Foundations of Best Practice for Skin and Wound Management

BEST PRACTICE RECOMMENDATIONS FOR THE Prevention and Management of Surgical Wound Complications

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These 2017 updates build on the work of previous author teams and incorporate the latest research and expert opinion.

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Introduction

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The Canadian Patient Safety Institute has identified the safety of surgical care as one of its four priority areas.[1] According to the Organization for Economic Co-operation and Development, 378,448 surgical procedures were performed in Canada in 2013.[2] Surgical procedures can be performed either as inpatient, day surgery with admission of at least one night or, depending on the procedure, in outpatient ambulatory care settings. The final step in the surgical procedure is to close the surgical incision (wound). Many surgical procedures are complex and may carry significant risks for patients regardless of the health-care setting.[3] The patient facing surgery brings their own unique individual health history. Some bring excellent health with the expectation of rapid healing, while others have surgery when their complex health history/issues seriously impair their general recovery and wound healing.[4]

Seventy-seven percent of surgical patient deaths are reported to be related to infection.[5] Infection has a direct correlation to open surgical wounds. Surgical site infection (SSI) is the most common health-care-associated infection among surgical patients.

The Centers for Disease Control in the United States reported that while advances have been made in infection control practices, including improved operating room ventilation, sterilization methods, barriers, surgical technique and availability of antimicrobial prophylaxis, SSI remains a substantial cause of morbidity, prolonged hospitalization and death.[6] Therefore, recognition of the potential for surgical wound infection may be the most important issue to address when discharge planning for a post-surgical patient.[7] In addition, it is estimated that 75% of surgical procedures are

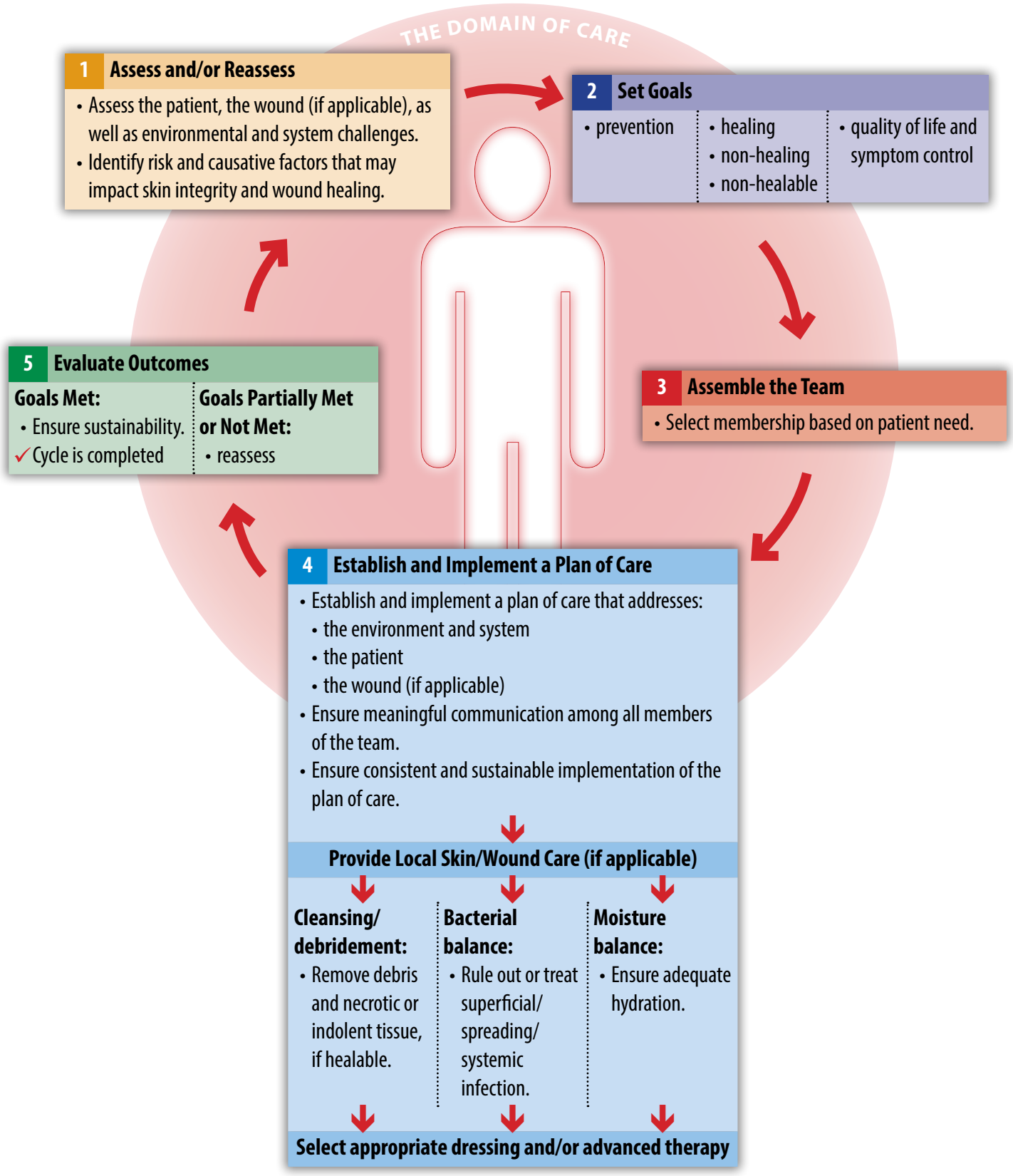
performed on outpatients, making the issues of prevention, detection, treatment and reporting of SSIs in the community or long-term-care sectors essential. For patients who develop an SSI, increased hospital length of stay (LOS) is approximately seven to eight days, while urinary tract infections increase LOS by one to four days, blood-stream infections increase LOS by seven to 30 days and pneumonia increases LOS for seven to 30 days.[8]

SSIs are of growing concern to the health-care system. SSIs account for 16% of all health-care-associated infections; of these, 1% related to orthopedic procedures and 10% to large bowel surgery. SSIs can often be prevented through initiatives focused on pre-, intra- and post-operative care and education.[9,10]

The Wound Prevention and Management Cycle

This paper offers a practical, easy-to-follow guide incorporating the best available evidence that outlines a process, or series of consecutive steps, that supports patient-centred care. This process, called the Wound Prevention and Management Cycle (see Figure 1) guides the clinician through a logical and systematic method for developing a customized plan for the prevention and management of wounds from the initial assessment to a sustainable plan targeting self-management for the patient.

Figure 1: The Wound Prevention and Management Cycle



The recommendations in this document are based on the best available evidence and are intended to support the clinician, the patient, his/her family and the health-care team in planning and delivering the best clinical practice. Two foundational papers supplement this document with additional evidence-informed information and rec-

ommendations that are general to all wound types: "Skin: Anatomy, Physiology and Wound Healing,"[11] and "Best Practice Recommendations for the Prevention and Management of Wounds."[12]

There are three guiding principles within the best practice recommendations (BPRs) that support effective prevention and management of skin breakdown:

1. the use of the Wound Prevention and Management Cycle regardless of the specifics to prevent and manage skin breakdown
2. the constant, accurate and multidirectional flow of meaningful information within the team and across care settings
3. the patient as the core of all decision making

Quick Reference Guide

The quick reference guide (QRG) (see Table 1) provides the recommendations associated with the five steps in the Wound Prevention and Management Cycle (see Figure 1). These recommendations are discussed with the supporting evidence.

Table 1: Wound Prevention and Management Quick Reference Guide

Step		Recommendation	Evidence
1	**Assess and/ or Reassess**	1.1 Select and use validated patient assessment tools. 1.2 Identify risk and causative factors that may impact skin integrity and wound healing. 1.2.1 Patient: Physical, emotional and lifestyle 1.2.2 Environmental: Socio-economic, care setting, potential for self-management 1.2.3 Systems: Health-care support and communication 1.3 Complete a wound assessment, if applicable.	RNAO Ia NICE 2/ RNAO I–IV RNAO IV
2	**Set Goals**	2.1 Set goals for prevention, healing, non-healing and non-healable wounds. 2.1.1 Identify goals based on prevention or healability of wounds. 2.1.2 Identify quality-of-life and symptom-control goals.	RNAO IV
3	**Assemble the Team**	3.1 Identify appropriate health-care professionals and service providers. 3.2 Enlist the patient and their family and caregivers as part of the team. 3.3 Ensure organizational and system support.	NICE 4/RNAO IV RNAO IV RNAO IV
4	**Establish and Implement a Plan of Care**	4.1 Identify and implement an evidence-informed plan to correct the causes or co-factors that affect skin integrity, including patient needs (physical, emotional and social), the wound (if applicable) and environmental/ system challenges. 4.2 Optimize the local wound environment aided through 4.2.1 Cleansing 4.2.2 Debriding 4.2.3 Managing bacterial balance 4.2.4 Managing moisture balance 4.3 Select the appropriate dressings and/or advanced therapy. 4.4 Engage the team to ensure consistent implementation of the plan of care.	NICE 2+/RNAO IV RNAO Ia-III RNAO Ia-IV NICE 4/RNAO IV
5	**Evaluate Outcomes**	5.1 Determine if the outcomes have met the goals of care. 5.2 Reassess patient, wound, environment and system if goals are partially met or unmet. 5.3 Ensure sustainability to support prevention and reduce risk of recurrence.	RNAO IV RNAO Ib-IV NICE 4/RNAO IV

Each recommendation above is supported by the level of evidence employed by the Registered Nurses' Association of Ontario (RNAO) (see Table 2) and the National Institute for Health Care Excellence (NICE) guideline development panels.[13,14] To access the NICE guideline levels of evidence, please use the following link: www.nice.org.uk/guidance/ph1/evidence/methods-for-development-of-nice-public-health-guidance-120988045.

Table 2: Levels of Evidence[13]

Ia	▪ Evidence obtained from meta-analysis or systematic review of randomized controlled trials
Ib	▪ Evidence obtained from at least one randomized controlled trial
IIa	▪ Evidence obtained from at least one well-designed controlled study without randomization
IIb	▪ Evidence obtained from at least one other type of well-designed quasi-experimental study
III	▪ Evidence obtained from well-designed non-experimental descriptive studies, such as comparative studies, correlation studies and case studies
IV	▪ Evidence obtained from expert committee reports or opinions and/or clinical experiences of respected authorities

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The Canadian Patient Safety Institute (CPSI) has developed the "Preventing Surgical Site Infection: Getting Started Kit (2016)" for teams to access and implement.[15]

Step 1: Assess and/or Reassess

Step 1: Assess and/or Reassess

Discussion: Clinicians should complete a holistic patient assessment to identify factors that may affect surgical wound healing in the pre-, intra- and post-operative phases. It is important to note that reassessment needs to occur during the entire post-operative phase. The pre-operative phase is a critical time, offering the opportunity to create an environment that prevents surgical wound complications.

Surgical wounds should be assessed and the findings documented using a standardized approach.[4] Assessment using a comprehensive wound assessment tool provides a baseline and assists with the identification of wound changes. This information assists with identifying either wound healing or deterioration and should guide ongoing treatment decisions. Assessment of the person with a surgical wound begins immediately post-op, however most surgical incisions are not usually assessed until 48 hours after surgery since, in most cases, the original post-operative dressing remains in place for the first 48 to 72 hours.[4,10]

Recommendations

1.1 Select and use validated patient assessment tools.

Discussion: In addition to the wound assessment tools recommended in Wounds Canada's "Best Practice Recommendations for the Prevention and Management of Wounds"[12] article, Pillen et al. identify three additional tools for assessment of surgical and general wounds:[16]

- The Barber Measurement Tool (BMT) uses the percentage reduction in wound size over time as an indicator of healing but was not supported by data.[17]
- The ASEPSIS tool was developed to evaluate the effectiveness of antibiotic treatment on surgical site infections by examining wound characteristics. It was validated for high inter-rater reliability but not evaluated for validity, intra-rate reliability or responsiveness.[18]
- The Granulometer's purpose was to assess the status of skin grafts and had inter- and intra-rater reliability when used by surgeons to determine wound-healing progression. It was not tested with other health-care professionals. It had a non-significant predictive ability for graft take, suggesting that it was not sensitive to small changes.[19]

An additional assessment tool, which contains a section specifically for surgical wounds, is the Outcome and Assessment Information Set-C (OASIS-C), a modification to the Outcome and Assessment Information Set (OASIS) that home health agencies in the United States must collect in order to participate in the Medicare program (Wound, Ostomy and Continence Nurses Society). It provides guidance regarding what is and is not considered a surgical wound.[20] As well, Trexler provides a helpful review of how to use the OASIS-C surgical wound item M1342 to classify surgical wounds.[21]

If the wound results from an intervention that interrupts the intact integumentary system (skin, hair, nails and sweat glands), it is a surgical wound. OASIS-C states that surgery on a pre-existing wound or due to a traumatic injury involving the skin is *not* classified as a surgical wound; however, surgery to repair or remove an injured internal organ due to trauma, where the skin was intact *is* considered a surgical wound.

Also according to OASIS-C, skin grafts over existing wounds are *not* surgical wounds, but donor sites *are* surgical wounds.[22] These definitions are open to discussion and interpretation and, generally, if a surgical procedure is involved, any resulting incision, wound or skin graft is considered either a surgical incision or a surgical wound. If it is not healed in 30 days, it is still considered to be a surgical wound. It is important that there is agreement within each health-care organization about what is and what is not categorized as an open surgical wound.

In OASIS-C item M1342, "Status of Most Problematic (Observable) Surgical Wound," there are four possible choices, each with further description (see Table 3):[23]

1. Newly epithelialized
2. Fully granulating
3. Early/partial granulation
4. Not healing (may or may note be associated with infection)

For wounds healing by primary closure with well-approximated incisions, the close proximity of the incisional edges leaves no areas for granulation to occur. Therefore, only the "newly epithelialized" and "not healing" choices apply. For wounds healing by secondary intention, all four choices would apply.[21]

This guidance applies to surgical wounds closed by either primary intention (specifically, approximated incisions) or secondary intention (specifically, open surgical wounds).

Table 3: Surgical Wound Descriptions

1. Newly epithelialized: ▪ wound bed completely covered with new epithelium ▪ no exudate ▪ no avascular tissue (eschar and/or slough) ▪ no signs or symptoms of infection
2. Fully granulating: ▪ wound bed filled with granulation tissue to the level of the surrounding skin ▪ no dead space ▪ no avascular tissue (eschar and/or slough) ▪ no signs or symptoms of infection ▪ wound edges open
3. Early/partial granulation: ▪ ≥ 25% of wound bed covered with granulation tissue ▪ < 25% of wound bed covered with avascular tissue (eschar and/or slough) ▪ no signs or symptoms of infection ▪ wound edges open
4. Not healing: ▪ wound with ≥ 25% avascular tissue (eschar and/or slough), OR ▪ signs/symptoms of infection, OR ▪ clean but non-granulating wound bed, OR ▪ closed/hyperkeratotic wound edges, OR ▪ persistent failure to improve despite appropriate comprehensive wound management

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1.2 Identify risk and causative factors that may impact skin integrity and wound healing.

Discussion: Performing a thorough and holistic pre-operative assessment will identify any patient-specific risk factors that can be addressed in preparation for surgery. When the surgery is emergent and risk factors cannot be addressed before the intervention, it is important to identify any intrinsic and extrinsic factors that can be mitigated in the post-operative period and to intervene as soon as possible.[24]

1.2.1 Patient: Physical, emotional and lifestyle

Discussion: Knowing which patients are at risk for a surgical wound complication such as an SSI, what to look for, and recognizing the signs and symptoms as early as possible are crucial in order to implement the appropriate plan of care. SSIs are one of the leading causes of nosocomial infections impacting patients.[6]

Pre-operative Physical Assessment

An important strategy to prevent surgical wound complications is completion of a detailed pre-operative assessment to identify potential factors that may impact healing and increase the risk for an SSI. All factors identified pre-operatively that may affect wound healing must be reported to all health-care professionals involved in the patient's post-operative care.[24] If the surgery required is urgent, pre-operative assessment should focus on the body system immediately involved.

The American Society of Anesthesiologists[25] has established categories to classify the patient's physical status to identify patient-related (endogenous) risk factors for developing an SSI, with patients in Class III to V being at higher risk:[26]

- Class I: a normally healthy patient with no functional limitations
- Class II: a patient with mild systemic disease that limits activity but is not incapacitating
- Class III: a patient with severe systemic disease that limits activity, but is not incapacitating
- Class IV: a patient with severe systemic disease that is a constant threat to life
- Class V: a moribund patient who is not expected to survive without the operation

The following 12 key risk factors for complications should be identified and addressed wherever possible:

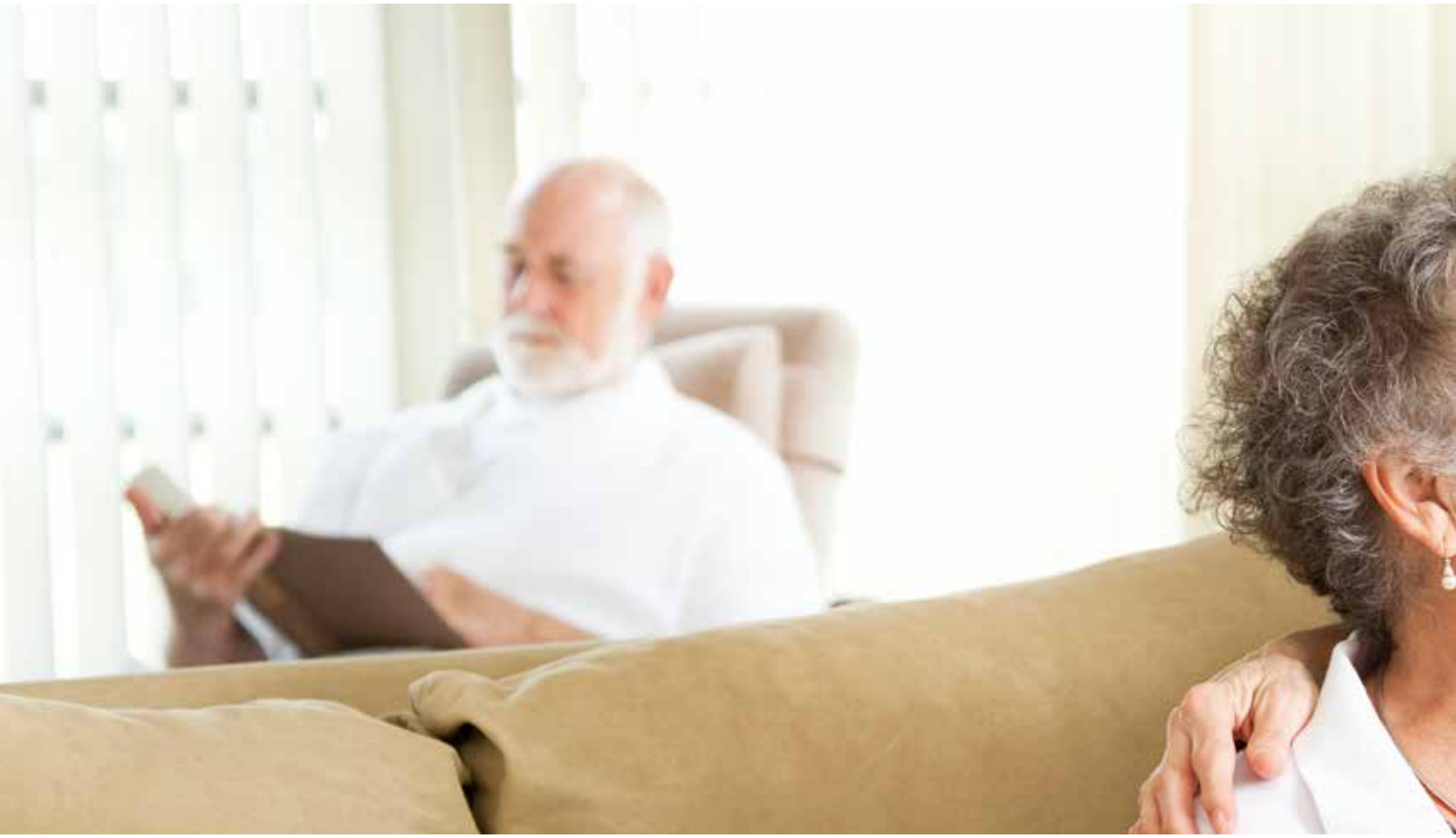
1. obesity
2. malnutrition
3. smoking
4. hypertension and coronary artery disease
5. pre-existing body site infection[5]
6. diabetes mellitus (poor glycemic control)[27]
7. size and virulence of the microbial inoculums[28]
8. general health and co-morbid disease processes, including medications that affect integrity of the individual's host defences[28]

9. alcohol or substance use
10. physical activity and mobility limitations
11. previous complications with anesthetic and surgeries[29]
12. advanced age[24]

Malnourishment impairs healing and increases SSI risk. A body mass index (BMI) that is above or below the recommended level will place the patient at increased risk of poor outcomes. Of concern are males with a BMI > 25 kg/m^2 and women with a BMI > 30 kg/m^2, as this is associated with a five times greater risk of an SSI with subsequent complications than for non-obese individuals.[24,30] This is thought to be related to the increased cardiac output, stroke volume and poorly oxygenated adipose tissue in obese individuals.[31] When there is fatty tissue around the neck and diaphragm and laparoscopic gases, breathing is hindered, causing hemodynamic compromise and further tissue hypoxia.

Surgical patients at risk of possible malnutrition should be screened by a registered dietitian. For hospitalized patients, the assessment should be conducted using a valid and reliable tool appropriate to the patient population. Screening should occur at admission or as soon as possible after admission.[32]

Poor glycemic control and smoking are identified as risk factors for surgical site infections. Patients with diabetes mellitus (DM) are at double the risk of surgical site infections compared with their non-diabetic cohorts.[33] Elevated post-operative glycemic levels are a significant risk factor for SSIs and should be aggressively treated.[34] Ata et



al. state that post-operative glycemic control is of more importance than pre-operative levels in relation to SSIs.[34] Hyperglycemia is associated with surgical mortality and morbidity.[35] In a meta-analysis completed by Sorenson, it was identified that SSIs are two times as likely to occur in smokers than in non-smokers. Assuming that pre-operative screening can occur, smoking cessation should be encouraged for at least four weeks prior to surgery.[36] Discussion regarding risk of smoking when surgical interventions are planned should be part of informed patient consent.[35]

Pre-operative Emotional Assessment

Patient readiness for surgical intervention and emotional health can impact healing and surgical outcomes. For some, the surgery is a welcome solution to a physically limiting condition. For other patients, however, the surgery may be unexpected or consented to only as a life-saving procedure—for example, when a limb is amputated related to diabetes mellitus to prevent the progression of infection. Here the patient may not be fully prepared for this body alteration. The emotional results of this will impact the engagement of the patient to participate in their health and recovery.

For some patients, surgery may mean the end of pain or hope for a cure. It is important to clearly communicate with the patient and family the intended clinical surgical outcomes and the potential unexpected results. Many people experience some level of anxiety prior to surgery, and for people with pre-existing anxiety, it can be exacerbated. Some methods to reduce anxiety include education and patient handouts, with opportunities to talk about their concerns, as well as listening to music or reading prior to surgery, or using relaxation techniques.[37] Sedatives are often administered within two hours prior to surgery, which can help to relieve immediate stress. A com-

prehensive literature review by Rosenberger et al. found in five orthopedic studies that patients who were worried, anxious or depressed pre-operatively were likely to experience a slower recovery, but it did not link these factors to an increased risk of surgical site infection.[38] While we know that psychological stress impacts the immune system and can negatively impact wound healing, at this time the literature does not show a direct link to surgical site infections.[39]

Intra-operative Risks

The risk of developing an SSI can be affected by the nature of the intended surgical procedure; whether or not an SSI develops can depend upon how these factors interact:[28]

- Length of procedure (greater than 75th percentile of predicted operating time increases risk)[26]
- Status of surgery: i.e., clean; clean surgery involving placement of a prosthesis or implant; clean-contaminated; contaminated; or dirty and infected
- Type of surgery: Colon surgery carries the highest risk of an SSI, followed by vascular surgery, cholecystectomy and organ transplant.
- Method of surgery: Laparoscopic versus open colorectal surgery has a statistically lower rate of SSI ($P < 0.0001$), although risk for both types is dependent on the classification (clean versus dirty) and length of surgery.[40] For obese patients, laparoscopic surgery reduces SSI rate by 70 to 80% compared with open surgery across general abdominal surgical procedures.[41]
- Level of oxygenation of the tissues: Surgical wounds are at high risk of hypoxia, so preventative measures should include keeping subcutaneous perfusion and oxygenation optimal (arterial pO_2) and preventing conditions that restrict peripheral perfusion, such as hypovolemia, excessive pain, vaso-constricting drugs and hypothermia.[42]
- Emergent (vs. elective) surgery
- Implants (vs. no implants)
- Use of internal mammary artery grafts (for coronary artery bypass graft)
- Prolonged ventilation
- Use of blood products

Although it can be assumed that the patient's stress levels are reduced with medication during surgery, Nilsson et al. examined the use of relaxing music played in the operating room and concluded that it may decrease post-operative pain.[43]

Post-operative Risks

Many of the SSI risks following surgery are the same as the pre-operative ones. In addition, saturated and/or leaking wound dressings allow migration of bacteria to the wound in a rapid manner.[44] Disruption of the sutured or staple incision by vigorous cleansing before it has re-epithelialized can introduce bacteria below the dermis. Wound dehiscence can occur around the seventh day post-op[21] and often is linked with exudate continuing past 48 hours post-op, an SSI, poor glycemic control, malnutrition and obesity. In addition, mechanical stress on the wound bed from heavy lifting, coughing, vomiting, sneezing and straining increases the risk of dehiscence.[45]

Patients are also at risk for post-operative infections related to post-operative respiratory and urinary infections, infections secondary to wound sepsis or medical devices such as indwelling Foley catheters and intravenous (IV) lines, and diarrhea related to use of antibiotics (e.g., *Clostridium difficile*–associated disease).[10]

Wound dehiscence is a complete or partial disruption of wound closure with or without evisceration and protrusion of tissue or organs. This is a severe complication that may lead to immediate surgical intervention, the possibility of repeat dehiscence, a surgical site wound infection and/or development of incisional hernia formation.[46] In addition, hematoma or seromas may develop and require intervention.[4] The presence of hematomas and/or seromas increases pressure, compresses blood vessels, causing wound ischemia and, if untreated, may cause tissue necrosis. Hematomas can also cause flap necrosis due to a free-radical-induced cytotoxic mechanism.[47] There is an increased occurrence of hematoma or seroma in surgical wounds associated with the increased clinical use of anticoagulants and prophylactic treatments now recommended and implemented for deep vein thrombosis.[4]

1.2.2 Environmental: Socio-economic, care setting, potential for self-management

Discussion: Poor patient self-efficacy, knowledge required for post-operative wound monitoring and communication may lead to negative clinical outcomes.[48] In the RNAO's "Person and Family-Centred Care Nursing Best Practice Guideline," it is recommended that to achieve the goal of "having the person's proactive and meaningful engagement as an active partner in their health care, we should listen and seek insight into the whole person to gain an understanding of the meaning of health to the person and to learn their preferences for care."[49] A therapeutic relationship between the person with the surgical wound and the health-care professional is needed to build a genuine, trusting and respectful partnership.

The RNAO guidelines remind us that we must respect the person as an expert on themselves and their life, which can be difficult in cases where it is identified that they are making negative lifestyle choices.[49] Families and caregivers also have an important role in the care for and recovery of people who have had surgery, and if those supports are not part of an individual's normal life, the patient may be at increased risk for complications.[10]

The patient's values, beliefs, culture, ethnicity, spirituality, wishes, interests, life circumstances (including financial security or worry) and previous health experiences all affect their priorities, concerns and preferences. The RNAO advises the clinician to "take the time to be present, and actively listen (without judgment) to hear and learn."[49]

1.2.3 Systems: Health-care support and communication

Discussion: The National Healthcare Safety Network (NHSN) recommends that SSI surveillance periods be at least 30 days for superficial incisional, deep incisional and organ/space SSIs.[5] In addition, 90-day surveillance is required for specific surgeries (prosthesis/implants). The list of surgical procedures can be found at www.cdc.gov/nhsn/pdfs/pscmanual/9pscssicurrent.pdf. It is the responsibility of organizations to reduce harm, improve health care and protect Canadians by establishing SSI surveillance programs.[5]

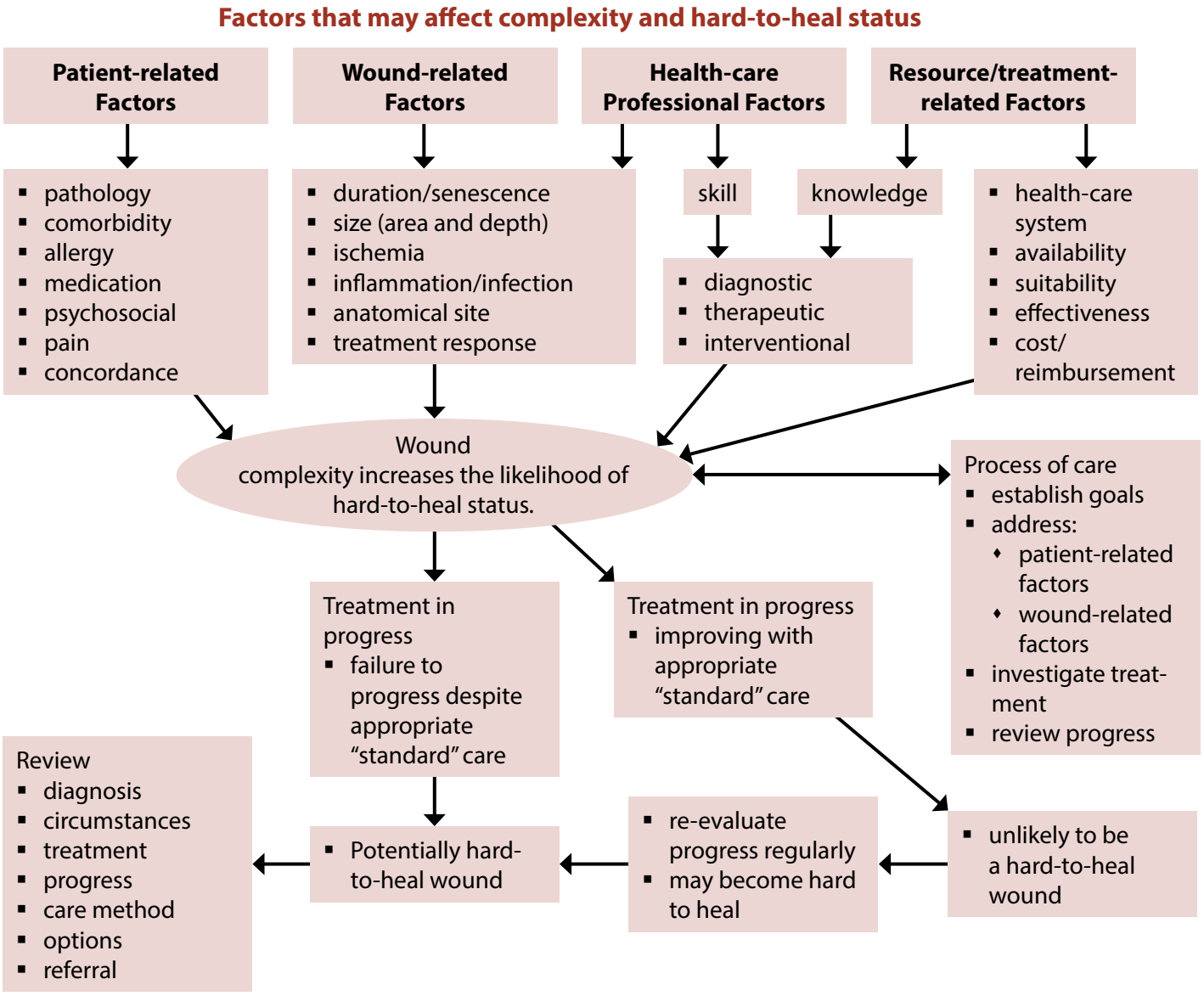
With an increasing number of surgical outpatient procedures taking place,[29] many SSIs will not be captured by hospital SSI surveillance programs. Post-discharge surveillance should occur, with participation of family physicians, nurse practitioners, community

home-care agencies, long-term care facilities, and with a mechanism to report and track recognized signs and symptoms of SSI, so that outcomes and trends can be reported back to hospitals, surgeons and health authorities.

Effective surveillance of SSI includes a focus on targeted high-risk and high-volume operative procedures. Successful SSI surveillance includes "epidemiologically sound infection definitions and effective surveillance methods, stratification of SSI rates according to risk factors associated with SSI development, and data feedback."[29]

In addition, if a surgical wound occurs as a result of an SSI or because it is left open to heal by secondary intention, there are four main factors that may affect hard-to-heal wounds (see Figure 2).[50] This algorithm outlines the relationships among patient, wound, health-care professional and resource/treatment-related factors and is intended to support clinicians in recognizing the complexity of wounds.[51]

Figure 2: Predictors for Wound Healing



Moffat C, Vowden P. Hard-to Heal Wounds: A Holistic Approach. London: MEP Ltd. 2008:1–17. Reprinted with permission.

1.3 Complete a wound assessment, if applicable.

Discussion: It is important to complete a head-to-toe skin assessment to determine risk of or presence of additional skin issues not directly related to the surgical interventions.[12] Assess for skin tears, pressure injuries,[52] medical-device related pressure injuries, mucosal pressure injuries[52] and/or moisture-associated skin damage (MASD-4 types) including: incontinence-associated dermatitis (IAD), intertriginous dermatitis (intertrigo) and moisture-related damage due to tube or drain use or to peristomal issues. In addition, assess for any wounds separate from the post-operative wound assessment.

The three steps below provide a systematic approach to surgical wound assessment and treatment. Depending on their organization, clinicians should follow the recommended assessment for post-operative surgical wound assessment. MEASURE is one example of a mnemonic that helps the team assess wound parameters.[53,54]

1. What are you seeing?

The following parameters identified in the MEASURE mnemonic should be included in the wound assessment and may help the team connect in a common language when monitoring a wound.[53]

- Measure: length, width, depth
- Exudate: quality and quantity
- Appearance: wound bed, including tissue type and amount
- Suffering: pain type and level
- Undermining: presence or absence
- Re-evaluate: monitoring of all parameters regularly
- Edge: condition of edge and surrounding skin

2. When are you seeing it?

It is equally important to note when to look for changes in the surgical wound. Bates-Jensen and Woolfolk describe outcomes and expected time frames for positive and negative results of surgical wound healing.[55]

Positive outcomes

- **Incision:** Colours of the incision are a progression from red with approximated edges (days 1 – 4) to bright pink (days 5 – 14) to pale pink (day 15 – 1 year).
- **Scar tissue:** Light-skinned persons will have white or silver scarring, while persons with darkly pigmented skin will progress from pale pink to darker than usual skin colour.
- **Peri-incision:** There is edema, erythema or skin discolouration, and patient may have warmth or pain; should resolve by day 5.
- **Exudate:** There is minimal/moderate sanguineous to serous exudate (days 1 – 4); this should resolve by day 5.
- **Closure:** Epithelial closure should be seen by day 4 along the entire incision. A healing ridge of newly formed collagen can be felt along the whole incision line during

days 5 to 9. Wound closure materials are removed at some point between days 9 and 14, with skin closure strips or tape strips used after their removal.

Negative outcomes (which may have many deviations from normal):

- **Incision:** Colours of the incision may be red days 1 to 4, but there may be tension on the incision line. By days 5 to 9, the incision may no longer be well-approximated, and the tension remains. By days 10 to 14, the colour may remain red or progress to bright pink, and over the next year, there may be prolonged epithelial resurfacing and/or keloid or hypertrophic scarring.
- **Scar tissue:** There may be prolonged epithelial resurfacing and/or keloid or hypertrophic scarring.
- **Peri-incision:** There may be *absence* of inflammation: no edema, erythema, skin discolouration or warmth, and minimal pain at incision site. May have hematoma or seroma forming, which can progress to days 10 to 14. By days 5 to 9, the signs of inflammation may be present, extending to days 10 to 14. Beyond this, healing can stall or plateau, with no healing and ongoing inflammation lasting 1 to 2 years or longer.
- **Exudate:** Minimal to moderate exudate on days 5 to 9 may be serosanguinous, serous or purulent; any type or amount of exudate beyond that is abnormal.
- **Closure:** When healing is not progressing as expected, removal of skin closures will be delayed for primary closure. For wounds healing by secondary intention, the edges do not approximate, and the wound fails to contract. There will be a lack of epithelial resurfacing of the entire incision by day 4, or it may be only partially present, with lack of the collagen healing ridge and dehiscence evident by day 14. Long-term results will be keloid or hypertrophic scarring.

3. What should you consider if you see it?

Early recognition of alterations in healing, as outlined in number 2, will support early intervention to return the patient to a healing trajectory.

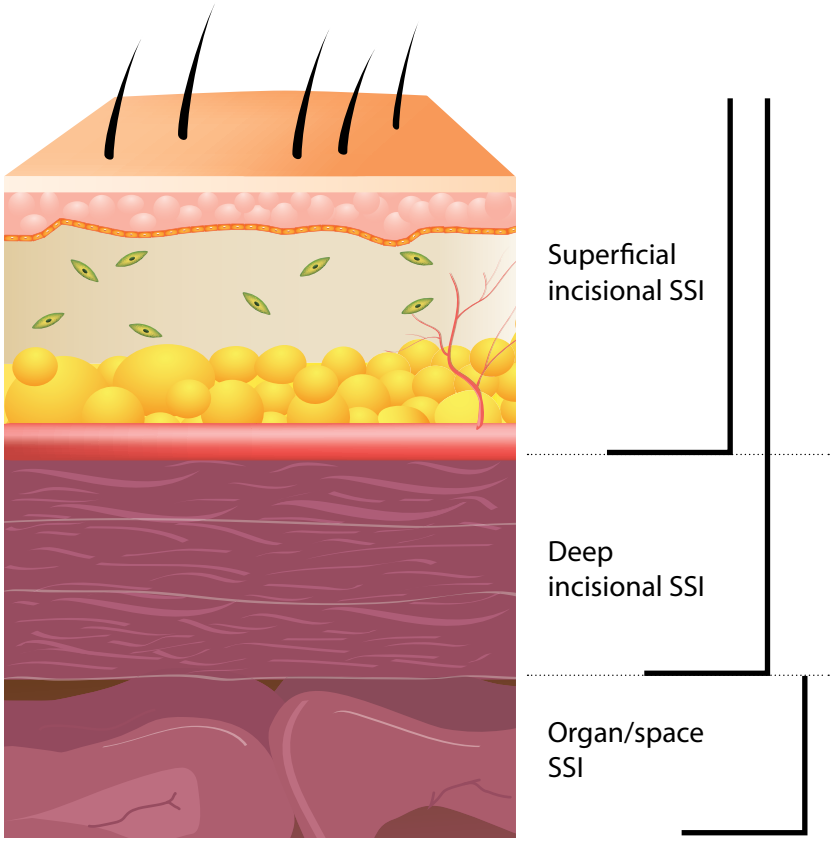
SSIs can be acute (occurring within and lasting < 30 days) or chronic (occurring after 30 days) and range from superficial to deep incision or organ/space infection (see Figure 3).

After surgery, the wounds (not procedures) are classified as follows by the Centers for Disease Control and Prevention (CDC):[29]

- **Clean:** An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital or uninfected urinary tracts are not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage. Operative incisional wounds that follow non-penetrating (blunt) trauma should be included in this category, if they meet the criteria.
- **Clean-Contaminated:** Operative wounds in which the respiratory, alimentary, genital or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, operations involving the biliary tract, appendix, vagina and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered.

- **Contaminated:** Open, fresh, accidental wounds. In addition, operations with major breaks in sterile technique (e.g., open cardiac massage) or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered, including necrotic tissue without evidence of purulent drainage (e.g., dry gangrene) are included in this category.
- **Dirty or Infected:** Includes old traumatic wounds with retained devitalized tissue and those that involve existing clinical infection or perforated viscera. This definition suggests that the organisms causing post-operative infection were present in the operative field before the operation.

Figure 3: Cross-section of Abdominal Wall Depicting CDC Classifications of Surgical Site Infection[56]



Drawing licensed from iStock. Adapted.

The respective clinical presentations are different, with differing long-term outcomes. Studies have identified the importance of SSI surveillance for at least 30 days, if not for a year, following surgery.[57,58] Certainly SSIs related to artificial hardware, such as total hip or knee arthroplasty, can occur up to a year following the surgery and need to be identified as such.

SSIs can be divided into three categories, with various signs and symptoms.

For a detailed description of the criteria for each of the three categories of SSI—superficial incisional, deep incisional and organ/space—please visit the following page: www.cdc.gov/hicpac/SSI/table1-SSI.html.

Step 2: Set Goals

Step 2: Set Goals

Discussion: Goals are set with patients living with surgical wounds and the rest of the care team.

Based on identified risk factors and complete patient, wound and environmental assessment, goals need to be set in collaboration with the patient, family and/or caregiver. Patient priorities and goals for health care in regard to the surgical wound must be identified along with the available options so that informed decisions can be made. Although it may not always be easy, in the end, health-care providers must respect the person's right to choose the interventions they prefer for their health.[49] There *are* times when the patient's wishes cannot be consulted: during surgery, if a decision must be made, based on clinical decisions alone, to leave the wound open to heal by secondary or tertiary means, or if a primarily closed wound continues to drain beyond the expected 48-hour time-frame and/or if the wound dehisces.

Recommendations

2.1 Set goals for prevention, healing, non-healing and non-healable wounds.

Discussion: When the person with a surgical wound is initially recovering, they are also coping with the effects of anesthesia, analgesia, disrupted sleep patterns and impaired nutrition, and they may have weakness, nausea and pain. The initial short-term goals should address these issues and promote healing and restoration of health.

2.1.1 Identify goals based on prevention and healability of wounds.

Discussion: In the absence of an SSI, the factors that delay healing in surgical wounds are similar to those in any chronic wound. There are some significant differences, however, regarding the results of an SSI, when there are implanted devices, hardware, mesh or organ transplants.

The three surgical wound closure goals are as follows:

1. Closed surgical wounds that heal by primary intention are those where the skin edges are joined together, without any areas of separation, eliminating dead space and minimizing the need for new tissue formation.[59] These wounds generally heal without complications and with minimal scar formation and do not contain granulation tissue. Exudate from acute surgical wounds is rich in white blood cells, essential nutrients and growth factors that support the stimulation of fibroblasts and production of endothelial cells.[60] Re-epithelialization of the uppermost approximated skin edges normally occurs within 24 to 48 hours and wound closure at two to three days.[61,62] Normal practice, however, is to keep sutures or staples intact for seven to 10 days and sometimes longer at the surgeon's discretion. Acute surgical wounds heal within an expected time frame and without complications.[4]
2. Delayed primary closure of a surgical wound may be used to prevent infection in contaminated surgical wounds. The wound is allowed to remain open for several days before final closure to ensure all sources of contamination have been removed and/or infection is resolved.[59] Another term for this method is *healing by tertiary intention*.

3. Surgical wounds that may be dirty or infected heal best by secondary intention, where the wound is left open and heals when granulation tissue fills the wound from the base up.[59] Failed primary closure incisions that dehisce or separate are often best left to heal by secondary intention.

It may also be that the wound is deemed "non-healable," because there is no opportunity for healing due to co-morbid factors, or that major surgery is required to close the wound but the person's health precludes that from happening.

2.1.2 Identify quality-of-life and symptom-control goals.

Discussion: Not all patients look to healing as a goal of care. Pain or tenderness alone can be a symptom of an SSI, and pain levels need to be consistently addressed to determine if pain reduction goals are being met.[29]

Step 3: Assemble the Team

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Discussion: Health-care professionals and patients must take responsibility for doing all they can to support a holistic, integrated approach to care and work together to ensure the best possible outcomes. As surgery-related procedures (including preparation, intervention, discharge and follow-up) involve shorter hospital stays, a trusting, positive relationship must be developed among the patient, surgical team and follow-up clinicians. Patients need to know who the members of their team are, and the roles each plays, if they are to fully participate in the planning of their care long-term.

Recommendations

3.1 Identify appropriate health-care professionals and service providers.

Discussion: Surgical-wound healing requires a collaborative team approach.[9] An integrated approach allows for the safe and efficient treatment of patients who are at high risk for surgical site complications.[63] From the physician consult to the laboratory and diagnostic department, community pharmacists, the pre-admission care team, community nurses, dietitians, spiritual care providers, physiotherapists and the in-house surgical team—in pre-, intra- and post-operative phases—many clinicians are involved with the patient and family. It is important that the goals that are set support the patient through the physical and psychosocial challenges that arise from having a surgical wound—especially one with complications.

The team's attitude and approach can affect surgical wound healing. Collaboration and mutual respect, leadership sharing, decision-making, authority and responsibility are key elements of successful integrated teams, and this applies whether the team is within one organization or scattered across the care continuum.[13] Surgeons are legally responsible for the care of surgical wounds until they heal. Nurses must be aware of their own authority, as regulated by their college of nurses and their scope of practice, regarding wound care.

For example, in Ontario, initiation of wound care below the dermis is within the controlled acts authorized for Registered Nurses (RNs) and Registered Practical Nurses (RPNs). The College of Nurses Ontario notes that "Nurses may independently decide that a specific procedure is required and initiate the proce-

dure *in the absence of a direct order or directive from a physician*."[64] When a surgeon has provided an order for a specific wound treatment, a nurse does not have authority to change the order. Doing so, without contacting and communicating with the physician, jeopardizes the surgeon-patient-nurse relationship.

Instead, through surveillance and collaboration, teamwork helps to prevent surgical wound complications and manage them when they occur. Effective teamwork requires clear communication. Griffin reported that "communication failure is at the core of nearly every medical error and adverse event."[5,65]

3.2 Enlist the patient and their family and caregivers as part of the team.

Discussion: Patient involvement starts in the doctor's office or emergency room, as soon as patients are made aware of the need for a surgical intervention. When possible, patients can work with their family doctor, the surgeon and the pre-operative team for optimal surgical preparation to reduce post-surgical complications. Healthcare professionals can help patients verbalize their wishes and set short- and long-term goals.

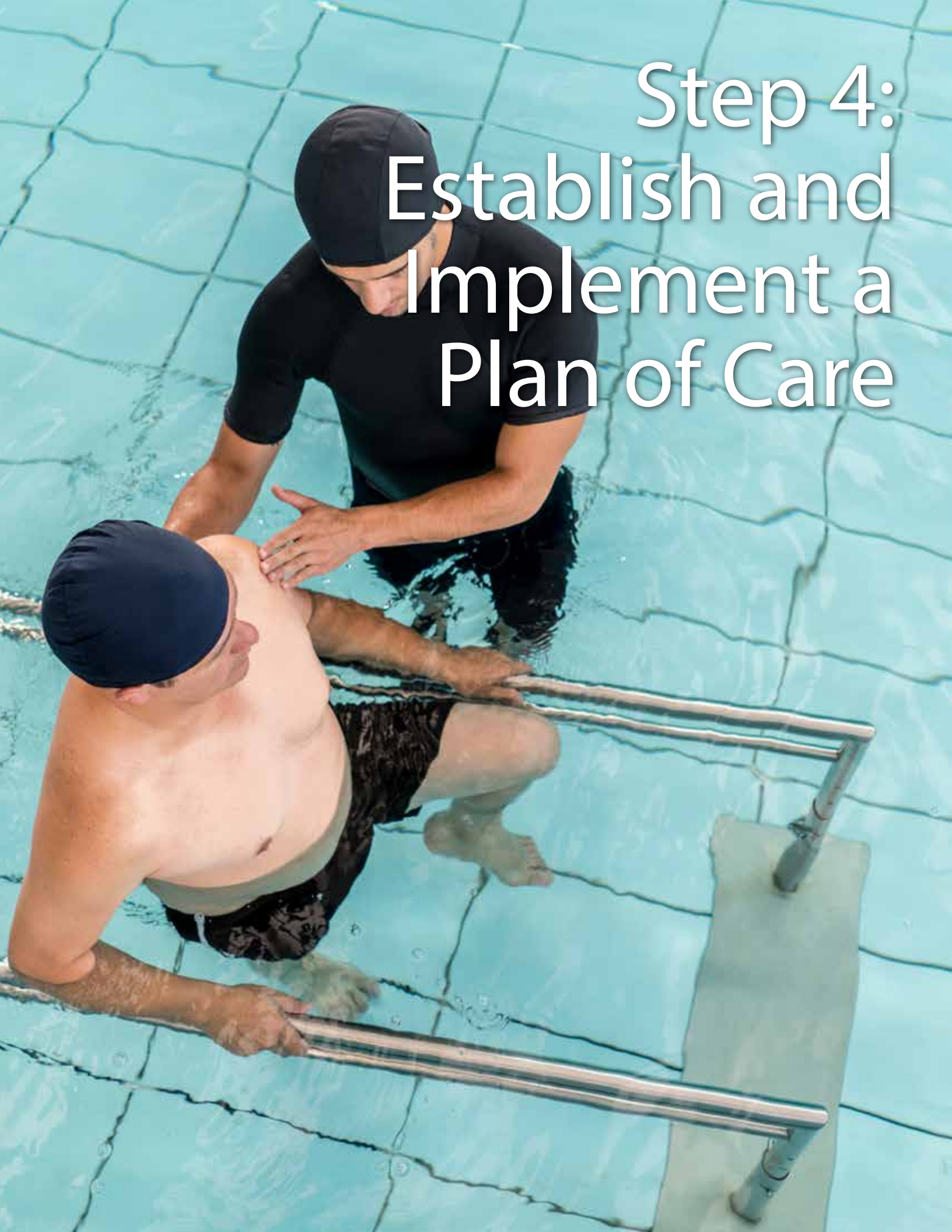
Each patient must be understood and approached as a unique human being.[66] The plan of care needs to be meaningful to the person within the context of their life.[49] In our richly diverse country, care should be culturally appropriate, sensitive to traditions and still meet patient and family needs. According to the Public Health Agency of

Canada (PHAC), "Offering patients and [caregivers] clear, consistent information and advice throughout all stages of their care . . . including the risks of SSIs, what is being done to reduce them and how they are managed," is a key priority.[9]

3.3 Ensure organizational and system support.

Discussion: The RNAO Interprofessional Best Practice Guideline (BPG) has clear recommendations for leaders of key agencies to collaborate to make interprofessional care a collective strategic priority.[13,66] Interprofessional care must align with organization initiatives for healthy work environments, including an evidence-informed approach to planning, implementation and evaluation of joint activities.

The reality is that the integrated health-care team for care of an open surgical wound may work for and report to a number of agencies, depending on the province or territory. For example, the surgical operating theatre personnel may write a report or discharge summaries that are not, or cannot be, shared with the regulated health-care providers responsible for patient care in the community (e.g., the primary care general practitioner, physician, nurse practitioner, home-care staff or long-term care staff). In the same way, community nurses are often challenged by a lack of patient post-operative surgical information and a secure electronic way of sending wound photographs to the surgeon. As well, there is a need for more research to develop and test options for integrated care/case conferencing and securely sharing patient information in a timely way within a virtual environment.



Step 4: Establish and Implement a Plan of Care

Step 4: Establish and Implement a Plan of Care

Discussion: The integrated team needs to create a treatment plan to eliminate or reduce factors that may negatively affect surgical-wound healing in the pre-operative, intra-operative and post-operative phases of care. Strategies that promote timely healing of surgical wounds are essential in all phases of care.

Recommendations

4.1 Identify and implement an evidence-informed plan to correct the causes or co-factors that affect skin integrity, including patient needs (physical, emotional, and social), the wound (if applicable) and environmental/system challenges.

Discussion:

Pre-operative Strategies

Pre-operative treatment plans can reduce the risk of a surgical wound failing to heal, a wound dehiscence, an SSI, or any surgical-wound complication. Plans in the pre-operative phase may include smoking cessation, review of physical activity levels, obesity assessment and education about glycemic control, nutritional screening and counselling to correct any deficiencies that may cause delayed healing or immunosuppression. The Canadian Malnutrition Task Force has guidelines and a screening tool, found at http://nutritioncareincanada.ca.

Pre-admission nursing staff, family physicians, diabetes educators, enterostomal therapists/wound care clinicians and pharmacists can all play a role in patient education and pre-operative discussions. People having surgery and their caregivers should receive information and advice on wound and dressing care, including how to recognize problems with the wound and whom to contact if they are concerned.[10] Pre-operative education should involve a review of post-operative instructions with the patient, family and/or caregivers. In this case, patients may choose a family member or caregiver to participate in the education sessions.

Surgical education should continue post-operatively with the patient and family-designate. Education materials for patients need to reflect the needs of the population to which they are distributed. Topics should include hand hygiene, SSI risks, team members' contact information and should reflect the languages, reading levels, culture and traditions of the population.

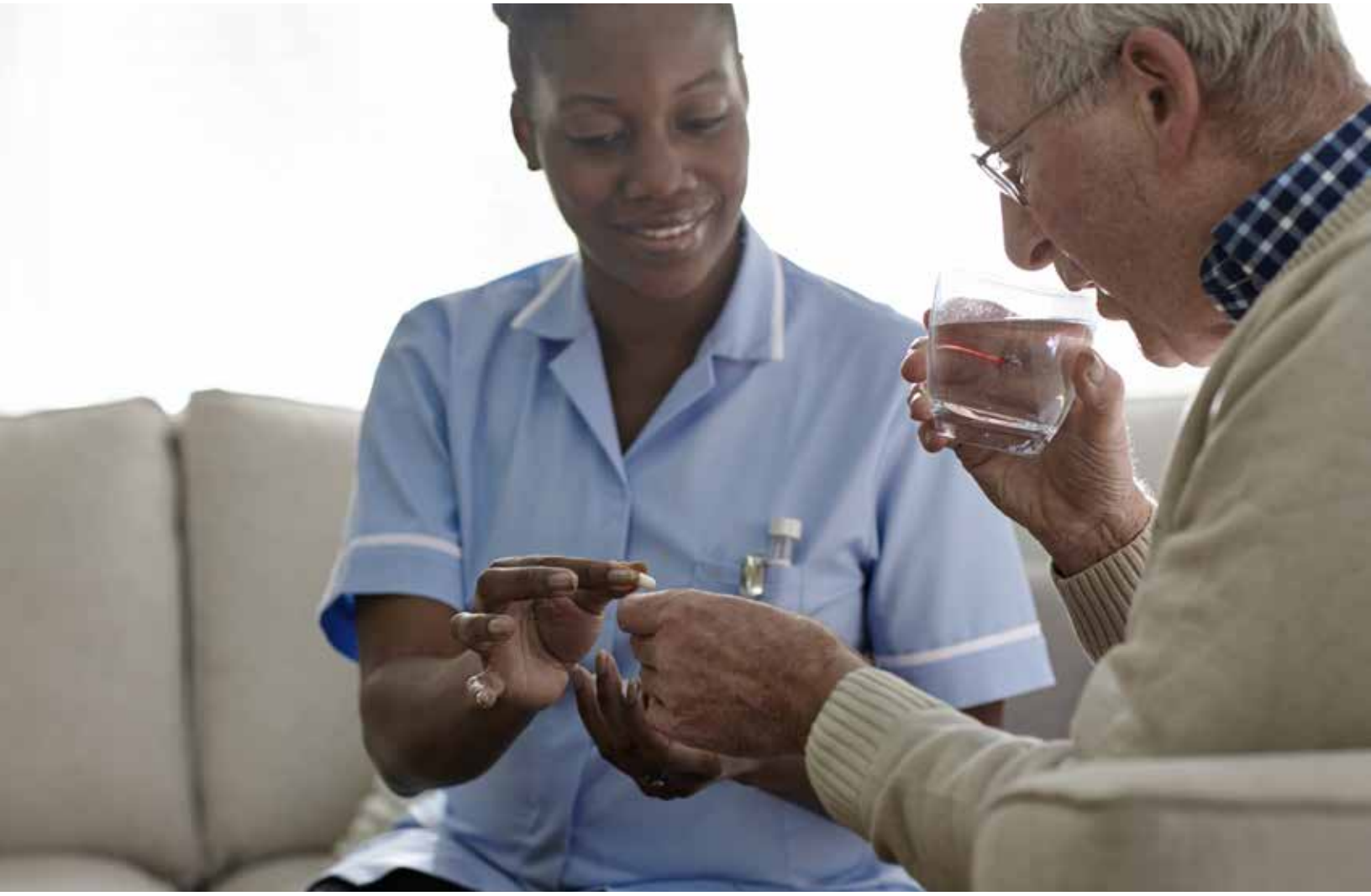
Recommendations for SSI reduction during the pre-operative phase include several strategies. Patients should be advised or helped to have a shower, bath or bed bath using soap on the day before or the day of surgery. Recent studies report the role of pre-operative showering or bathing with antiseptics in preventing surgical site infections to be uncertain. More research is needed on this important topic.[10] Similarly, evidence related to the role of pre-operative hair removal in reducing SSIs is insufficient. If hair removal is needed, it is best to clip hair the day of surgery.[10]

People having surgery for which antibiotic prophylaxis is indicated receive this in accordance with the local antibiotic formulary.[10] Local epidemiology and resistance patterns do vary, especially as antibiotic choices can change with specific cases. An excellent Canadian resource can be found in the Canadian Patient Safety Institute

"Getting Started Kit," which includes recommended doses, administration and re-dosing intervals for commonly used antimicrobials for surgical prophylaxis.[5]

Intra-operative Strategies

People having surgery are cared for by an operating team that minimizes the transfer of micro-organisms during the procedure by following best practice in hand hygiene and theatre wear, and by not moving in and out of the operating area unnecessarily.[10] Staff protocols should include the removal of all hand jewellery, artificial nails and nail polish before operations.[9]



The skin should be prepared at the surgical site immediately before incision, using an antiseptic (aqueous or alcohol-based) preparation. Povidone-iodine or chlorhexidine are most suitable.

A paradox occurs with the use of diathermy to create the surgical incision: it *increases* the risk of an SSI, even though it is faster than a scalpel and causes less bleeding, both of which individually, when not associated with diathermy, *decrease* the risk of an SSI. If diathermy must be used, antiseptic skin preparations should be allowed to dry by evaporation. Pooling of alcohol-based solutions should be prevented.[9] Studies comparing different closure techniques, i.e., continuous versus interrupted sutures, have not found a statistically significant difference in the SSI rate, but using continuous

sutures is quicker.[68] Suturing techniques such as progressive tension closure using a regular or a barbed suture technique in conjunction with drains for abdominoplasty are being explored as ways to decrease the risk of seromas,[69,70] and low-tension sutures are more conducive to healing than those applied with too much tension, which can cause skin injuries on their own. Retention sutures, which are intended to prevent wound dehiscence in abdominal surgery, can cause increased pain, lacerations and pressure injuries. A prospective study examining the benefit of prophylactic retention sutures post-laparotomy concluded there was no significant decrease in incidence of post-operative evisceration, wound infection and post-operative pain.[70]

Adults having surgery under general or regional anaesthesia must have normothermia maintained before, during (unless active cooling is part of the procedure) and after surgery.[10] Strategies to maintain patient homeostasis and normal body functions during the intra-operative and post-operative periods include maintaining a body temperature of 37°C or 98.6°F, providing supplemental oxygen in the recovery room and maintaining a hemoglobin saturation rate (SpO_2) of 95% during the operation and the immediate post-operative period.[9] Proper hydration during the peri-operative period is warranted, although further research is required to demonstrate whether supplemental fluids reduce the risk of an SSI.[9]

Safer Healthcare Now recommends the initiation of four key strategies in the peri-operative phase to reduce an SSI:[5]

1. Perioperative antimicrobial coverage
   a. appropriate use of prophylactic antibiotics
   b. antiseptic use – bathing, showering
   c. decolonization
   d. antiseptic-coated suture
2. Appropriate hair removal
3. Maintenance of peri-operative glucose control
4. Peri-operative normothermia

Post-operative Strategies

Depending on the surgery type, post-operative pain can be either nociceptive or neuropathic, or a combination. Opiates remain key to post-operative pain management, but nonsteroidal anti-inflammatory agents (NSAIDS) can help to reduce the amount of opiates required in the acute phase, thus reducing opioid side effects.[72] Post-operative music therapy may reduce the patient's anxiety, pain and morphine consumption.[43] Other comfort measures such as non-stick dressings, warmed solutions and sitz baths for perineal wounds can be tailored to the patient's needs and situation but need to be evaluated for effectiveness.[10] The patient must be given an opportunity to discuss their knowledge and beliefs about pain management strategies and provide information as needed. Their response to the pain management interventions must be consistently reassessed using the same re-evaluation tool. The frequency of reassessments will be determined by presence and type of pain, e.g., acute versus persistent, pain intensity, medical condition and practice setting.[10]

Consider prompt post-operative nutritional support to prevent wound dehiscence caused by malnutrition.[45]

Managing an SSI may require that an infectious disease practitioner be added to the integrated team. SSIs resulting from inpatient procedures may be recognized while the patient is still in hospital or, more commonly, after discharge. Furthermore, since up to three-quarters of all surgical procedures are performed in the hospital outpatient setting, most SSIs will be recognized in the community; therefore, discharge planning must address the recognition of the early signs and symptoms of surgical wound complications.[56,73]

System Support

SSIs are the third most common hospital-acquired infections in Canadian acute-care facilities, and they cause considerable morbidity and increased medical costs. Therefore, maintaining only in-hospital surveillance can conceal significant SSI rate increases or outbreaks and prevent timely feedback and implementation of interventions to improve patient outcomes. Because many post-operative infections occur after discharge from acute care, careful follow-up in the community is essential.[7] Community-care nurses are well-positioned to support post-discharge SSI surveillance programs among the various types of patients in which SSIs can occur.[74,75]

4.2 Optimize the local wound environment through

4.2.1 Cleansing

Discussion: Wound cleansing at its best should remove foreign bodies such as organic or inorganic debris, inflammatory contaminants such as devitalized tissue, bacteria and wound exudate without causing trauma to healthy cells or introducing bacteria deeper into the wound.[76]

Care of a post-operative wound healing by primary intention should employ a non-touch aseptic technique using sterile saline up to 48 hours after surgery. Showering is permitted 48 hours after surgery in most cases; however, the decision is up to the attending surgeon and will be tempered by factors such as drains, hardware and skin grafts.[9] Attempts to cleanse a primary incision in early stages can disrupt the pathogenic organisms along the suture line.[77] Most surgical incisions do not require cleansing,[78] but cleansing may contribute to patient comfort and remove any materials that may delay the healing process.[79]

Cleansing of surgical wounds that dehisce, are to heal by secondary intention or have an increased bacterial load require clinical assessment and consideration of the type of cleansing agent and technique to be used. Each of the options may have clinical benefits as well as precautions. The NICE guidelines recommend that tap water be utilized for wound care after 48 hours if the incision has separated or has been surgically opened to facilitate the drainage of pus. The Joanna Briggs Institute cautions that tap water for post-operative wounds should not be used if it has been declared non-potable.[80] If used, the tap should be run for 15 seconds prior to use, and safety of the tap water must be assured in rural areas. The choice of solution should reflect patient preference and a formal economic evaluation. Boiled and cooled water is an acceptable solution in the absence of potable tap water, although in the authors' experience, many health-care professionals still prefer to use sterile normal saline in their care of dehisced incisions, high-risk wounds and particularly when vascular grafts or hardware are involved.

A primary incision that has even small areas of dehiscence should *never* be irrigated without speaking with the surgeon first; irrigation can introduce pathogens into deeper compartments, causing increased risk of infection, particularly in highly vascularized areas such as the scalp and face.[81]

Wound irrigation considerations are as follows:

- Hand hygiene procedures and aseptic technique should be employed.
- The clinician and patient should wear protective goggles and clothing as required.
- Some clinicians advise that irrigation is not appropriate if you cannot see the

base of the wound; decisions about irrigation of surgical wounds should rest with the surgeon, as noted above.

- Forcing the irrigation fluid should never be done, as it can breach the fascial plane.
- The volume of irrigation solution should be dependent on the size of the wound and the amount of infection and/or devitalized tissue. An adequate volume of solution should be used to assist in removal of debris (biofilm).
- A non-sterile container should be used to catch and measure the amount of irrigation solution. Use of gauze, blue pads or abdominal pads to catch irrigation returns is needless and costly.
- The tissue above the tunnel or undermining should be massaged gently to expel the irrigation fluid.
- Where possible, the patient should turn from side to side to assist with irrigation returns.
- It is important to ensure that the majority of the irrigation fluid is recovered. If it is not, irrigation is not appropriate.
- Two adages may apply here: "The solution to pollution is dilution" and "Irrigate until the returns are clear."[81]

4.2.2 Debriding

Discussion: The removal of necrotic tissue will help to reduce bacterial burden in the management of an SSI. In collaboration with the surgeon, clinicians must determine what method of debridement is most appropriate: debridement with speed (surgical debridement done by the surgeon), conservative sharp wound debridement (CSWD) of necrotic tissue by a competent physician, nurse or physiotherapist; mechanical debridement, using irrigation with forces of 7 to 15 pounds per square inch (psi), adequate volume of solution, or compresses; autolytic debridement with careful dressing selection or a combination of methods.[12]

The team must decide who is the most appropriate health-care professional to perform debridement of the necrotic tissue. Policies, procedures and skilled practitioners need to be in place for effective conservative sharp wound debridement.[82] More extensive debridement should be carried out only by the surgical team or by persons with the appropriate skill level. Sharp debridement requires that appropriate analgesia be provided to the patient before, during and after the procedure, and that the setting allow for the achievement of hemostasis.[12]

According to the NICE guidelines, eusol (hypochlorite bleach) in gauze, moist cotton gauze or mercuric antiseptic solutions should NOT be used to manage surgical wounds that are healing by secondary intention. [9] There is not enough high-quality evidence to support eusol versus that of alginates, so the issue is not that it caused harm. The toxicity index would be dependent on the amount of dilution used. There *are* newer, safer antiseptic solutions for use when wounds contain bacterial biofilm, localized infection, debris or necrotic tissue. These include a non-toxic, pH-balanced, hydrochlorite 1:1000 and hypochlorous acid solution being used for debridement and odour management, and a polyhexamethylene biguanide (polyhexanide or PHMB) formulation that reduces surface tension, aids removal of debris, bacteria and biofilm, and can be used following sharp debridement.[83]

In some centres, medical-grade maggot therapy may be employed to debride surgical wounds, but there is limited access, and they are not routinely used across Canada at this time. An excellent resource for nurses can be found at www.clwk.ca/buddydrive/file/guideline-maggot-debridement-therapy/.

4.2.3 Managing bacterial balance

Discussion: Management of bacterial balance is essential for decreasing SSI risk. A complete and holistic patient assessment prior to surgery will allow the health-care team to identify and address factors that increase a patient's risk of developing an SSI to more effectively reduce bacterial load and optimize patient status. If an infection is suspected, a semi-quantitative wound swab for culture and sensitivity should be done to determine appropriate antibiotic intervention.

The use of peri-operative prophylactic antibiotics can effectively decrease bacterial load and SSI risk. However, the indiscriminate use of antibiotics has contributed in part to the development of antibiotic-resistant strains of bacteria (e.g., methicilliin-resistant *Staphylococcus aureus* [MRSA], vancomycin-intermediate or -resistant strains of *Staphylococcus aureus* [VISA/VRSA], vancomycin-resistant *Enterococcus faecium* and multi-drug-resistant *Pseudomonas aeruginosa* and *Acinetobacter* species). Therefore, peri-operative antibiotic prophylaxis should be used based on SSI risk assessment. Surgeries that require the use of antibiotic prophylaxis include clean surgeries involving the placement of a prosthesis or implant, clean-contaminated procedures and contaminated surgeries.[10]

When an SSI occurs, treatment will be based on assessment of patient, infection (acute versus chronic) and organism factors.

Acute SSI

Recommendations for the treatment of acute SSIs are shown in Table 4, organized by the parameters of time.

SSIs rarely occur during the first 48 hours after surgery, and fever during this early period usually arises from noninfectious or unknown causes. Superficial SSIs occur within 30 days of surgery, and 90 days for deep or organ space SSI.[29] This is a change from the CDC 1999 definitions, which included up to one year for implants.[79]

Chronic SSI

Managing a chronic SSI requires treatment based on the duration (generally more than one month) and location of the wound and the type of infection involved. Clear guidelines for the management of infection in a chronic surgical wound are less well defined and usually rely on expert opinion.

Generally, the clinician must identify and correct the underlying surgical and non-surgical factors that have led to the infection. Further surgical intervention is frequently required, depending upon the problem, usually to remove devitalized tissue or infected foreign material, close a fistula or ulcer space or drain/remove a sinus tract. Multi-resistant micro-organisms such as MRSA, other Gram-negative bacteria or fungi may be involved. Long-term antibiotics are usually required, based on the antimicrobial susceptibility patterns of the isolated microbiota. Rehabilitation is frequently needed as part of the recuperation phase. In part depending on the type of surgery involved, such as hip or knee arthroplasty, an SSI may mean a further loss of mobility. In the Canadian Institute for Health Information (CIHI) report on compromised

wounds in Canada 2011–2012, iatrogenic wounds, which include post-procedural complications/infection/disruption, post-device, implants and graft infection and obstetric surgical wound or puerperal infection, accounted for the following numbers:[84]

- Acute care 41,255 (1.7%)
- Home care 3,152 (2.9%)
- Continuing complex care 2,753 (13.8%)
- Long-term care 1,818 (1.3%).

According to the to the CIHI, "Complex continuing care, primarily in Ontario, provides hospital-based, medically complex and specialized services, sometimes over extended periods of time, that are not available at home or in long-term care facilities. Complex continuing care had by far the highest reported prevalence of compromised wounds. Not only are the patients in this setting at highest risk, but some are admitted to complex continuing-care beds in part to treat persistent post-surgical wounds or ulcers acquired in other settings."[84]

Table 4: Management Recommendations for Acute Surgical Site Infections[86,87]

Parameters of time	Action
Fever < 48 hours after procedure (and up to 96 hours)	▪ Less likely to represent SSI in this time period ▪ If no other systemic signs/symptoms are present, observation is indicated. ▪ True soft-tissue emergencies include necrotizing clostridial, streptococcal or mixed anerobic infections. Management for these cases includes the following: ♦ urgent surgical consultation for debridement of involved tissue ♦ administration of empiric antimicrobial therapy, based on the diagnosis, likely causative micro-organisms and local resistance patterns ♦ specialist (infectious disease) consultation may be required. Antimicrobial combinations may include: · piperacillin/tazobactam, ampicillin/sulbactam or carbapenems +/– vancomycin (in the absence of a definitive diagnosis) · penicillin G + clindamycin (definitive therapy) · cefazolin + metronidazole · vancomycin + metronidazole
Fever > 96 hours after procedure	▪ Conduct a wound assessment for signs/symptoms of infection and assess for systemic signs/symptoms of infection. ▪ When applicable, remove sutures, perform incision and drainage of the surgical site and culture for bacterial pathogens. ▪ Consider ultrasound studies to assess for abscess formation. ▪ Systemic antibiotic therapy is indicated for cases with systemic signs of infection. ▪ For surgical procedures conducted above the waist (i.e., trunk, head, neck or extremities), consider the following antimicrobial therapy: ♦ first-generation cephalosporin with MSSA activity (e.g., cefazolin) ♦ vancomycin or linezolid (based on local MRSA rates) ▪ For surgical procedures involving the axilla, gastrointestinal tract, perineum or genitourinary tract, agents with activity against Gram negative and anerobic bacteria are recommended: ♦ cefazolin + metronidazole ♦ ciprofloxacin + metronidazole ♦ vancomycin + ciprofloxacin + metronidazole

Localized Infection

Wolcott et al. found that 95% of all bacteria that might be associated with or causative factors for SSIs are never isolated and so have never been identified and actually require molecular techniques to detect. More than 99% of bacteria identified in every environment are organized in biofilm communities (natural state of existence).[87] Biofilms are more successful on surfaces, especially interfacing wound surfaces, such as those found in many types of surgical wounds.

Physical removal of biofilm by thorough and frequent debridement and/or wound cleansing (7 – 12 psi, 100 – 150 mL) forces the biofilm to reconstruct and makes it more susceptible to effective antimicrobials, antibiotics or antiseptics to prevent re-formation (using a debride-and-cover with antimicrobial dressing strategy).[87] Topical antimicrobials are not recommended without prior debridement of necrotic tissue and debris and thorough cleansing, as they need to be in contact with viable tissue and may be ineffective due to poor penetration.[88]

4.2.4 Managing moisture balance

Discussion: Provide optimal wound moisture balance to promote healing by choosing an appropriate dressing for the acute and chronic phases of surgical wound healing. Appropriate wound care and dressing selection promotes healing and reduces the risk of infection.[10] Surgical wounds often are associated with high levels of exudate due to complications such as inflammation, infection, seroma or hematoma, causing increased capillary leakage and edema, which can have an adverse effect on wound healing.[89] Excessive moisture slows down wound healing by preventing cell proliferation, interfering with growth factor availability and elevating levels of inflammatory markers and cytokines. Excessive exudate will also cause the periwound tissue to become macerated (white, overly moist and non-viable), impairing the advancement of the wound edge and risking periwound skin injury.[90,91]

Caution: Antimicrobial dressings should never be mixed!

A wide variety of active chemical agents (or biocides) are found in antimicrobials, many of which have been used for hundreds of years for antisepsis, disinfection and preservation. They kill micro-organisms and may be bactericidal, fungicidal, virucidal or sporicidal. The antiseptic interacts with the cell surface followed by penetration into the cell and action at the target sites, but some are cytotoxic and can be harmful to healthy tissue. Others are non-cytotoxic in dilute preparations but can be cytotoxic in higher strengths. Mixing two or more of these products in the dressing can change the chemical formula of each, which may be cytotoxic to the healthy tissue or inactivate the antimicrobial effect. Studies on the efficacy and safety of antimicrobial dressings do not include using them with another antimicrobial dressing or antiseptic product. If one product appears to be ineffective, with lack of response or deterioration, it is time to reassess for reasons, which may be other than infection. It may also indicate the need for a different product or systemic antibiotics.[89]

Moisture-associated skin damage (MASD) can occur in the tissue surrounding the wound as a result of prolonged exposure to excessive wound exudate. The volume and composition of the wound exudate are key factors that contribute to development of MASD. Wound exudate containing heparin-binding proteins, proteolytic enzymes, high concentrations of inflammatory cytokines or high bacterial burden and their associated toxins all increase the likelihood of MASD.[92] Essential to the protection of periwound skin, while still keeping the wound bed moist, is choosing a dressing capable of containing wound exudate and wicking it from the periwound skin, and changing the dressing at a frequency that prevents skin irritation.

4.3 Select the appropriate dressing and/or advanced therapy.

Discussion: Surgical wounds should be covered with an appropriate interactive dressing at the end of surgery. The patient should be referred to an enterostomal therapy nurse or wound clinician with advanced education and training in wound management for advice on appropriate dressings for the management of surgical wounds that are healing by secondary intention.[9]

Post-operative Strategies

The post-operative team members that provide wound care and dressing changes for patients should receive education and support in order to provide care that reflects best practices.[9] Education for surgical staff should include the importance of continued assessment,[14] hand hygiene and the use of aseptic non-touch technique for changing or removing surgical wound dressings.[9] Dressing selection for surgical wounds is determined by the type of closure (primary, delayed primary or secondary intention), as well as the amount of wound exudate and the presence of any tunnels, undermining, underlying vascular grafts or hardware. Consideration should also be given to patient concerns, caregiver knowledge and time, setting and available resources.[60,90,91]

Primary intention

Incisions closed by primary intention generally require only the application of a dry, sterile semipermeable cover dressing for 24 to 48 hours, as the wound will re-epithelialize within two to three days.[93] More evidence is needed to support the use of any specific dressings immediately post-operatively for wounds healing by primary intention; the recommendation is that dressings should be selected on the basis of cost and the interactive properties of the dressing.[10] As reviewed by NICE, silver nylon dressings appear be more effective than gauze in preventing surgical site infections.[10] Limitations were that the silver nylon was compared to gauze (not another advanced dressing), that infections were diagnosed by an unblinded member of the operating

team, a potential bias and that the length of the incision was not documented in each case. Further research is needed that compares silver dressings with other commonly used modern wound dressings.

Secondary intention

Acute surgical wounds that are left open to heal by secondary intention require a moist wound environment to support healing.[59] In addition to preserving moisture balance, the dressing should function to prevent bacteria from entering and critically colonizing wound tissue.[60,90,91,94] Interactive advanced wound products have an advantage over wet gauze dressings as they prevent bacterial penetration of the wound.[95]

Pouching is another option for the management of heavily exudating wounds. Although minimal research exists in this area, expert opinion supports the use of pouching when exudate, significant odour or the need for skin protection from exudate are of concern. Generally, wounds with > 25 mL discharge or those requiring dressing changes more than three to four times per day may be considered for this option. Other important considerations for pouching include the location of the wound, patient comfort and mobility and staff time. Troughing a wound—using ostomy paste strip products and film dressings to channel the exudate into a pouch—may be an option for larger wounds. The involvement of an ETN or a wound clinician with advanced training in wound management is encouraged when exploring pouching or troughing options.[96,97]

Negative Pressure Wound Therapy

There is an evolving body of evidence in support of the application of negative pressure wound therapy (NPWT) over closed incisions. The benefits of NPWT are thought to be the control of skin flora exposure, with the dressing being applied in the operating room under sterile conditions and remaining in place for five to seven days, the removal of exudate, the reduction of lateral incisional tension and the reduction of hematoma or seroma formation at the surgical site.[98] Evidence supporting the

application of NPWT to the primary incision has been demonstrated in sternotomy,[99] orthopedic[98] and vascular surgeries,[100] with multiple ongoing randomized controlled studies for a variety of surgical procedures currently underway.

The use of NPWT for open wounds has been an accepted wound treatment modality for many types of open wounds as well as a method of bolstering flaps and skin grafts.[101] When the wound is highly exudative, the periwound skin benefits from protection with a barrier film/hydrocolloid and may also benefit from NPWT.[90,94] NPWT therapy should be considered as "first-line treatment for dehisced sternal wounds following cardiac surgery."[102] There is also interest in using NPWT to prevent dehiscence, though there is little evidence to support it at this time. The NICE Evidence Update did report that NPWT appears to reduce SSI rates following invasive treatment of lower-limb trauma, but cautioned that it may be less effective in other patient groups with multiple co-morbidities and that further research is needed.[10]

Indeed, NPWT has "revolutionized the treatment of open abdominal wounds . . . [by] improving survival, decreasing the number of dressing changes, enabling a higher rate of total abdominal wall closure, decreasing the need for secondary surgical reconstruction, [and] reducing complications (e.g., incisional hernia, infection)."[10,101] NPWT is used when clinicians have been successful in advanced education required by their organization/agency. Policies and procedures and supported clinician education must be established prior to use of this therapy. NPWT use is accompanied with warnings, contraindications and precautions for each device and application use. Clinicians are responsible for being knowledgeable about the specific uses of NPWT, which offers advanced management of many wound types. Patient selection, wound bed preparation, debridement, dressing selection, application and clear interprofessional team communication is crucial for successful use of NPWT.[103]

Dry Wounds

For some wounds, too little moisture causes the wound bed to dessicate, preventing growth of granulation tissue and re-epithelialization.[90–94] Dry surgical wounds with healing as a goal may benefit from the addition of a hydrogel, hydrocolloid, non-adherent mesh dressing or transparent film to hold moisture in and protect the wound bed.[94]

For more information on dressing selection, please refer to the Wounds Canada Product Picker series,[104] available at www.woundscanada.ca/Product-Pickers. This can be adapted to be a fillable PDF so that once completed with the formulary for the given area, health-care providers can use it to guide decision-making, specific to their agency or institution.

Common Types of Surgical Wounds

The following discussion covers those types of surgical wounds commonly seen in wound clinics and community settings, but it is not inclusive of *all* types of surgical wounds that may be encountered.

Abdominal wound/open abdomen +/– new ileostomy or colostomy/ enterocutaneous fistula

An open abdomen surgical wound occurs when intra-peritoneal organs are exposed as a result of surgery for complex intra-abdominal situations where primary closure is not appropriate, such as in the case of severe sepsis, abdominal trauma and after grafting of ruptured aortic aneurysms.[10] When perforation of the bowel has occurred,

and there is pus and fecal contents present in the abdominal cavity, surgeons usually choose to leave the abdominal wound open to heal by secondary intention to prevent further abscesses.[45] This results in a large, exudate wound with a new ostomy in close proximity. Due to the complexity of this type of wound the involvement of an Enterostomal Therapy Nurse (ETN) with expertise in ostomy, fistula and complex wound management is highly recommended.[105,106]

Several commercial wound and fistula management systems are available, although their success in managing large wounds close to a new ostomy or those containing a fistula will be dependent on the amount and type of fecal output and bodily contours that lead to leakage. Negative pressure wound therapy is often appropriate for these wounds. The end point is to achieve healing, either as delayed primary closure of the abdomen (particularly after an abdominal aneurysm repair), secondary healing, split-thickness skin grafts, mesh repair, muscle components separation, flaps or a combination of these.[10]

The presence of an enteric fistula within an open abdominal wound is called an enteroatmospheric fistula and is a complication with a mortality rate as high as 70%.[107,108] The high mortality rate is directly related to the septic response arising from the bacterial load accompanying the bowel content soiling the open abdomen. Both surgical management and conventional wound care options are often ineffective.[107] There are a number of novel treatment options utilizing negative pressure wound therapy that might be considered. One such option places the polyvinyl alcohol foam on the mouth of the fistula, so long as there is no mucosal eversion leading to primary closure.[107] Other primary closure treatments include the use of fibrin glue or fistula coverage with a muscular flap. If primary closure is not a possibility, then isolating and diverting effluent out of the abdominal wound and collecting it in an ostomy pouching system may prevent sepsis and promote wound healing.[107] The care of a patient with an enteroatmospheric fistula is complex and requires a team approach that includes the expertise of the ETN and a team that is aware of the risks.

Caesarian (C) section incision

C-section surgery has a five to 20 times higher risk of postpartum complications such as wound infections, endometritis, pelvic peritonitis or pelvic abscesses, compared with vaginal deliveries.[109] Premature rupture of the membranes, diabetes, obesity, hypertension, anemia, emergent rather than planned C-section and post-op wound hematoma have been identified as risk factors that need to be addressed.[110] Since hematoma was the strongest independent risk factor for SSI development post low-transverse C-section, the incision should be monitored for redness, swelling and pain.[111] In obese women, a vertical incision may be necessary. A vertical incision is associated with a higher rate of infection, as is the use of interrupted sutures or staples rather than a continuous intercutaneous suture.[112–114] The patient dealing with complications post C-section incision is also a new mother coping with a new baby, physiological and hormonal changes, pain, inconvenience and concern regarding use of antibiotics, which may be transferred to the baby if she is breastfeeding.

Hernia repair with infected mesh

The use of prosthetic polypropylene mesh is associated with fewer recurrences in ventral or inguinal hernia repair. Unfortunately, the risk of superficial SSI or deep infection of the mesh with complications resulting in exposed mesh or unincorporated mesh or the formation of chronic abscesses, sinuses and/or drainage or development of spontaneous enterocutaneous fistula is as high as 3%.[113,116] Removal of the infected mesh is a difficult surgery that should be considered if local wound care cannot manage the wounds and drainage. Prevention of post-operative evisceration and maintenance of a competent abdominal wall are key secondary goals of hernia mesh removal.[113] Many patients must live or choose to live with small, chronic draining areas that periodically require debridement of mesh as it protrudes out of the wound. In these cases, the principles of chronic wound self-care should be applied along with management of bacteria, odour, exudate and periwound irritation. Supports must be in place for patients with non-healable wounds as management of wound drainage will impact an individual's quality of life, including patient frustration and disheartenment. Psychological and physiological stressors such as depression and anxiety have a relationship to delayed wound healing.[97,117]

Hip and knee arthroplasty

Chowdry and Chen described an ideal dressing to prevent SSIs in a post-operative orthopedic surgical incision as being absorbent, protective, permeable, transparent, able to provide a moist environment, able to remain *in situ* (i.e., to require minimal changes), able to act as a complete barrier, having low adherence and being cost-effective.[118] Orthopedic total joint arthroplasty incision complications include blistering and infection that may lead to dehiscence. A dressing requiring frequent changing, and skin trauma caused by dressing adhesive or blistering can lead to exposure of external infectious sources. Although the incidence is low (1 – 2%), periprosthetic joint infection (PJI) after total hip or knee arthroplasty is considered to be a catastrophic complication. The infection may be just in the incision (localized SSI) or it may be deep at the area of the prosthetic (PJI). The orthopedic surgeon needs to assess this as soon as possible and, until then, local interventions such as wound irrigation, probing or packing *should be avoided* due to the risk of inadvertently introducing bacteria. Diagnosis is often difficult and relies on the surgeon's judgement of the clinical presentation, the findings on physical examination and the interpretation of relevant investigations. Deep infections that are caught early (within several days of their onset) and

those that occur within weeks of the original surgery may sometimes be cured with a surgical washout of the joint and debridement of all contaminated soft tissues. The implant is thoroughly cleaned and plastic liners or spacers are replaced. After the procedure, intravenous antibiotics are prescribed for approximately six weeks. Sometimes, two or more surgeries are required, with removal of the prosthesis, an implant of antibiotic-laden cement and eventual replacement of the prosthesis. Amputation is also a possible consequence.[119,120]

Incision and drainage (I&D) of abscesses

Incision and drainage is historically the treatment of choice for cutaneous abscesses.[121] Treatment is dependent in part on the etiology, such as of sebaceous cyst, pilonidal sinus, hidradenitis suppurativa, foreign body; but generally abcesses requiring I&Ds are either sutured primarily or left open and packed loosely and dressed, with or without an oral antibiotic.[122] Community-associated MRSA is considered to be endemic in North America and is a frequent cause of abscesses, making it important to:

- Confirm the diagnosis of MRSA infection in immunosuppressed patients by Levine method semi-quantitative swab culture.[123]
- Recognize that treatment with systemic antimicrobial therapy to which the bacterial isolate is susceptible is controversial.[121]
- Recognize that for cases of mild illness (patient afebrile, abscess < 5 cm, no other medical co-morbidities) I&D with or without *topical* antibiotics may be sufficient.[124]

Packing of these wounds is controversial, yet a large number of patients in the home-care setting are admitted with orders for daily packing for incision and drainage of abscesses (see Table 5).

Table 5: To Pack or Not to Pack

Study	Intervention	Packing versus No Packing
O'Malley et al.[125] RCT (n = 48)	I&D of simple cutaneous abscesses	There was no difference in complication or infection rate between groups, but it had limited real-world applicability due to the small size of the study.
Tonkin et al.[126] Randomized (n = 43)	anorectal abscesses	There was a similar time to healing, but the median pain score in the non-packing group was significantly lower.
Kessler et al.[127] RCT (n = 57) pediatric patients	abscesses	The failure rates were 19/27 (70%) with packing and 13/22 (59%) without. The difference was 11%, 95% confidence interval 15 – 36%.
Schmitz et al.[123]	cutaneous abscesses	The study suggests packing does not provide additional benefit.
Liu et al.[128]	uncomplicated skin and soft tissue infections	I&D was recommended, but the authors' opinion was that antibiotics were not likely needed and did not mention packing.
May et al.[129] retrospective audit (n = 135)	inconsistencies in technique, irrigation methods, use of antibiotics and variation in packing techniques	The audit did not include outcomes for the types of packing. In the panel's opinion, packing is best used to wick the wound open to facilitate drainage.

Tight packing allows the edges to scar and become fibrotic, which actually delays wound healing. Larger studies are needed to better validate the equivalency of these two strategies, which could potentially result in savings of many thousands of dollars spent on needless packing materials, prolonged need for analgesia and nursing visits. Retained packing or lost packing is a foreign body and becomes a source of infection. Each facility or organization should have a policy and procedure regarding types of packing agents to use (e.g., high tensile strength), strategies to avoid loss of packing agent (e.g., one piece of packing agent only, secure tail of packing on intact skin, etc.) and procedure to follow when unable to locate packing that should have been in the wound. Documentation of size and length of packing materials used in the wound is essential. Patients can tell you if they visualized packing that "fell out," but if they did not see it, and you cannot find it, this must be reported to the responsible physician and an appointment made so that they can examine the patient and the wound.

Lower leg vascular bypass/saphenous vein harvesting

SSI incidence is between 3.5 and 32% with peripheral vascular surgery. SSIs can lead to major amputation as well as mortality.[130]

An unfortunate fact is that the patients who require lower leg bypass surgery or coronary artery bypass graft (CABG) with saphenous vein harvesting often have diabetes, hypertension and obesity as well as other co-morbidities. Selected patients undergoing elective femoral popliteal bypass of a leg without critical limb ischemia (CLI) required discharge to a rehabilitation or skilled nursing facility rather than to the home. Multiple risk factors such as diabetes, dialysis, congestive heart failure and cere-

brovascular accident contribute to prevention of discharge back to the home. Patients who require discharge to a facility (either rehabilitation or skilled nursing) have higher rates of infectious complications, myocardial infarction, operative transfusion and unplanned reoperation while hospitalized for the initial surgery.[131]

Post-operative edema of the lower legs, lasting up to three months, often contributes to failure of primary closure of these incisions.[132] Edema is a multifactorial problem not only with vascular surgery but also with orthopedic surgery and surgical interventions following trauma. Alterations in arterial and capillary perfusion, transcapillary fluid filtration and lymph transport all contribute to the formation of edema.[133] A lower level of physical activity in the initial post-operative period decreases the calf-muscle pump activity and increases the risk for accumulation of edema in the lower limb. Various methods of edema management are being utilized with varying effectiveness. Intermittent pneumatic compression (IPC) following femoropopliteal bypass surgery compared to compression stockings failed to show any statistical difference in reduction in edema in a small (n = 35) study, but the length of intervention was only one week.[132] In real-life practice, one week may be the usual time of hospitalization for these patients, and it would seem prudent to continue compression once discharged home. Alireza et al., in a study with 100 patients having saphenous vein harvesting for coronary artery bypass graft surgery (CABG), compared the use of thigh-high medical grade compression stockings versus no compression stocking/stocking applied irregularly, for four weeks post-op.[134] There was a statistical difference in edema of the calf between the two groups at one, two and four weeks post-op ($P = 0.004$, $P < 0.001$, and $P < 0.001$ respectively), with the stocking group having less edema. Wound complications (ecchymosis and infection) occurred in 12 patients with edema but did not occur in patients without peripheral edema at four weeks ($P = 0.09$). They found

that patients who were more physically active also had decreased edema, although low compression elastic stockings do not improve calf-muscle pump activity when the patient is walking.[135] Additional research is needed to look at the role of resistant compression bandages in preventing/reducing post-operative edema and wound healing. With venous leg ulcers, pro-inflammatory cytokine and matrix metalloproteinase levels are reduced, and the anti-inflammatory cytokine IL-1 Ra are increased in response to multi-layer high-compression therapy.[136] In addition to having an anti-inflammatory effect, compression bandaging that provides resistance and is safe to use when the ankle brachial pressure index (ABPI) is between 0.5 and 0.8 actually increases laser Doppler flux under the bandage without decreasing the toe pressure or transcutaneous oxygen pressure ($TcPO_2$) distal to the bandage.[137] Resistant compression also potentiates the action of the venous pump by increasing the ejection fraction.[137] Compression therapy would ideally need to be used immediately post-operatively and for as long as the risk of edema is present, which may be weeks or months.[133] Further robust studies are needed to determine the best choices.

Pilonidal sinus surgery

The Harris Pilonidal Sinus Protocol outlines the complex reasons for failure of pilonidal sinus wounds to heal, whether they are healing by secondary intention or are a failed primary intention closure.[138–140] Recognition and treatment of signs and symptoms of localized and deep infections is key, particularly as there are three signs that happen with pilonidal sinus wounds that are not found in others: bridging and pocketing in the base of infected granulation tissue and premature epithelialization with corresponding tunneling running underneath. Treatment is aimed at multiple factors that

contribute to the infection and lack of healing. Frequent meticulous removal of peri-wound hair, decontamination of periwound skin, optimal personal hygiene practices with increased self-care management strategies, reducing causes of chronic inflammation, optimizing nutrition and pain management, hygiene and dressing changes following bowel movements and modified physical activity all play a role. A recent update to the protocol is now available, which debates the use of silver nitrate in these wounds.[140]

Skin graft and donor sites

Skin grafts are a section of epidermis and dermis that has been completely separated from its blood supply in one part of the body (donor site) with the goal of transplanting it to another area of the body (recipient site).[141]

Although the OASIS tool (see Step 1.1) does not consider skin grafts to be surgical wounds if done to repair an existing wound, donor sites and skin grafts *are* the result of surgical interventions. Full-thickness skin grafts are used for small areas. Skin can be acquired from the pre-and post-auricular region, the neck, upper and lower extremities, groin and abdomen. Split-thickness grafts use the epidermis and a portion of the dermis. This skin is harvested from any body location, but the thigh is most common. Grafts may be non-meshed or meshed. If meshed, then it is created by pie-crusting with a scalpel or with a mesher that creates fenestrations at equal distances. The purpose of meshing is to create a larger surface area from a smaller graft. It also permits drainage of fluid from the wound to prevent hematoma or seroma formation.[141]

Donor site wound care requires the application of moist wound healing principles. There are many commercial dressings available to support moist wound healing.[142] Donor sites heal by re-epithelialization usually requiring transparent dressings or fine mesh gauze.[142,143] The donor site can be more painful than the graft site and requires protection and patient education to heal.[141]

Recipient sites

Full-thickness and partial-thickness skin grafts are sutured, stapled or glued in place, treated like a primary incision and covered with a dressing. If a bolster dressing is utilized it should only be removed by the treating physician unless otherwise specified. NPWT is sometimes utilized as a bolster for skin grafting, as previously stated.[144] It is important that movement in the area of the graft site be minimized in the first five to seven days. The decision about which dressing is appropriate for the grafted recipient site usually remains with the surgeon responsible for the wound.

Post-operative risks are an SSI, seroma and/or hematoma formation and graft contracture. An SSI can lead to disintegration of the graft or excessive exudate that prevents the graft from adhering to the bed.[145] It can take three to six weeks for the skin graft to turn a normal colour and, until then, it may look grey, pale, purpuric or dull. Scars can take take from 18 months to two years to mature and for inflammation to resolve. Unfortunately, grafts to the scalp following removal of skin cancers can be problematic, with chronic small areas of exposed skull or skull replacement materials at the margins of the graft. These wounds may never resolve and may require ongoing dressing use and protection.

Advanced Therapies

When warranted, the clinician should consider the use of advanced therapies and biologically active dressings as they pertain to surgical wounds.

Hyperbaric oxygen therapy (HBOT)

The Cochrane Review of HBOT for acute surgical and traumatic wounds found that, while two small trials suggested that HBOT may improve the outcomes of skin grafting and trauma, these trials were at risk of bias. Further evaluation by means of high-quality RCTs was recommended.[146]

Electrical stimulation (ES)

In a review of 21 RCTs involving electrical stimulation for wound healing, Thakral et al. concluded that it is underutilized in plastic surgery and could improve flap and graft survival, accelerate post-operative recovery and decrease necrosis following foot reconstruction.[147] The authors described ES as addressing three key factors in surgical wound complications: decreasing bacterial proliferation and increasing local perfusion, thereby accelerating wound healing. They recommended more clinical trials to better determine the dosage, timing and type of ES for care of surgical wounds.

A new muscle-pump activator worn at the knee electrically stimulates the common peroneal nerve, causing muscle activation replicating at least 50% of blood flow generated by walking.[148] It is recommended for prevention of vein thromboembolism (VTE).[10] Alharbi et al. demonstrated applicability of this device for kidney and pancreatic transplant surgery in preventing post-operative lower leg edema and improved blood flow.[149] Further evaluations are underway.

4.4 Engage the team to ensure consistent implementation of the plan of care.

Discussion: Individuals within the circle of care must understand their roles and responsibilities in relation to the formal care team for each specific element of care.[49] Early recognition and treatment of surgical complications, including SSI, is important. Providing the following information to patients, families and caregivers should lead to prompt treatment and reduce infection-related morbidity:[10]

- the risks of an SSI and what is being done to reduce it, including any antibiotics given in hospital
- the signs and symptoms of an SSI, how they are managed and who to contact if they are concerned
- the signs and symptoms of other surgical site complications such as a hernia or a wound dehiscence

- who is responsible for what portion of their care and when follow-ups should be booked
- who to call when they have concerns
- how to care for the wound after discharge, including hand hygiene

The team should use an integrated care pathway for preventing complications to help communicate this information to patients and all involved in their care after discharge from hospital. Documentation of the information shared is necessary. Several patient handouts are available online for public use. Examples can be found at the following websites:

- http://swrwoundcareprogram.ca/53/Resources_By_Wound_TypeTopic/
- www.healthlinkbc.ca/healthtopics/content.asp?hwid=tc4128spec

Step 5: Evaluate Outcomes

Step 5: Evaluate Outcomes

Discussion: Determine the effectiveness of interventions and reassess if healing is not occurring at the expected rate and if the goals the team has set have not been met or have been only partially met. Assess the wound and periwound regions to identify rate of healing and determine if the treatment approach is optimal.

Recommendations

5.1 Determine if the outcomes have met the goals of care.

Discussion: The overall goal is to assist patients and their caregivers in maximizing their rehabilitation potential. Progress toward achieving established goals is monitored with the patient, documented using standardized patient assessment tools and communicated to the appropriate team members. The responses observed in the patient's surgical wound are compared with the responses specified in the stated goals and expected outcomes. The patient and families and caregivers should participate in decision-making and evaluation. The effectiveness of the interventions must be determined by a clinician who has the knowledge and skills to assess.

5.2 Reassess patient, wound, environment and system if goals are partially met or unmet.

Discussion: A healable wound that is not responding to the treatment plan needs reassessment. Has the cause of the wound been addressed? What host factors are contributing to delayed healing?[60,90,94] Is the treatment optimal for the situation? When wound healing is not feasible, assess whether the treatment is preventing infection and deterioration, is decreasing dressing frequency, managing pain and improving the patient's quality of life, where possible.[60,91]

5.3 Ensure sustainability to support prevention and reduce risk of recurrence.

Discussion: Primary care physicians, nurse practitioners and visiting health-care professionals should recognize wound complications and immediately communicate and/or refer the patient back to the surgeon. However, it is patients and their caregivers who are the first line of defence in preventing and identifying complications. As per Step 4.4, informational materials should be available for the patient and caregiver and discussed both before (if possible) and following surgery. This is essential so patients can prepare appropriately. They will need time to make adjustments to their environment, activities, nutrition, working lives, support system and more.

Outpatient clinics' and surgeons' time are important resources that should be optimized so that follow-ups for patients whose situation warrants it can be done in a timely manner, possibly avoiding unscheduled trips to hospital emergency departments.

Conclusion

The prevention and management of surgical wound complications is a growing area of concern for patients, health-care professionals and administrators alike. In these times of rationalization of health-care dollars, it is important to ensure that patients receive appropriate screening and care, beginning at the pre-operative assessment and continuing through to post-operative care and monitoring in the community. Clinicians have a superb resource in the Safer Healthcare Now! "Preventing Surgical Site Infections: Getting Started Kit," and the Centers for Disease Control SSI works, which are accessible online. The best practice recommendations presented in this paper synthesize these resources and, when combined with evidence-informed interventions found in the discussions, should help clinicians develop the skills and tools needed to identify those at risk for complications and develop plans in collaboration with their patients to ensure a best practice approach.

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