coagulase-negative staphylococci,
- Enterococcusspp, and
- *Escherichia coli*.

SSIs have a negative impact on patients' physical and mental health. They lead to increased patient morbidity, mortality, pain, delayed wound healing and anxiety. Tangible costs include loss of earnings during recovery, which can also be distressing for the patient's family.[8]

The development of an SSI causes a substantial increase in the clinical and economic burden of surgery. The financial burden of surgery is increased due to the direct costs incurred by prolonged hospitalization of the patient, diagnostic tests, and treatment. Certain patients may also require reoperation after the contraction of an SSI, which is associated with considerable additional costs.[9] In European hospitals, patients who develop an SSI constitute a financial burden approximately double that of patients who do not develop an SSI. The same review also reported that the length of hospitalization was more than twice as long for patients with an SSI relative to uninfected patients.[9]

RISK FACTORS FOR SURGICAL SITE INFECTIONS

Identification of high-risk patients can improve resource utilization and allow modifications in perioperative management to optimize outcomes.[10] There are numerous endogenous (patient-related) and exogenous (process- or procedural-related) variables

that affect a patient's risk of developing an SSI. A number of well-documented potential factors include:[11]

- nutritional status,
- obesity,
- diabetes,
- tobacco use,
- proper use of antibiotics, and
- intraoperative technique.

These factors can be improved to bolster the likelihood of a positive surgical outcome; other common variables, such as age and gender, are not amenable to change or improvement. The remainder of this section will discuss patient-related risk factors that can be addressed with preparation, planning and methodical implementation.

Perioperative Inadvertent Hypothermia

Hypothermia is a reduction in core body temperature below 36°C (96.8°F) and is one of the most common patient risk factors for perioperative complications and SSI.[12] Temperatures just 1.5°C below normal can result in an SSI, among other adverse events. The loss of body heat is the result of a combination of factors shown in Table 2.

Inadvertent hypothermia during surgical procedures has a reported prevalence ranging from 50% to 90%.[13] General anesthesia produces vasodilation with a rapid redistribution of warmer core blood being redistributed to cooler extremities, reduction in metabolic heat generation and loss of shivering response. Major procedures requiring large thoracic or abdominal incisions also expedite core heat loss and impede most warming strategies. The most expeditious way to manage hypothermia is to prevent heat loss from occurring altogether. Noninvasive strategies noted to have increasing effectiveness include the routine use of warmed intravenous (IV) fluids and skin prep solutions, warmed blankets, thermal lamps, hot water mattresses, forced-air warming systems and direct conduction thermal pads.[13]

Table 2 – Risk Factors for Inadvertent Hypothermia

RISK FACTORS FOR INADVERTENT HYPOTHERMIA	
PATIENT-RELATED FACTORS	**CONTRIBUTING FACTORS**
Cachexia	Pre-surgery fasting
General illness	Low ambient temperatures in the perioperative setting
Gender	Use of cold skin prep solution
Age (significantly younger or older)	Cold OR table
Type of anesthesia	Cold IV fluid
Type and length of procedure	

Source: Hart S, Bordes B, Hart J, Corsino D, Harmon D. Unintended perioperative hypothermia. *Ochsner J.* 2011;11(3):259-70. PMID:21960760.
Moola S, Lockwood C. Effectiveness of strategies for the management and/or prevention of hypothermia within the adult perioperative environment. *International Journal of Evidence-Based Healthcare*. 2011;9(4):337-45. DOI: 10.1111/j.1744-1609.2011.00227.x.

Tobacco Use

Cigarette smoking has been associated with increased risk of SSI, wound complications, decreased circulation to the skin and compromise to the immune and respiratory system. Smoking may also be one of the preexisting patient factors amenable to intervention, especially with the relatively new smoking cessation aids available (ie, acupuncture, hypnotherapy, nicotine patch or bupropion hydrochloride).[14] Patients should be encouraged to discontinue tobacco use at least one month prior to elective surgery.

Preexisting Diabetes Mellitus

Diabetes mellitus (DM), particularly adult-onset (type 2 diabetes), has become increasingly prevalent in the US. Type 2 diabetes is a chronic disease that is a combination of insulin resistance and a secretory defect. Insulin in the blood signals the cells on how much glucose to absorb. When levels of glucose in the blood rise, the body produces more insulin in an attempt to maintain normal blood sugar levels. In diabetes, the cells resist the effects of insulin allowing glucose to continue to build up in the blood. Approximately 20 million people live with the disease, one-third of whom are unaware of their disease state.[15] The percentage of surgical patients with diabetes can be high, depending on the type of procedure performed. One study noted that 44% of cardiac surgery patients were diabetic, with 48% of possible diabetics undiagnosed preoperatively.[16,17] DM is a well-recognized risk factor for requiring coronary artery bypass graft (CABG) surgery, with 25% to 30% of patients undergoing CABG surgery having preexisting diabetes. It is also one of the primary predictors of postsurgical morbidity and mortality, with approximately 35% to 50% of complications occurring in patients with that comorbidity.[17] Post surgical adverse outcomes related to DM are believed to be related to the preexisting complications of chronic hyperglycemia, which include vascular atherosclerotic disease, peripheral and autonomic neuropathies. All surgical patients should be evaluated preoperatively for undiagnosed or uncontrolled diabetes and placed on a predetermined regimen shown to effectively control serum glucose.

Malnutrition

Malnutrition means "poor nutrition" and is a serious condition that occurs when a person's diet does not contain adequate amounts of nutrients. Malnutrition refers to:

- **Undernutrition:** not consuming enough nutrients.
- **Overnutrition:** consuming more nutrients than needed.

Poor nutrition may be caused by having an inadequate diet or a problem absorbing nutrients from food. There are many reasons why these might happen, including reduced mobility, a chronic condition or a low income.

Screening for malnutrition begins with the recognition that it cannot be seen by the naked eye or even on the scale; nutritional status is not body mass index. For example, any obese patient could be taking in too many calories, but not enough protein or other nutrients, due to an unhealthy diet. Serum albumin level is the surrogate marker most commonly used to classify nutritional status, with a normal range considered to be 3.4-5.4 g/dL. Once a patient has been diagnosed as malnourished it is imperative that the etiology of this comorbidity is identified.[18]

Malnutrition has long been identified as a risk for nosocomial infections, including SSIs, among patients undergoing any type of surgery.[18] Nutrition plays a vital role throughout the stages of wound healing. Patients who are malnourished have been found to have less competent immune response to infection and can lead to delayed or impaired wound healing.

Protein-energy malnutrition is especially common in elderly patients for a number of reasons. These include poverty, limited mobility, social isolation and depression, poor dentition, medication-related anorexia, as well as decline in cognitive and functional status.[19] Nutrition screening, using a validated tool for the perioperative setting, should be undertaken on all adults with a wound or suspected infection to identify the risk of poor healing due to nutritional problems. Possible interventions include family-support discussions, dental consults, diet counseling and social service referrals. Depending on the surgical urgency, delay of surgery until the patient's nutritional status improves may be indicated. Preoperative and postoperative fasting should be kept at a minimum for these patients, as even short-term deprivation may exacerbate risks.

Obesity

Obesity describes the ranges of weight that is greater than what is considered healthy for a given height. Obesity is increasing in prevalence, creating a costly and problematic public health concern globally and in the US. Obesity is the fastest growing chronic condition in the US with at least one-third of adults and almost one-fifth of adolescents having a body mass index (BMI) greater than 30.[20] A BMI below 18 is considered underweight, 18.5 to 24.9 is considered healthy, 25 to 29.9 is considered overweight and a BMI of 30 or higher is considered obese.

Obesity is a complex disease involving metabolic, environmental, social, behavioral and psychological factors.[21] Obesity, particularly morbid obesity, increases the risk for serious health conditions such as hypertension, type 2 diabetes, coronary heart disease,

infection and abnormal lipid concentrations,[22] which increases the number of complex patients entering healthcare facilities for inpatient care and surgery.

There are many factors that affect wound healing, and obesity is a major one. Patients who are morbidly obese are naturally predisposed to a variety of skin challenges, including incontinence dermatitis and fungal infections. They are also more likely to develop ulcers caused by pressure to the skin and they tend to experience delayed wound healing. These challenges are intensified in the perioperative setting. Difficulties with mobilization and repositioning, unpredictability of pharmacokinetic effects and lack of appropriate diagnostic equipment to accommodate patients of size place them at increased risk for skin breakdown, wound infection and healing problems.[23] In addition, perioperative subcutaneous wound and tissue oxygen tension is substantially reduced in morbidly obese patients. Tissue hypoxia is pronounced during surgery and may contribute to wound infection risk in obese patients.[24] Wound edges must be assessed for stress on the surgical incision, including pain and obvious dehiscence. An appropriately sized abdominal binder may be needed to support the abdominal wall during surgery.[25] Wagner et al [26] studied the progenitor cell levels in peripheral blood samples obese and non-obese persons and found that progenitor cells that are critical for effective wound healing were impaired in the obese participants. The researchers suggested impaired vasculogenic progenitor cell function and number are associated with impaired obese wound closure and healing. A leading cause of skin breakdown and infection is when a large panniculus is present. A panniculus is characterized by a large abdominal apron of skin and soft tissue that is commonly found in morbidly obese patients. This tissue is prone to chronic infection, dermatitis, ulceration, sinus tract formation and lymphedema at the skin folds (see Figure 3).[27, 28]

Figure 3 – Infection Associated with Large Panniculus

According to the American College of Obstetricians and Gynecologists,[29] nearly 50% of obese mothers with BMIs between 35 and 39.9 undergo cesarean sections (C-sections). Data shows the panniculus creates difficulties and risks such as imprecise incisions and infection of the surgical site for cesareans. Several factors predispose obese patients to

loss of skin integrity. Adipose tissue has relatively less blood supply, leading to inadequate oxygenation. Excessive sweating increases skin moisture and consequently increases risk for bacterial and fungal invasion, especially within deep skin folds.[30] Immobility, friction, and shear due to the substantial weight stress the skin's barrier function. Another issue is nutrition. Although it may seem contradictory because of physical appearance, obese and morbidly obese persons can be markedly malnourished. Poor nutrition can lead to inadequate protein, vitamins, and nutrients essential to wound repair. Iatrogenic damage due to tubes, catheters, and other intervention can affect the skin.[30] A large panniculus in obese patients can complicate wound healing, causing incision dehiscence and seroma or hematoma formation.[22] Hematoma and seroma are collections of blood and serum, respectively. Hematomas are more common than seromas and usually result from failure of primary hemostasis or a bleeding diathesis (eg, anticoagulation). Hematomas and seromas can cause the incision to separate and predispose to wound infection since bacteria can gain access to deeper layers and multiply uninhibited in the stagnant fluid. Seroma and hematoma development under surgical sites can also lead to incision wound failures. Use of abdominal support, systemic treatment of infection and nutritional interventions may improve incisional wound healing and decrease incidence of dehiscence.[22]

Wound Contamination

The primary source of infection for most surgical sites is the patient's endogenous microorganisms.[31,32]

All patients are colonized with bacteria, fungi and viruses; however, not all bacteria, fungi and viruses are created equal. Patients with a history of DM or other chronic illness who have had repeated hospitalizations or courses of antibiotics are more heavily colonized. All surgical wounds will be contaminated with bacteria to some degree during surgery; although only a small percentage become infected because most patients defenses are capable of controlling and eliminating the offending organisms. Patient's skin is never sterile. However, there are strategies that can reduce microorganisms. First, patients should bathe or shower with an antiseptic at least once prior to surgery. One of the Association for periOperative Registered Nurses' (AORN's) evidence-based practice guidelines on surgical skin antisepsis indicates that hair in the surgical incision area should not be removed[33] unless removal is necessary for the procedure. If hair removal is required, the perioperative nurse should do so with clippers immediately prior to surgery. Additional strategies that hinder bacterial migration into the surgical incision include the use of antiseptic-impregnated adhesive drapes or cyanoacrylate-based skin sealants that are applied over the skin prep to immobilize residual skin flora, including those imbedded in hair follicles.

Wound infection is most commonly characterized by:[34]

- redness,
- pain,
- swelling,
- elevated incisional tissue temperature, and
- systemic fever.

Ultimately, the wound is filled with necrotic tissue, neutrophils, bacteria and proteinaceous fluid that together constitute pus.[34] The risk of infection varies by type of surgical incision site. Invasive procedures that penetrate bacteria-laden body sites (ie, the bowel) are more prone to infection. The traditional wound classification system designed by the Centers for Disease Control and Prevention (CDC) stratifies the increased likelihood and extent of bacterial contamination during the surgical procedure into four classes of procedures.[35,36]

Clean Wounds (I)

A clean wound is defined as an uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tract is not entered. A clean wound is primarily closed and, if necessary, can be drained with closed wound drainage. Operative incisional wounds that follow non-penetrating (ie, blunt) trauma should be included in this category if they meet the criteria. Clean wounds show no signs of infection.

Clean-contaminated Wounds (II)

A surgical site falls into this category when the operative procedure enters into a colonized viscus or cavity of the body, but under elective and controlled circumstances. SSI rates in this class of procedures range from 4% to 10%.

Contaminated Wounds (III)

A contaminated wound is one where gross contamination is present but infection is not obvious. As with clean-contaminated procedures, the contaminants are bacteria that are introduced by tainting the surgical field. SSI rates in this class of procedures can exceed 20%.

Dirty Wounds (IV)

If an active infection is already present in the surgical site, it is considered a dirty wound. Pathogens of the active infection as well as unusual pathogens will likely be encountered. SSI rates in this class of procedures can exceed 40%.

Preexisting Remote Body Site Infection

Although infrequent, patients can harbor inactive or underactive tissue infection at the time of surgery. The two primary concerns regarding the presence of preexisting infection are that it may be the source for spreading through the bloodstream or a remote site for bacterial transfer.[37] These infections have been linked to increasing SSI rates three- to five-fold. Remote infections should be identified and treated prior to surgery.

BEST PRACTICES FOR WOUND CARE AND SSI PREVENTION

One of the primary goals for the perioperative team is the prevention of SSIs. During the past decade, US healthcare has entered a period of best practices bundling in patient care actions that have been identified as improving outcomes. SSI reduction strategies have greatly benefited from this approach.

Elective surgery patients, who may wait days or weeks between the decision to proceed with surgery and the actual date of surgery, are the optimal candidates upon whom to

focus SSI prevention strategies. Rather than consider this interval time as an unnecessary delay, it should be viewed as a window of opportunity to optimize the patient's resources and defenses against potential perioperative complications, as well as to ensure that the healthcare system is functioning at optimal level to protect the patient.

When implementing SSI prevention strategies, it is important for perioperative personnel to have products and equipment designed for obese patients readily available. Specialized equipment (eg, bariatric lifts, friction-reducing products and products to assist with dressing changes) can substantively increase the safety of obese patients, especially when they are immobilized during surgery.[38]

PREOPERATIVE ANTIBIOTIC PROPHYLAXIS

Preoperative antibiotic prophylaxis is the administration of antibiotics prior surgery to help prevent SSI. The use of antibiotic prophylaxis is just one of many actions taken to help reduce the rate of surgical site infections. The goal when determining the best antibiotic is to have the narrowest spectrum of activity while still ensuring the most common organisms are targeted.

Perioperative antibiotic prophylaxis (PAP) can reduce the incidence of SSI by providing an adequate level of the antimicrobial agent in the tissues before surgery. However, the appropriate choice of antimicrobial agents, dosage regimen, timing, duration and route of administration must be evidence based. In fact, inappropriate use (eg, overconsumption or inappropriate timing) has been shown to increase the risk of adverse drug reactions, hospital costs, emergence of resistant strains of microorganisms and superinfections. Most antibiotics should be given within 60 minutes of a surgical incision. Exceptions include vancomycin and levofloxacin, which requires administration within 120 minutes of the procedural incision due to longer administration times.[39] Unless there is a known infection, prophylactic antibiotics should be discontinued within 24 hours.

Although the principles of PAP in surgery are clearly established and several guidelines have been published in order to prevent SSIs, the implementation of these guidelines has proven challenging and failure to comply with this standard of care has been widely reported.[39,40]

WOUND DRAINAGE SYSTEMS

There are three types of wound drainage systems. A closed drainage system, which is a system of tubing or other apparatus that removes fluids in an airtight circuit via suction and prevents any type of environmental contaminants from entering the wound or area being drained. A negative pressure drainage system uses a pump or mechanical device to help evacuate excessive fluid or air from the body. An open drainage system, which is generally a tube or drain, which is inserted into the body and drains the fluid out onto a dressing.[41]

Closed Wound Drainage System

A closed wound drainage system flows into a sterilized airtight tubing and container with a suction-generating device. In this system, the tubing connects to a reservoir (eg, a bulb

evacuator or a spring-loaded device), which uses suction to draw fluid out of the wound or incision. As a result, the reservoir is used as a mechanism of continuous suction pressure and for fluid collection. According to the CDC Guideline for Prevention of Surgical Site Infection,[42] the risk of SSI appears to be reduced when closed suction drains, rather than open drains, are used; closed suction drains effectively evacuate postoperative hematomas or seromas, however, the timing of drain removal is also important.

Negative Pressure Wound Drainage System

Negative pressure wound drainage is primarily used to expedite recovery in burn patients and to enhance healing of chronic or severe wounds.[43] They are also effective in the treatment of diabetic foot ulcers, traumatic wounds and venous insufficiency ulcers. This type of drainage system has a vacuum that adds negative pressure to the wound area, which facilitates drainage by removing fluid and desiccated tissue, enhancing blood flow through the affected region, lowering bacterial levels, stimulating cell growth, closing the wound edges and promoting granulation tissue.[44]

There are five mechanisms by which the application of negative pressure wound drainage may facilitate the healing process:[42,43]

- Wound retraction under negative pressure helps to approximate the wound edges, while putting mechanical stress on the tissue. This externally applied stress is believed to induce the mechanisms responsible for increasing matrix synthesis and cell proliferation within the wound.
- Stimulation of granulation tissue formation.
- Continuous wound cleansing, following surgical debridement, to decrease microorganisms present in a wound and remove substances that inhibit wound healing.
- Continuous removal of exudate. Exudate that accumulates in a wound can mechanically compress local capillaries, thereby restricting the flow of blood into the wound.
- Decreased interstitial edema.

Open Wound Drainage System

An open, passive drain is generally used more often in suppurative than in nonsuppurative wounds. An open drain assures that the wound remains open for drainage of thick suppurative and necrotic materials. This type of drain is usually secured with a safety clasp or it may be sutured to the patient's skin to prevent the drain from being dislodged or pulled either into or out of the wound. A common practice with an open drain is to gradually remove it over several days; this practice facilitates drainage and collapse of the wound cavity.[42]

PANNICULUS POSITIONING PRODUCTS

A panniculus is a large abdominal apron of adipose that can cover the abdomen, pelvis and perineal area in obese patients.[45] Due to the size of the panniculus, obese patients undergoing general, vascular, obstetrical or gynecological surgery often develop skin and wound complications[28] related to the challenges with elevating the panniculus, and keeping it suspended, above the operative field for the duration of a surgical procedure.

Traditional methods of panniculus retraction include pads, tape, sheets, straps, pannus retractors and manual manipulation.[46] All too often, manual retraction is used which demands additional perioperative staff to be assigned to cases. In recent years advancements have been made in commercial products that lift and hold the panniculus away from the abdomen and surgical incision. These products allow greater access, good visualization and adequate exposure of the operative site. This allows for greater ability to conduct a transverse incision (eg, Pfannensteil or Joel-Cohen), which is preferred over vertical incisions, especially in obese obstetrical and gynecological surgery.[47]

Pre-Surgical Infection Elimination

Pre-surgical infections (typically yeast) at the site of the incision can be eliminated by applying a wearable retractor up to 10 days pre-operatively to improve the environment at the surgical site (eg, breast, panniculus, etc.). The retractor exposes the incision site, which is typically under/in a skin fold, to reduce moisture and temperature, allowing more air and light to the incisional site.

Preoperative Use

Before beginning the patient's skin prep, perioperative nurses should assess the patient for allergies and sensitivities to skin antiseptic products, and evaluate their skin integrity.[33] To begin, the areas of greater contamination within the prep area (eg, umbilicus, foreskin, under nails, urinary or intestinal stomas) should be cleaned. The prep should be applied in an area that is large enough to allow for an extension of the incision, additional incisions, drain placement or shifting of the drapes. The prep should begin at the incision site and move away toward the periphery of the surgical site. Using a panniculus positioning product makes this process easier by increasing access to the abdomen, pelvis and perineal area and by holding the panniculus steadily in place while the skin prep dries.

Intraoperative Use

Intraoperative panniculus positioning retractors can be used in the OR, Cath lab and other procedural areas to allow full access to the procedural site. It holds the panniculus for the duration of the operation, freeing the surgeon's hands and those of the perioperative team so that they can directly care for the patient. As mentioned above, with the panniculus securely retracted, the surgeon can place a transverse incision above or below the fold. This type of incision increases wound strength, reduced postoperative pain, improved respiratory effort[48] and is cosmetically excellent.[49]

With the panniculus fully retracted and the incision site exposed, there is less concern for wound infection in the moist fold underneath the panniculus.[50] Once applied the

panniculus retractor remains securely in place and eliminates manual pushing and compressing of the pannus as well as the use of tape and other positioning devices.

Postoperative Use

Postoperative products can be applied in the post anesthesia care unit (PACU) or in the inpatient unit following recovery. The panniculus positioning retractor can be worn for up to 2 weeks post surgery (see Figure 4). Specific patient benefits include that when placed correctly, the adjustable retractor is comfortable and gentle on the skin. Comfort is particularly important as the patient returns to routine activities of daily living. It can be worn in the shower and dries quickly. During skin assessments and wound care, it is especially important that perioperative nurses are aware of the potential for the patient to feel embarrassed or exposed when applying a panniculus retractor. Care should be taken not to make the patient feel as if they are on display. Furthermore, the nurse's attitude about caring for patients of size can be easily transmitted to the patient, and it can be detrimental to a patient's compliance with care if the patient feels like the staff is not comfortable caring for them.[45]

Figure 4 – Panniculus Retractor

There have been anecdotal reports of patients experiencing a reduction in incisional pain leading to the reduced need for interventions such as wound devices and pain management drugs.[50] This is especially important as pain medication, namely opioids, have been the mainstay for treatment of postoperative pain for many years. However, over the last several years there have been overwhelming reports of adverse reactions or side effects for opioids such as confusion, nausea, vomiting, itching, constipation, respiratory depression, abuse and addiction. Obese patients present an added concern for practitioners as opioids can accumulate in fatty tissue.[51,52]

Abuse and addiction to opioids is a global epidemic. It affects over 26 million people globally,[53] with an estimated 2.1 million people in the US suffering from substance abuse disorders related to opioids.[54] Reports indicate that 60% of the opioids that are abused are obtained by a physician's prescription. The number of new abusers increased by 225% between 1992 and 2000 and deaths related to prescription opioids are on the rise.[55] By the early 2000s death certificates listed opioid analgesic poisoning as a causeof

death more often than heroin or cocaine.[56] In response to the worsening epidemic of prescription drug abuse and overdoses in last decade, regulatory and governing entities have given a directive to implement interventions to alter the need for opioids and other pain management drugs.

NURSING CONSIDERATIONS: SKIN ASSESSMENT

Proper assessment of a wound is a critical component in effective wound management to avert complications including incorrect diagnosis and treatment. Wound assessment requires detailed observational skills, knowledge of evidence-based practices and the use of the approved terminology in order to accurately communicate findings with the care team (Table 3).[33]

Location

The anatomic location of the wound should be documented using landmarks (eg, sternum, iliac crest, gluteal fold, sacrum) for specificity. Descriptions such as superior, posterior, medial and proximal should be used to describe the proximity of the wound to the landmark.

Dimensions

Linear measurements of the wound should be taken at the greatest length and width perpendicular to each other. Wound measurements should be described in terms of formal units of measurements such as, millimeters or centimeters. Using comparisons such as fruit, coins or other objects is not appropriate.

Wound Edges (Periwound)

The condition, color and temperature of the wound should be described using the appropriate terminology:

- ecchymosed (bruised),
- erythematous (red),
- indurated (firm), and
- edematous (swollen).

Describe the quality of the wound edges using terminology such as diffuse, well defined, or rolled. It should also be noted whether or not the edges are attached or unattached to the wound bed as unattached wound edges typically signify a disruptive process.

Pattern and Arrangement

The distribution, or pattern, refers to the dispersion of lesions. The arrangement describes the position of nearby lesions and is helpful in confirming a diagnosis. Satellite lesions are small peripheral lesions around the larger central wound. Linear lesions are found in a straight-line pattern.

Wound Tissue

The types of tissue found in the wound should also be described. Normal granulation tissue has a beefy, red, shiny and textured appearance that bleeds readily. Hypergranulation has more of a flaccid texture. Necrotic tissue is also called “slough,”

and is generally yellow-gray in color. Eschar is leather-like in texture and is black-gray and hard.

Drainage

Wound exudate is the accumulation of fluid that can contain white blood cells, cellular debris and bacteria. The amount, color, and consistency of wound drainage should be noted. The appropriate terminology to describe drainage is:

- serous (clear),
- serosanguinous (blood-tinged),
- sanguinous (bloody), and
- purulent (pus).

Odor

An odor in a wound is a significant diagnostic tool; however, it is important to be sure that the odor is coming from the wound and not from the dressing. Certain types of dressings (eg, foams and hydrocolloids) have characteristic odors that are enhanced by the proteins present in wound drainage.

Table 3 – Components and Terminology for Describing Wounds

COMPONENTS AND TERMINOLOGY FOR DESCRIBING WOUNDS	
Location	**Anatomic location (superior, posterior, medial)**
Dimensions	Described in formal units of measure (millimeters or centimeters)
Condition, color and temperature	• Ecchymosed (bruised) • Erythematous (red) • Indurated (firm) • Edematous (swollen)
Pattern	• Satellite lesions (small peripheral areas around a larger central lesion) • Linear lesions (straight line pattern)
Tissue type	• Normal granulation (beefy, red, shiny and textured) that bleeds readily • Hypergranulation (flaccid texture) • Necrotic tissue (usually yellow-gray and soft is called “slough”) • Eschar (black-gray, hard and leathery)
Drainage	• Serous (clear) • Serosanguinous (blood-tinged) • Sanguinous (bloody) • Purulent (yellow, tan, milky pus)
Odor	• Drainage combined with a foul odor typically indicates presence of Pseudomonas

POSTDISCHARGE PATIENT AND FAMILY EDUCATION

Surgical procedures are increasingly performed on an outpatient basis resulting in more patients being discharged home from an acute care setting earlier in their recovery period.[57] For this reason, surgical wound care is often conducted by the patient, their family members or home healthcare providers. Therefore, in addition to providing effective wound care in the perioperative environment, nurses must also educate patients and their loved-ones about wound care, aseptic technique, etc., because patient compliance is an important factor in preventing infection and optimizing wound healing. Wound care instruction should occur verbally and in writing. Important signs and symptoms that patients should report to their physician include:[33, 58, 59] Erythema, marked swelling, tenderness, increased warmth around the wound or red streaks near the wound.

- Chills or a temperature greater than 37.7°C (> 100°F).
- Purulent drainage or a foul odor from the wound.
- Special instructions:
    - Confirm showering and bathing parameters.
    - Review wound care products; explain the procedure and how often it should be performed.
    - Emphasize the need to keep the wound clean and dry.
    - Advise on the need to assemble all supplies needed for wound care before starting the procedure.

SUMMARY

One of the primary goals for surgical patients is to remain free from the signs and symptoms of an SSI, which is one of the leading causes of postoperative morbidity and mortality. SSI risk depends on a number of patient factors, including preexisting medical conditions, amount and type of resident skin bacteria, perioperative glucose levels, core body temperature fluctuations as well as pre-, intra- and postoperative care. This makes it challenging to predict which wounds will become infected. For that reason, perioperative nurses should strive for early identification of risk factors amenable to intervention to minimize the risk of wound contamination in surgical cases.

The wound healing process is a complex response to tissue disruption caused by trauma. It is a highly reliable process in the absence of infection. However, SSI is the most common cause of delayed wound healing. Proper wound and incision site care are two critical factors in preventing them. Several factors can interrupt tissue repair and healing, such as the patient's nutritional status, oxygenation level, immune system, overall health status, surgical technique and BMI, all of which are critical in tissue repair and healing.

Bundling evidence-based interventions is considered an integral component of the best practice SSI prevention that can be provided to patients. Antibiotics, surgical drains and panniculus positioners are among the interventions that can be bundled to reduce infection and promote wound healing. It is important that perioperative nurses are aware of the proper applications of these interventions and how they can work together to give surgical patients optimal outcomes.

GLOSSARY

Abuse	In this context, the harmful and inappropriate misuse of hazardous substances such as drugs.
Clean Wounds	Uninfected operative wounds in which no inflammation is encountered and the respiratory, alimentary, genital, or uninfected urinary tract is not entered.
Clean-Contaminated Wounds	Operative wounds in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination.
Contaminated Wounds	Open, fresh, accidental wounds; operations with major breaks in sterile technique (eg, open cardiac massage) or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered.
Dermis	The largest portion of the skin that provides strength and structure; contained within the dermis are blood vessels, lymph ducts, hair roots, nerves, and sebaceous and sweat glands.
Diabetes Mellitus	A disease in which the body's ability to produce or respond to the hormone insulin is impaired, resulting in abnormal metabolism of carbohydrates and elevated levels of glucose in the blood and urine.
Dirty Wounds	Old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera; this definition suggests that the organisms causing postoperative infection were present in the operative field before the operation.

Endogenous	Growing from or on the inside; caused by factors within the body or arising from internal structural or functional causes.
Epidermis	The surface epithelium of the skin overlying the dermis.
Exogenous	Growing from or on the outside; caused by factors (as food or a traumatic factor) or an agent (as a disease-producing organism) from outside the organism or system; introduced from or produced outside the body.
Exudate	The discharge of fluid, cells, pus, or other substances from cells, blood vessels, or wounds.
Granulation tissue	The fibrous collagen formed to fill the gap between the edges of a wound healing by secondary intention. Capillaries and fibrous collagen project into the wound during the healing process, filling the wound as it heals.
Infection	The invasion and multiplication of microorganisms in body tissues that cause cellular injury and clinical symptoms.
Malnutrition	A serious condition that occurs when a person's diet does not include adequate amounts of nutrients.
Microorganism	An organism that is too small to be seen with the naked eye and requires a microscope. Bacteria, viruses, fungi, and protozoa are generally called microorganisms.
Obesity	Having excess body fat, clinically known as adipose tissue.

Opioid	A drug with opium-like qualities. Opioids reduce pain, cause relaxation or sleepiness, and carry an addictive potential. Opioids include some prescription painkillers, such as oxycodone and hydrocodone. Buprenorphine, methadone, and heroin are also opioids.
Panniculus	A dense layer of fatty tissue growth, consisting of subcutaneous fat in the lower abdominal area.
Subcutaneous Layer	The innermost layer of the skin; it is composed of adipose tissue that merges with the deepest layer of the dermis to provide insulation, shape, and support.
Surgical Site Infection	An infection at the site of a surgical incision; the infection may be superficial, deep, or it may extend to organs.

REFERENCES

1. Bucher B, Warner B, Dillon P. Antibiotic prophylaxis and the prevention of surgical site infection. *Current Opinion in Pediatrics*. 2011;23(3):334-338. DOI: 10.1097/MOP.0b013e3283464a75.
2. Leaper D, Tanner J, Kiernan M. Surveillance of surgical site infection: More accurate definitions and intensive recording needed. *J Hosp Infect*. 2013;83(2):83-86. DOI: 10.1016/j.jhin.2012.11.013.
3. McEwen DR. Wound healing, dressings, and drains. In: *Alexander's Care of the Patient in Surgery* 14th ed; JC Rothrock, ed. St. Louis, MO: Elsevier Mosby; 2011:250-254.
4. Clark RA, editor. The molecular and cellular biology of wound repair. Springer Science & Business Media; 2013.
5. Seifert S, Mower J. Planning and providing care. In: *Assisting in Surgery: Patient-Centered Care*. JC Rothrock, PC Seifert, Eds. Denver, CO: CCI; 2009:320.
6. Korol E, Johnston K, Waser N et al. A systematic review of risk factors associated with surgical site infections among surgical patients. PloS one. 2013;8(12):e83743. DOI: 10.1371/journal.pone.0083743.
7. Dulon M, Haamann F, Peters C, Schablon A, Nienhaus A. MRSA prevalence in European healthcare settings: A review. 2011;11:138. DOI:10.1186/1471-2334-11-138.
8. Badia JM, Casey AL, Petrosillo N, et al. Impact of surgical site infection on healthcare costs and patient outcomes: a systematic review in six European countries. *J Hosp Infect*. 2017;96(1):1-5. DOI: 10.1016/j.jhin.2017.03.004.
9. Broex E, Van Asselt A, Bruggeman C, Van Tiel F. Surgical site infections: how high are the costs?. *J Hosp Infect*. 2009;72(3):193-201. DOI: 10.1016/j.jhin.2009.03.020.
10. Mueck K, Kao L. Patients at high-risk for surgical site infection. *Surg Infect*. 2017;18(4):440-446. DOI: 10.1089/sur.2017.058.
11. Leaper D, Tanner J, Kiernan M. Surveillance of surgical site infection: more accurate definitions and intensive recording needed. *J Hosp Infect*. 2013;83(2):83-86. DOI: 10.1016/j.jhin.2012.11.013.
12. Hart S, Bordes B, Hart J, Corsino D, Harmon D. Unintended perioperative hypothermia. *Ochsner J*. 2011;11(3):259-270. PMID:21960760.
13. Moola S, Lockwood C. Effectiveness of strategies for the management and/or prevention of hypothermia within the adult perioperative environment. *Int J Evid Based Healthc*. 2011;9(4):337-45. DOI: 10.1111/j.1744-1609.2011.00227.x.
14. Tahiri M, Mottillo S, Joseph L, Pilote L, Eisenberg M. Alternative smoking cessation aids: a meta-analysis of randomized controlled trials. *Am J Med*. 2012;125(6):576-584. DOI: 10.1016/j.amjmed.2011.09.028.

15. Chen L, Magliano D, Zimmet P. The worldwide epidemiology of type 2 diabetes mellitus—present and future perspectives. *Nat Rev Endocrinol*. 2012;8(4):228. DOI: 10.1038/nrendo.2011.183.

16. Pear SM. Relationship of Perioperative Hyperglycemia and Major Infections in Cardiac Surgery Patients. *Dissertation for Ph.D in Epidemiology*. University of Arizona; 2004. http://hdl.handle.net/10150/280565. Accessed January 18, 2018.

17. Jonkers D, Elenbaas T, Terporten P, Nieman F, Stobberingh E. Prevalence of 90-days postoperative wound infections after cardiac surgery. *Eur J Cardiothorac Surg*. 2003;23(1):97-102. DOI: 10.1016/S1010-7940(02)00662-0.

18. Alexander J, Solomkin J, Edwards M. Updated recommendations for control of surgical site infections. *Annals of surgery*. 2011;253(6):1082-1093. DOI: 10.1097/SLA.0b013e31821175f8.

19. Moucha C, Clyburn T, Evans R, Prokuski L. Modifiable risk factors for surgical site infection. *JBJS*. 2011;93(4):398-404. PMID:21553798.

20. Ogden C, Carroll M, Kit B, Flegal K. Prevalence of childhood and adult obesity in the United States, 2011-2012. *JAMA*. 2014;311(8):806-14. DOI: 10.1001/jama.2014.732.

21. Colquitt J, Pickett K, Loveman E, Frampton G. Surgery for weight loss in adults. *The Cochrane Library*. 2014. DOI: 10.1002/14651858.CD003641.pub4.

22. Lowe J. Skin integrity in critically ill obese patients. *Critical Care Nursing Clinics*. 2009;21(3):311-322. DOI: 10.1016/j.ccell.2009.07.007

23. Bamgbade O, Rutter T, Nafiu O, Dorje P. Postoperative complications in obese and nonobese patients. *World Journal of Surgery*. 2007;31(3):556-60. DOI: 10.1007/s00268-006-0305-0.

24. Kabon B, Rozum R, Marschalek C, Prager G, Fleischmann E, Chiari A, Kur, A. Supplemental postoperative oxygen and tissue oxygen tension in morbidly obese patients. *Obes Surg*. 2010;20(7):885-894.

25. Phillips J. Care of the bariatric patient in acute care. *J Radiol Nurs*. 2013;32:21-31.

26. Wagner IJ, Szpalski C, Allen RJ et al. Obesity impairs wound closure through a vasculogenic mechanism. *Wound Repair Regen*. 2012;20(4):512–522. DOI: 10.1111/j.1524-475X.2012.00803.x.

27. Graf A, Yang K, Klement K, Kim N, Matloub H. Abdominal suspension during massive panniculectomy: A novel technique and review of the literature. *JPRAS Open*. 2016;8:23-28. DOI: 10.1016/j.jpra.2016.04.001.

28. Gallagher S, Gates J. Obesity, panniculitis, panniculectomy, and wound care: understanding the challenges. *J WOCN*. 2003;30(6):334-341.DOI: 10.1016/S1071-5754(03)00434-0.

29. American College of Obstetricians and Gynecologists (ACOG). Committee on Obstetric Practice. *Committee Opinion*. 2015;549: 1-4.

30. Rush A, Muir M. Maintaining skin integrity in bariatric patients. *Br J Community Nurs*. 2012;17(4):154-159. DOI: 10.12968/bjcn.2012.17.4.154.

31. Cheadle W. Risk factors for surgical site infection. *Surg Infect*. 2006;7(1):S7-S11. DOI: 10.1089/sur.2006.7.s1-7.

32. Dohmen P. Influence of skin flora and preventive measures on surgical site infection during cardiac surgery. *Surg Infect*. 2006; 7(1):S13-S17. DOI: 10.1089/sur.2006.7.s1-13.

33. Burlingame B, Davidson J, Denholm B. Guideline for preoperative patient skin antisepsis. *Guidelines for Perioperative Practice*. 2017;1. DOI: 10.6015/psrp.15.01.043

34. Owens CD, Stoessel K. Surgical site infections: epidemiology, microbiology and prevention. *J Hosp Infect*. 2008;70:3-10. DOI: 10.1016/S0195-6701(08)60017-1.

35. Mioton L, Jordan S, Hanwright P, Bilimoria K, Kim J. The relationship between preoperative wound classification and postoperative infection: a multi-institutional analysis of 15,289 patients. *Archives of Plastic Surgery*. 2013;40(5):522-529. DOI: 10.5999/aps.2013.40.5.522.

36. Mangram A, Horan T, Pearson M, Silver L, Jarvis W. Guideline for prevention of surgical site infection, 1999. *Infect Control Hosp Epidemiol*. 1999; 20(4):247-278.

37. Grabe M, Botto H, Cek M et al. Preoperative assessment of the patient and risk factors for infectious complications and tentative classification of surgical field contamination of urological procedures. *World J Urol*. 2012;30(1):39-50. DOI: 10.1007/s00345-011-0722-z.

38. Dean E. Loaded issue. *Nurs Stand*. 2011;25(41):18-19. PMID: 21815511.

39. Nemeth T, Beilman G, Hamlin C, Chipman J. Preoperative verification of timely antimicrobial prophylaxis does not improve compliance with guidelines. *Surg Infect*. 2010;11(4):387-391. DOI: 10.1089/sur.2008.054.

40. Barchitta M, Matranga D, Quattrocchi A, et al. Prevalence of surgical site infections before and after the implementation of a multimodal infection control programme. *J Antimicrob Chemother*. 2012;67(3):749-755. DOI: 10.1093/jac/dkr505.

41. Kosins AM, Scholz T, Cetinkaya M, Evans GR. Evidence-based value of subcutaneous surgical wound drainage: the largest systematic review and meta-analysis. *Plast Reconstr Surg*. 2013;132(2):443-50. DOI: 10.1097/PRS.0b013e3182958945.

42. Berríos-Torres S, Umscheid C, Bratzler D, et al. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. *JAMA Surg*. 2017;152(8):784-791. DOI: 10.1001/jamasurg.2017.0904

43. Stannard J, Gabriel A, Lehner B. Use of negative pressure wound therapy over clean, closed surgical incisions. *Int Wound J*. 2012;9(s1):32-39. DOI: 10.1111/j.1742-481X.2012.01017.x.

44. Kilpadi D, Cunningham M. Evaluation of closed incision management with negative pressure wound therapy (CIM): hematoma/seroma and involvement of the lymphatic system. *Wound Repair Regen*. 2011;19(5):588-596. DOI: 10.1111/j.1524-475X.2011.00714.x.

45. Beitz J. Providing quality skin and wound care for the bariatric patient: an overview of clinical challenges. *Ostomy Wound Manage*. 2014;60(1):12-21. https://pdfs.semanticscholar.org/9706/a7fceafca1750ad9560d3e60fff3f7f12a54.pdf. Accessed January 21, 2018.

46. Viegas C, Viegas O. Preventing a surgical complication during cesarean delivery in a morbidly obese patient: A simple apparatus to retract the abdominal panniculus. *Medscape General Medicine*. 2006;8(1):52. PMID:16915182.

47. Wall PD, Deucy EE, Glantz JC, Pressman E. Vertical skin incisions and wound complications in the obese parturient. *Obstet Gynecol*. 2003;102(5):952-956. DOI: 10.1016/S0029-7844(03)00861-5.

48. Alanis M, Villers M, Law T, Steadman E, Robinson C. Complications of cesarean delivery in the massively obese parturient. *Am J Obstet Gynecol*. 2010;203(3):271.e1-271.e7. DOI: 10.1016/j.ajog.2010.06.049.

49. Best S, Nakada S eds. Standard laparendoscopic single-site surgery. In: *Minimally Invasive Urology An Essential Clinical Guide to Endourology, Laparscopy, LESS and Robotics*. Springer. New York. 2015.136-139. DOI: 10.1007/978-4939-1317-6.

50. Johnson D, Society for Maternal-Fetal Medicine (SMFM). Management of cesarean delivery in the morbidly obese woman. 2012. http://contemporaryobgyn.modernmedicine.com/contemporary-obgyn/news/modernmedicine/modern-medicine-feature-articles/management-cesarean-delivery?id=&pageID=1&sk=&date=&total_page=3. Accessed January 22, 1018.

51. Bodor G. The laboratory's role in opioid pain medication monitoring. *EJIFCC*. 2012;23(2):55. PMID: 27683413.

52. Lavernia C. Surgeons explore non-opioid options for pain management. *Ortho Today*. 2014. https://www.healio.com/orthopedics/total-joint-reconstruction/news/print/orthopedics-today/%7B9da4e094-2f3d-451d-acbc-5a5f7d4d3e46%7D/surgeons-explore-non-opioid-options-for-pain-management. Accessed January 22, 2018.

53. World Drug Report 2012. United Nations Office on Drugs and Crime (UNODC). http://www.unodc.org/unodc/en/data-and-analysis/WDR-2012.html. Accessed January 21, 2018.

54. Results from the 2012 National Survey on Drug Use and Health: Summary of National Findings. Substance Abuse and Mental Health Services Administration (NSDUH). Series H-46, HHS Publication No. (SMA) 13-4795. Rockville, MD: Substance Abuse and Mental Health Services Administration; 2013.

55. US Department of Health and Human Services (DHS). Results from the 2010 National Survey on Drug Use and Health: Summary of national findings. Substance Abuse and Mental Health Services Administration: Rockville, MD. 2011. http://archive.samhsa.gov/data/NSDUH/2k10nsduh/2k10results.htm#1.1. January 21, 2018.

56. Paulozzi L, Budnitz D, Xi ,Y. Increasing deaths from opioid analgesics in the United States. *Pharmacoepidemiology and drug safety*. 2006;15(9):618-27. DOI: 10.1002/pds.1276.

57. Ambulatory Surgery Center Association (ASCA). ASCs: A positive trend in health care. http://www.ascassociation.org/advancingsurgicalcare/aboutascs/industryoverview/apositivetrendinhealthcare. Accessed January 21, 2018.

58. Anderson DJ, Podgorny K, Berrios-Torres SI, et al. Strategies to prevent surgical site infections in acute care hospitals: 2014 update. *Infect Control Hosp Epidemiol.* 2014;35(6):605-27. DOI: 10.1017/S0899823X00193869.

59. Pieper B, Sieggreen M, Freeland B, Kulwicki P, Frattaroli M, Sidor D, Palleschi MT, Burns J, Bednarski D, Garretson B. Discharge information needs of patients after surgery. *J Wound Ostomy Continence Nurs.* 2006;33(3):281-290. PMID: 16717518.

POST-TEST

Multiple choice/True or False.

Complete the Test Questions. Missed questions will offer the opportunity to re-read the question and answer choices. You may also revisit relevant content.

1. Surgical site infections (SSIs) are diagnosed by a collection of clinical findings occurring within:
   a. 24 hours of surgery.
   b. 7 days post surgery.
   c. 2 weeks post surgery.
   d. 30 days post surgery.

2. According to the text, SSIs are an important target for healthcare-associated infection (HAI) surveillance in:
   1. Europe.
   2. United States.
   3. South America.
   4. Canada.

   a. 1
   b. 1 & 2
   c. 2 & 3
   d. 4

3. Risk factors for SSI include:
   1. obesity.
   2. tobacco use.
   3. intraoperative technique.
   4. high blood pressure.

   a. 1 & 2.
   b. 1 & 4
   c. 1, 2 & 3
   d. 2 & 3

4. During which phase does new epithelium begin to cover the patient's wound?
   a. Reactive phase
   b. Regeneration phase
   c. Maturation phase
   d. Inflammation phase

5. When exudate containing blood, lymph and fibrin clot and loosely bind to the edges of a wound, what begins to form?
   a. Scab
   b. Infection
   c. Inflammation
   d. Scar

6. Obesity is best described as a patient with:
   a. a body mass index over 30.
   b. insulin resistance.
   c. insufficient nutrition.
   d. a body weight above 160 lbs.

7. Obese surgical patients are naturally predisposed to:
   1. intraoperative hemorrhage.
   2. difficulties with positioning.
   3. delayed wound healing.
   4. respiratory Complications.

   a. 1 & 2
   b. 1 & 4
   c. 2 & 3
   d. All of the above

8. The panniculus of an obese patient:
   1. is a large abdominal apron of skin and soft tissue.
   2. is prone to infection.
   3. is extremely dry between the skin folds.
   4. is not prone to infection.

   a. 1
   b. 1 & 2
   c. 1, 2 & 3
   d. 1 & 4

9. A 30 day postoperative surgical site that is red and inflamed in a patient with a temperature of 103.4°F:
   a. is a sign of the normal wound healing process.
   b. is a wound that may be infected.
   c. should be reopened immediately.
   d. is a sign the patient needs to be on antibiotics.

10. The most effective item to use for retracting and holding the panniculus in place during surgery is:
    a. tape.
    b. straps.
    c. panniculus retractors.
    d. manual retraction.

11. Products designed to lift and hold the panniculus can be used:
    a. preoperatively.
    b. intraoperatively.
    c. postoperatively.
    d. All of the above

12. Examples of surgery where a panniculus retractor may be beneficial are:
    1. general surgery.
    2. gynecological surgery.
    3. cranial surgery.
    4. shoulder surgery.

    a. 1
    b. 1 & 2
    c. 3
    d. All of the above

13. The outermost layer of the skin, the dermis, is partly made up of keratin that:
    1. hardens hair and nails.
    2. protects the body from fluid loss.
    3. provides insulation, shape and support.
    4. protects the body from pathogen invasion.

    a. 1, 2, & 4
    b. 1, 3 & 4
    c. 2, 3 & 4
    d. 2 & 3

14. During the nursing skin assessment:
    1. proper assessment of the wound is critical.
    2. can help to avert complications.
    3. the nurse should use approved medical terminology.
    4. the nurse should communicate all findings to the rest of the care team.

    a. 1 & 2
    b. 2 & 3
    c. 1, 2 & 3
    d. All of the above

15. Wound healing is a complex biological process that involves:
    1. inflammation, which is the vascular and cellular response to disposing of bacteria.
    2. the final stage of wound healing where the edges of the wound to form a scab.
    3. epithelial cells migrate to and proliferate the wound to provide a protective barrier that prevents fluid and electrolyte loss and introduction of bacteria.
    4. a process where fibers are closely packed in a crisscross pattern creating a scar.

    a. 1 & 3
    b. 1, 3 & 4
    c. 2, 3, & 4
    d. 2 & 3

16. Nutritional status is important for wound healing. Which of the following directly contributes the growth of new tissue?
    a. Glucose
    b. Ketones
    c. Fructose
    d. Protein

17. When a patient has a large panniculus:
    1. excessive moisture in the skin fold can increase the risk of bacterial incursion.
    2. they are at risk for skin breakdown.
    3. it shields the wound from bacteria and promotes healing.
    4. the pressure of the skin prevents hematoma and seroma formation.

    a. 1
    b. 1 & 2
    c. 3
    d. 3 & 4

18. Hematoma and seroma can be a complication in obese patients with a large panniculus. Hematomas are pools of blood and seromas are collections of:
    a. epithelial cells.
    b. serum.
    c. bacteria.
    d. lipids.

19. Although a patient's skin is never sterile, what should the perioperative nurse do to reduce microorganisms?
    1. Use antiseptic skin prep on the operative area.
    2. Shave the surgical incision area as soon as the patient arrives.
    3. Use antiseptic adhesive drapes.
    4. Use cyanoacrylate-based skin sealants.

    a. 1, 2 & 3
    b. 1, 2 & 4
    c. 2, 3 & 4
    d. 1, 3, & 4

20. When an operative procedure enters into a cavity of the body under controlled circumstances, a surgical site is classified as a:
    a. clean-contaminated wound.
    b. contaminated wound.
    c. dirty wound.
    d. soiled wound.

21. When a wound is grossly contaminated, but infection is not obviously infected it is considered a:
    a. clean-contaminated wound.
    b. contaminated wound.
    c. dirty wound.
    d. soiled wound.

22. An active infection is present in the surgical site it is considered a:
    a. clean-contaminated wound.
    b. contaminated wound.
    c. dirty wound.
    d. soiled wound.

23. In which wound classification does SSI rates exceed 20% and 40% respectively?
    a. Contaminated and soiled wounds.
    b. Contaminated and dirty wounds.
    c. Dirty and soiled wounds.
    d. Dirty and clean-contaminated wounds.

POST-TEST ANSWERS

1. d
2. b
3. c
4. b
5. a
6. a
7. c
8. b
9. b
10. c
11. d
12. b
13. a
14. d
15. b
16. d
17. b
18. b
19. d
20. b
21. a
22. c
23. b