

# SAFE PRACTICES *in Patient Care*

Helping to promote a culture of safety

**P**atients in long-term facilities are at an increased risk to develop serious, chronic wounds. According to Dorothy Doughty, effective wound management, including prevention and management of infectious complications, is a major priority in long-term care. Effective wound care requires a clear understanding of the factors affecting wound repair, implementation of a comprehensive program to promote healing, and prevent infection.

More than 30 million operative procedures are performed each year in the United States.<sup>1</sup> Operative procedures disrupt the most important barrier we have to infection—our skin—resulting in a risk of surgical site infection (SSI). SSIs are associated with a significant burden, both in healthcare expenditures and human lives. Historically, SSIs occurred in 2% to 5% of patients undergoing inpatient surgery or approximately 500,000 SSIs occurred each year.<sup>2</sup> The mean attributable cost for SSI has ranged from \$3089 to \$25,546, depending on the type of operation and infecting organism.<sup>3,4</sup> There is a 2 to 11 times higher risk of death in patients with an SSI, compared with operative patients without an SSI.<sup>3,5</sup> Current infection prevention strategies have been helping decrease the SSI burden.

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## Wound Care in Long Term Care: Focus on Infectious Complications

By Dorothy B. Doughty, MN, RN, CWCN, FAAN

**W**ound management is a significant challenge in the long-term care setting, for several reasons. First, residents in long-term care are at high risk for development of chronic wounds such as pressure ulcers, and many are actually admitted with existing wounds. Second, these patients are at high risk for delayed healing and for development of infectious complications due to comorbidities such as diabetes and vascular disease. Finally, resources are sometimes limited in long-term care; this includes human resources as well as products needed for state-of-the-science wound care.

It seems clear that effective wound management, including prevention and management of infectious complications, is a major priority in long-term care. Effective wound care requires a clear understanding of the factors affecting wound repair, implementation of a comprehensive program to promote healing, prevent infection, and consistent monitoring to promptly address adverse events, including wound infection and/or deterioration.<sup>1</sup>

### Principles of Effective Wound Management

The key elements of an effective wound management program have been well-defined and include the following: (1) identification and correction of etiologic factors (to the extent possible), (2) attention to systemic factors affecting the wound healing process, and (3) evidence-based topical therapy.<sup>1</sup> In addition, it is critical to establish a systematic process for comprehensive and regular wound assessment with the goal of quickly identifying wounds that are “in trouble”, i.e. not healing or actively deteriorating. Deterioration in wound status mandates notification of the prescribing physician/provider, and failure to show measurable improvement for 2 consecutive weeks mandates careful review of the entire treatment plan. Infectious complications are a common reason for sudden deterioration; thus the treatment plan must include measures to reduce the risk of infection. Routine monitoring and prompt intervention for any infections that do occur are necessary.<sup>2-5</sup>

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### Identification and Correction of Etiologic Factors.

A commonly repeated principle of pressure ulcer management is: “You can put anything on a pressure ulcer except the patient.” While this is certainly an exaggeration, it points out the critical importance of accurately identifying etiologic factors for any wound and then intervening to correct those factors. See Table 1 for common etiologic factors and implications for management.<sup>6</sup>

### Systemic Support for Healing.

In managing any open wound, the clinician must remember that dressings don't heal wounds – only the body itself can heal a wound. This means that the wound care clinician must do everything possible to support the body in healing the wound, which translates into providing the protein, vitamins, and minerals required for collagen synthesis, and eliminating systemic factors that interfere with wound healing, such as hyperglycemia and tobacco use. Table 2 lists the systemic factors most critical to repair, and implications for management.<sup>1,4,17</sup>

### Evidence-based Topical Therapy.

The third factor critical to wound healing is appropriate wound care, i.e. selection of prod-



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## Panel Discussion Surgical Site Infections: Where are we today?

**Moderator:** Robert G. Penn MD, FACP, FSHEA  
**Panelists:** Sandra Vyhldal, RN, MSN, CIC  
Margaret Olsen, PhD, MPH  
Kathleen McMullen, MPH, CIC  
Larry Lovelace, BS, MT (ASCP), CIC

The following is a discussion by a panel of infection control experts of current strategies and the changing role of the infection control practitioner in surgical site infection prevention.

*Discuss current SSI prevention efforts for changing health care worker behavior.*

**Vyhldal:** Successful strategies for behavior changes are founded in finding one or more staff champions who value and believe that the recommended practices will lead to positive patient outcomes. Preferentially, one should seek out a hands-on staff whose peers will value their opinions and support the project initiative. The buy-in begins with this person being involved in reviewing best practices to enhance his/her knowledge base. Next, the champion observes current practice and identifies gaps in practice when compared to best practice. The champion needs to be involved with the brain-storming approaches to address the gaps and selection of change interventions. This step fosters ownership. As goals and timeframes are established, start with small achievable steps in realistic timeframes. Progressive step-by-step stages may reduce resistance and defensiveness among hands-on staff. It is also important to celebrate successful steps. A key concept to instill in all staff is that negative results do not mean failure; it means a learning step has occurred; this intervention needs to be adjusted or changed.

**Olsen:** Current SSI prevention efforts include assessment of compliance, double gloving, adherence to prophylactic antibiotic recommendations, minimization of hair removal, checking intraoperative glucose levels, restricting flash sterilization to emergency use, minimization of room traffic, and appropriate terminal room cleaning.<sup>1</sup> There is considerable evidence that process or product changes are more effective than education alone in improving compliance with evidence-based recommendations.<sup>2</sup> For this reason, many current prevention strategies focus on process/product changes that are easier to implement and assess for compliance, including the use of alcohol-based handrubs to promote hand hygiene,<sup>3</sup> double gloving for surgical personnel, and adherence to surgical antibiotic prophylaxis recommendations via standardized orders, computerized or visual reminders, or pharmacist control. Ensuring compliance with behavioral changes may best be pursued via checklists, as exemplified by the Michigan Keystone Project and decrease in catheter-associated bloodstream infection rates.<sup>4</sup> Performance improvement via checklists requires more than just distribution of the list, however. Education to emphasize the importance of the steps in the

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list, audit and feedback, and empowerment of key healthcare workers to ensure compliance are necessary to ensure sustained improvement.<sup>5</sup>

**McMullen:** Cleaning and disinfection of equipment and the environment is still one of the biggest challenges. The OR, including pre and postoperative areas, should be viewed as a continuous environment. Assessing the flow of equipment and material throughout this flow is essential in understanding what needs to be cleaned, disposed of, etc. It needs to be clear about who is responsible for cleaning each part of the environment. Turnaround time is a big factor for this area, so if necessity demands deviations from the assigned process, clear communication of these deviations is essential to proper completion of the cleaning. This is also another place where each member should be accountable to all the rest – it should be perfectly acceptable to double-check that procedures have been followed.

Sterilization of medical supplies starts with Central Sterile Process Department (CSPD) awareness of manufacturer requirements. At our institution, gross failures of the cleaning/sterilization process are recorded in an online “safety event system” and promptly reported to all involved. This allows CSPD to be aware of instruments that may present particular problems. In addition, data on items that are flash sterilized is gathered routinely. Analysis of this data allows the identification of items that need to be purchased. Infection prevention is then able to identify whether patients with a surgical site infections had either a report in the safety

event system or items flash sterilized. Appropriate surgical prophylaxis is probably best handled through the use of standing order sets, with understanding by pharmacy that deviation of these orders must be justified. Cases where appropriate prophylaxis is not given should be reviewed by the OR.

**Lovelace:** Our facility joined a state-wide surgical infection prevention (SIP) collaborative in 2002. This has since become known as SCIP (Surgical Care Improvement Project). It helped us improve our surgical antibiotic prophylaxis. We also performed several workouts and lean projects to work through the issues. Surgery has to take ownership for any programs involved; you must have their buy in. Education of staff and surgeons is very important and a must. Coworker buy in and participation on the grass roots level is important for better problem solving and action. Measurement tools need to be created. Accountability has to be assigned. Feedback to staff and surgeons is necessary. Strict adherence to aseptic technique is probably still handled best by making every person in the OR accountable. The people who are present in the OR daily are the best at catching little slips or errors. Of course, continuous education still has its place.

*Review examples and rates of success in applying newer technology and products for the prevention of SSI.*

**Vyhldal:** Examples of successful strategies include: (1) providing pre-op antimicrobial skin cleansing agents with instruction sheet to patients using multiple options, eg, surgeons office, hospital main campus registration desk, off-site hospital ambulatory surgery center registration desk, mailings to patient via the patient education department, and printed material informing patients what are acceptable products to purchase at their local pharmacy or grocery store, (2) standardizing pre-op antimicrobial agents per procedure using published best practice<sup>6,7,8</sup> and community practice guidelines, and (3) anesthesia administering ordered pre-op IV push antibiotics timely with re-dosing of short half-life agents during lengthy procedures, based on published best practices<sup>11,12,13</sup> with supporting practice measures (e.g., computerized standing orders; compliance reports to individual personnel).

**Olsen:** I will give you two examples of using newer technology and products for preventing SSI. The first is forced air warming, convective warming, circulating water garments, and resistive heating blankets to maintain normothermia. Kurz and colleagues performed a randomized trial of routine thermal care vs. maintenance of normothermia in patients undergoing colorectal surgery and found a significantly lower incidence of SSI in the patients randomized to normothermia (6%) compared to normal care (19%, p = .009).<sup>9</sup> Melling and colleagues randomized patients undergoing clean surgery to systemic warming (forced air warming blanket) or standard care, and found a significantly lower SSI rate in the warmed patients (5%) compared to patients given standard care (14%, p < .001).<sup>10</sup> Maintaining normothermia in colorectal surgery was added to the SCIP performance measures<sup>11</sup>, although due to an insufficient number of studies confirming its effect it was not included in

the Society for Healthcare Epidemiology of America (SHEA)/Infectious Diseases Society of America (IDSA) practice recommendations for strategies to prevent SSI.

The second example is the use of a chlorhexidine gluconate impregnated skin preparation cloth for surgical site antisepsis prior to incision. Daily cleansing with chlorhexidine cloths has been shown to reduce the incidence of catheter-associated bloodstream infection compared to normal soap bathing<sup>12,13</sup> and was associated with reduced acquisition of MRSA and VRE in a multicenter study. Chlorhexidine is also recommended for daily bathing of intensive care unit patients in the SHEA/IDSA guidelines. Based on these data and the activity of chlorhexidine against a wide range of Gram-positive and Gram-negative bacteria, many institutions have opted to use chlorhexidine for routine preoperative surgical site prophylaxis.

**Lovelace:** We did a study at our facility using antimicrobial dressings and reduced our SSI rates dramatically (81%). Our SSI rate went from 2.24 down to 0.45 during the 6-month trial. New equipment for cleaning, disinfecting and sterilizing surgical instruments has helped our turnaround and assures us that we will not be transmitting germs via equipment. New Bair Hugger® blankets have helped control normothermia. It was revealed through the SCIP project that controlling normothermia during surgery, was one of the many interventions that helped to reduce the risk of a surgical site infection. This was in addition to our antimicrobial dressings, glucose control, antibiotic prophylaxis, clipping instead of shaving, etc.

*What are the current challenges in reducing surgical site infections?*

**Vyhldal:** Challenges include the following: (1) finding a surgical skin prepping agent that is highly effective in killing/reduce diverse antimicrobials, quick drying without risk of fire, tinted to denote where it has been applied, adhesive-promoting to enhance drape adherence to skin, long duration, and easy for patient to remove, (2) traffic control within surgical areas, especially keeping surgical suite doors closed when not in use, (3) compliance regarding surgical attire as outlined in policy/procedure, (4) reducing the use of sterilization within the surgical suites/core area for short supply of sets or instruments, and (5) cleaning surgical instruments in the surgical theater for autoclaving equivalent to sterile processing procedure. Examples of equivalent practice between the two departments include using the same cleaning agents, placing brushes inside lumens and on rough-surfaced items, using non-hard water, and maintaining weight/density restrictions and configuration of tray items according to the manufacturer of the sterilizing unit.

**Olsen:** Probably the biggest challenge in terms of SSI prevention is the ongoing and explosive epidemic of obesity in the US. Obesity is one of the most important risk factors for SSI with virtually all surgeries from the neck down. The optimal solution to prevent risk associated with obesity is not feasible (i.e. weight reduction), so alternative strategies to lower the risk of SSI in obese persons need to be devised. Currently the only specific strategy for lowering the SSI risk in obese persons is to increase the dose

of prophylactic antibiotic to 2 g cefazolin rather than the normal 1 g. Other than the original study by Forse and colleagues<sup>14</sup> and a small retrospective observational study of ours,<sup>15</sup> to my knowledge no data to support the effectiveness of this strategy exists.

Another important area that needs more research is the role of glucose control in surgeries other than cardiac operations, for which the benefit is well established.<sup>16,17</sup> Given the rising prevalence of diabetes in the US and the role of diabetes as a risk factor for SSI, it is very important to investigate the impact of careful glucose control after noncardiac operations. We found that hyperglycemia independent of a diagnosis of diabetes was associated with increased risk of SSI after spine operations.<sup>18</sup> Campbell and colleagues analyzed multicenter data through the American College of Surgeons-National Surgical Quality Improvement Program, and found that the gap in SSI rates between diabetic and nondiabetic patients was significantly higher at hospitals identified with outlier SSI rates compared to all other hospitals. Although glucose control was not assessed in this study, the larger gaps in SSI rates in the high outlier hospitals were thought to be due to poor glycemic management in these hospitals.

**McMullen:** One big challenge I often hear about is traffic in the OR. In these days of increasingly difficult procedures, the vendors are important partners to our surgeons. However, they often do not receive the same level of training as OR staff, too often have a cavalier attitude toward entering/leaving the OR and show lack of respect for the sterile field. In addition, many institutions have students or visitors observing procedures who again may not have the same respect for the sterile field. Other than that, many ORs struggle with other traffic through rooms. One of the more creative ways to stop this has been the use of tape to make a big “X” at the point where the doors to the operative suite meet. This is easily broken, but the presence of the X and the sound it makes when the doors are opened are good cues to discourage excess non-necessary traffic.

**Lovelace:** The challenge is to apply interventions without increasing costs or time involved to utilize. Staff turnover requires more frequent education and re-education, but time for that is often not available. Drug resistance, such as MRSA, VRE, and *C. difficile*, requires that we not take the patients through the normal route that other patients go, such as the holding area. When you have exceptions like this, the challenge is to maintain the same level of care.

*When is an infection control intervention or change considered successful?*

**Vyhldal:** When the infection rate is reduced and maintained.

**Olsen:** An infection control intervention is generally considered effective when: (1) SSI rates are lowered significantly (both statistically and clinically) after implementation compared to before, (2) lowered SSI rates are sustained for months to years, rather than just a transient decrease in rates, (3) the intervention has buy-in from surgical personnel, including surgeons. This is absolutely essential to assure continued compliance with the intervention, and (4) the intervention is either intuitive, or can be accom-

plished via process changes so that it does not require continued thought on the part of healthcare workers to perform (i.e. hardwiring vs. behavioral change).<sup>19</sup>

**McMullen:** This is a big issue for many hospitals. Many successful interventions have taken place, resulting in infection rates that are already quite low. A successful intervention may slightly lower rates but the financial and time commitment to prove that these interventions will significantly lower SSI rates is often beyond many hospitals. As Dr. Olsen indicates, one great indicator that an intervention is successful is staff buy-in and engagement. If the intervention has biological plausibility to decrease infections or has been shown to work in other institutions, and has high compliance, it can be considered successful.

**Lovelace:** I agree with the other panelists that the best measurement is lower infection rates. You want the trendlines to be going down. Many surgeries now have zero based targeting so success is measured by having a zero infection rate for that procedure. Decreased length of stay would be considered a successful outcome. Better customer satisfaction feedback helps. Favorable “word on the street” is nice. An improved process that is a labor saver helps to reduce staff expenses. Expense reduction is a key outcome of fewer SSIs and readmissions due to complications.

*What process improvement changes will healthcare facilities make to avoid financial losses as a result of the CMS payment changes?*

**Vyhldal:** Standardizing definition of SSI at local, state and federal levels so everyone is talking the same language will help avoid losses, as will more aggressive administrative support to ensure compliance with practices, documentation, etc.

**Olsen:** Healthcare facilities willingness to support process improvement changes will likely depend on two factors: (1) the efficacy of the process improvement change in reducing the incidence of SSI and (2) the cost effectiveness of the process improvement. Many healthcare facilities have been willing to make process improvement changes to promote compliance with recommendations for the type and timeliness of prophylactic antibiotic administration, based on scientific evidence for the effectiveness of timely antibiotic prophylaxis to reduce the incidence of SSI<sup>20,21</sup> and expert recommendations.<sup>22,23</sup> An intervention to promote compliance with antibiotic prophylaxis recommendations was actually found to decrease costs of surgical prophylaxis in one study, most likely due to discontinuation of prolonged therapy and decreased utilization of more expensive broad-spectrum antibiotics.<sup>24</sup> Process improvement changes that have been implemented in hospitals to improve antibiotic prophylaxis compliance include standardized forms for ordering prophylaxis<sup>24,29</sup> pharmacist managed prophylaxis<sup>25</sup> and an integrated dispensing system.<sup>26</sup>

**McMullen:** Stand order sets allow hospitals to greatly increase the number of procedures that receive the correct preoperative antibiotics. Some ORs are incorporating a question about the administration of preop antibiotics into the ‘time out’ that checks the patient’s name, site of surgery, etc. In these cases, the incision is held

until the antibiotics are given. The discontinuation of prophylactic antibiotics within a short time of the surgery is probably the most difficult of the SCIP measures to comply with. Incorporating the help of nurses on the postoperative floors and empowering them to question physicians who continue to order antibiotics may be successful.

**Lovelace:** Better documentation by doctors and nurses on admission, throughout care and at discharge is necessary. Accurate coding by Health Information Management (HIM) is needed. This will enable us to see if any processes were omitted or need to be looked into. Any of the outcomes on the CMS list would need to be reported so that they can be investigated thoroughly. A Root Cause Analysis (RCA) might be needed to drill down the incident or outcome.

*What effect does utilizing antimicrobial dressings have on preventing surgical site infections?*

**Vyhlidal:** The literature on products indicates post operative dressings provide a positive effect on killing/log reduction on selected organisms commonly noted in SSI which lead to SSI reduced rates. One researcher reduced MRSA SSI infections by > 40%.<sup>27</sup> My clinical and research experience suggests a highly successful reduction of SSIs and cost avoidance in managing vascular surgical patients who had post-op non-intact incision suture lines, such as with peripheral or dependent edema in surgical extremity through the utilization of antimicrobial dressings.

**Olsen:** The efficacy of antimicrobial dressings to prevent SSI is not clear. It is thought that seeding of the operative wound occurs primarily during the surgical procedure itself, although the wound is at risk for contamination until it is completely closed. Theoretically, antimicrobial dressings could kill bacteria that come into contact with the wound before complete healing has occurred, thus preventing seeding. The proportion of SSIs that result from postoperative seeding of the incompletely healed wound is not known and thus the impact of antimicrobial dressings cannot be accurately estimated.

**McMullen:** I believe antimicrobial dressings may have some impact on SSI. However, it is important to remember that these dressings will have no effect on insults to the surgical site that happen in the OR. These dressings are best able to keep organisms from secondarily infecting the incision site, probably by mostly preventing superficial SSI.

**Lovelace:** Our facility did a 6-month trial using an antimicrobial dressing with 0.2% polyhexamethylene buguanide. It reduced our SSI rate by 81%. Our projected annual cost savings for our targeted procedures was \$273,173 and an estimated annual cost savings of \$579,725 for all surgical procedures. This information was presented at the annual APIC meeting in San Jose, California in 2007.<sup>28</sup> We continue to use this dressing and our SSI rate is still at least 50% lower than the date we started using the dressing. We have had to defend its use several times to purchasing personnel who want to reduce direct supply expenses. You have to stay firm and demand it.

*Discuss the changing role that infection control*

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*practitioners have in assuring patient safety for prevention of SSI.*

**Vyhlidal:** The role has changed from response and recovery to mitigation and preparation. We must step back from IPCs owning the high rates and implementation of needed practice changes, give them the role of facilitator, and let the surgical team own the whole process.

**Olsen:** I believe that the changing role of ICPs in assuring patient safety encompasses a more proactive role, emphasizing implementation and compliance with known preventive measures. We also need development and implementation of electronic SSI surveillance, to free up ICP time for interventions and monitoring compliance with preventive measures. This step is essential to provide ICPs with sufficient time to concentrate on SSI risk reduction activities.

**McMullen:** The traditional role of the infection prevention practitioner was mainly a direct observer who reports incorrect behaviors to OR management and physician leaders. The ICP of today is an important part of the OR quality improvement committee. They are respected as a source of recommendations and evidence based measures to prevent SSI and improve patient safety. This role increases communication and decreases the likelihood of surprises that lead to increased risk of SSI. A good working relationship with many members of the OR team needs to be painstakingly cultivated by the ICP.

**Lovelace:** The infection preventionist must stay informed. We have to be on top of all emerging diseases, especially the ones in our state. Administration support and buy-in is necessary. The CMS payment changes have helped with that. We cannot do it alone. Most programs must be multidisciplinary in order to accomplish the tasks. The IP must keep looking. Look at all processes in each area. In surgery, we must look at cleaning, disinfection, sterilization, air quality, hand scrubbing, etc. In nursing, we must look at hand hygiene, isolation compliance, documentation, wound care, etc. No area of the hospital is safe from our eyes and ears. We are accountable for the processes in every department and on

every floor.

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### Wound Care in Long Term Care: Focus on Infectious Complications—Continued

ucts and therapies that create a local environment favorable to repair. Research to date clearly suggests that no one dressing is inherently better than another; the goal in dressing selection is to select a dressing based on the specific characteristics of the wound and the goals for topical therapy. Specific goals for topical therapy may include the following:<sup>1,7-9</sup>

- Elimination of necrotic tissue (if goal is healing or if wound is infected)
- Control of bacterial loads (via selection of antimicrobial dressings that inhibit bacterial growth on the wound surface and/or within the wound dressing)
- Management of exudate and maintenance of a moist wound surface (via selection of dressings that effectively absorb excess exudate while maintaining a moist wound surface), and
- Protection of the healing wound from trauma and infection.

Each of these goals will be discussed in more detail, with implications and guidelines for wound care and dressing selection.

#### Elimination of Necrotic Tissue.

Necrotic tissue (eschar and/or slough) is a major impediment to wound healing and also provides a positive medium for bacterial

growth; wounds cannot heal until the necrotic tissue has been removed. Therefore, debridement of necrotic tissue is usually one of the first goals in wound care. However, there are some wounds that should not be debrided, so the clinician must first ask, “should this wound be debrided?” If the answer is yes, the clinician can focus on how to debride.<sup>7,9-11</sup>

When is debridement a good idea and when is it contraindicated? There are 2 situations in which debridement should be done and 2 in which it should not be done. The wound should be debrided if (1) the goal is healing (because debridement eliminates one of the impediments to repair), or (2) if the wound is complicated by infection, as evidenced by erythema, induration, and warmth of the periwound tissue (because necrotic tissue acts as an “all you can eat buffet” for bacteria). However, wounds should not be debrided when there is very limited potential for healing and no evidence of infection. Two common situations in which the wound should not be debrided are as follows: (1) the wound is covered with dry eschar and there are no signs of infection, and there is diminished blood flow to the wound bed (e.g. a foot ulcer covered with dry eschar in a patient with advanced vascular disease); or (2) the patient is bedbound or chairbound with a heel wound covered with dry eschar, and there are no signs of infection. In these situations removal of the eschar converts a closed wound to an open wound, which increases the risk of infection.

In situations where debridement is indicated, there are several options. If the necrotic tissue is loose, it can be removed at the bedside with sterile instruments, either by the physician, nurse practitioner, wound care specialist, or physical therapist. Slough (soft yellow-white tissue) can be removed by ultrasonic debridement or by pulsed lavage in settings where these modalities are available. In situations where instrumental debridement is not an option and ultrasonic debridement or pulsed lavage are not appropriate or not available, chemical and enzymatic debridement represent good alternatives. Chemical debridement involves use of dilute Dakin’s solution or Chlorpactin. Although use of these solutions remains somewhat controversial, many wound clinicians do advocate their use for wounds that are both necrotic and heavily contaminated or infected because of their ability to reduce bacterial loads while dissolving necrotic tissue. Enzymatic debridement with the pharmaceutical agent collagenase has the advantage of being widely available and very safe. A physician order is required since enzymatic ointments are pharmaceutical agents.

#### Management of Bacterial Loads

As noted, one of the primary goals in wound care is prevention of wound-related infections. Infection is a common complication because all open wounds are colonized with bacteria, which means that low numbers of bacteria are always present on the wound surface. Normally these limited numbers of bacteria are held in check by the patient’s immune system, and there is no interference to wound repair. Problems develop when the numbers of bacteria rise to a level that interferes with wound healing (critical colonization) or that permits invasion of the surrounding tissue (cellulitis) or bone (osteomyelitis).<sup>2,4</sup> Both of these conditions require systemic treatment.

The term “critical colonization” is used to indicate a condition in which the numbers of bacteria on the surface of the wound are sufficient to interfere with wound healing (probably by competing with fibroblasts and other cells for nutrients, and by secretion of damaging toxins) Critical colonization is not determined by wound culture; it is determined by careful comparative weekly evaluation of wound status. Indicators of critical colonization include a sudden deterioration in the quantity or quality of granulation tissue, persistent unexplained failure of the wound to form granulation tissue, an increase in exudate, and/or an increase in wound-related pain. Specific observations related to the quality of the granulation tissue include a change from crisp, red granulation tissue to tissue that appears “filmy, edematous, pale, and friable.”<sup>2,4</sup>

Critical colonization can be effectively managed with topical agents, because the interfering bacteria are all located on the surface of the wound. The agents most commonly used are antimicrobial dressings providing sustained release silver or sustained release cadexomer iodine.<sup>1,8</sup> Sustained release silver dressings are particularly popular and are available in a wide variety of dressing types (alginates, hydrofibers, hydrocolloids, foams, gels, etc.), however, the amount of silver provided and the specific mechanism of action differ from one dress-

Table 1: Common Etiologic Factors and Implications for Management (From ref. 6)

Etiologic Factor	Characteristics	Management
Pressure alone	Usually over bony prominence	Pressure reducing support surface
	Usually deep, extending into subcutaneous tissue, muscle, and/or bone	Routine turning and positioning
	Round or slightly oval with minimal undermining	Heel elevation
Pressure-shear	Usually over bony prominence in area exposed to sliding force	Pressure reducing support surface with low friction low shear surface
	Usually deep, extending into subcutaneous tissue, muscle, and/or bone	Routine turning and positioning
	Usually elongated and irregular with tunneling and undermining	Measures to minimize head of bed elevation
Friction and maceration (superficial lesions such as incontinence associated dermatitis or skin tears)	Located on areas exposed to urine/stool, handling by caregivers, or inadvertent trauma from siderails, etc.	Use of moisture barriers to protect skin against urine and stool
	Superficial (usually <1 mm in depth)	Gentle skin care
	No necrotic tissue	Protective sleeves or wraps
Venous ulcers	Located between ankle and knee, usually around malleoli	Elevation of legs when in bed
	Shallow ulcers with red base or thin layer adherent yellow tissue	Compression wraps to improve venous return
	Exudative	
Arterial ulcers	Usually associated with edema	
	Located distally (toes or forefoot) or in areas of trauma that are nonhealing	Vascular consult
	Deep ulcers with pale or necrotic wound base and minimal exudate	Avoidance all tobacco products
	Usually associated with diminished pulses, low ABI, and elevational pallor/ dependent rubor	Keep legs warm and dependent
		Avoid debridement of dry eschar when there are no signs of infection

Table 2: Systemic Factors Affecting Healing (from refs. 1, 4, &amp; 17)

Factor	Implications
Nutritional status	Nutritional consultation to assure adequate calories and protein intake (typically 30-40 calories and 1.2-1.5 gm protein/kg body wt) Multivitamin/mineral supplement Additional supplements as recommended by nutritionist
Glycemic Control	Goal is maintenance glucose levels in normoglycemic range (<140 mg/dl)
Steroid Intake	Steroids at doses >20 mg/day may interfere with healing; consult wound specialist regarding possible use of topical Vitamin A

ing to the next.<sup>12</sup> For example, some dressings donate silver to the wound bed and kill bacteria on the wound surface, while others pull the drainage and bacteria into the dressing and kill within the dressing. In addition, some dressings are “high release” silver agents – meaning that large amounts of silver ions are released into the wound bed – while others are “low release” dressings that exert their antibacterial effects over a number of hours. At this point we lack the data to state whether one type or approach is better than another; the clinician should be knowledgeable as to the mechanism of action (MOA) for specific types of dressings and should monitor the wound carefully for the desired effect (i.e. reduction in volume of exudate and progress in healing).

If the wound fails to respond, the clinician should consider a dressing with a different MOA. The clinician could choose to utilize a gauze or foam dressing impregnated with polyhexamethylene biguanide (PHMB) because the MOA is slightly different than silvers.<sup>13</sup> The clinician might also consider use of a topical antibiotic; however, a wound culture should be done to determine the infecting organism because antibiotic agents have limited bactericidal spectrums. In contrast, antiseptic agents such as silver and iodine are broad spectrum agents effective against almost all bacteria and fungi, so a culture is not required when using these agents.

In selecting an antimicrobial dressing, the clinician should consider the volume of exudate; a highly exudative wound is best managed with an antimicrobial alginate, hydrofiber, or foam, whereas a dry wound is best managed with an antimicrobial gel.<sup>1,14</sup>

Cellulitis occurs when the bacteria invade the healthy tissue surrounding the wound, triggering an inflammatory response. The indicators of cellulitis include erythema, induration, and increased warmth of the periwound tissue and may also include increased volume of exu-

Table 3: Proper Technique for Obtaining Wound Culture (from ref. 2)

- Flush wound with sterile saline to remove contaminants
- Moisten sterile swab with sterile saline
- Select 1 square centimeter of viable wound tissue; swab with enough force to produce exudates (about 5 seconds)
- Transport to laboratory

NOTE: Do NOT culture eschar, slough, or pus

date, purulent exudate, fever, and/or elevated white blood cell count. Because the infection involves healthy tissue adjacent to the wound bed, treatment always involves systemic antibiotics. Ideally, the choice of antibiotics is based on culture results, however, a valid culture can be obtained only if there is viable tissue in the wound bed. (Current guidelines for wound cultures are provided in Table 3.) When assessment reveals evidence of cellulitis, the nurse should obtain a culture (if possible) and should contact the physician to obtain orders for systemic antibiotics. When the wound is covered with slough or eschar, it is impossible to obtain a valid culture, and the physician will need to prescribe broad spectrum antibiotics.

Osteomyelitis is a potential complication whenever a wound extends into the deep tissue close to the bone.<sup>4</sup> Bone infection should be suspected whenever there is exposed bone in the wound bed and whenever a large deep wound closes down to a narrow nonhealing tunnel. When bone infection is suspected, an orthopedic or infectious disease specialist should be consulted.

### Strategies to Minimize the Risk of Wound-Related Infections

The long-term care population is particularly prone to development of wound-related infections, because aging is associated with multiple comorbidities and with compromised function of the immune system. Strategies to minimize the risk of infection and to promote prompt resolution of any infections that do occur include the following:<sup>4,7,15</sup>

- Ongoing attention to nutritional support – malnutrition is associated with reduced ability to fight infection due to deficiencies in the immune system.
- Tight glucose control – hyperglycemia (glucose levels >180 mg/dL) paralyzes the white blood cells and leaves the resident very vulnerable to infection.
- Strategies to improve perfusion and oxygenation of the wound bed, such as elevation of edematous limbs, routine repositioning to promote healing of pressure ulcers, provision of fluids by mouth to maintain adequate hydration, and oxygen therapy when ordered and indicated.
- Careful clean technique – handwashing, use of clean gloves, correct technique for removal/disposal of the old dressing and for application of the new dressing, and provision of a waterproof outer dressing for any wound exposed to contaminants

such as stool and urine.

- Use of antimicrobial dressings for residents who are very high risk for infection, such as those with diabetes, those receiving steroids, and those with poor perfusion to their wounds.
- Careful monitoring for any signs of critical colonization or invasive infection, with prompt notification of the physician.

### Guidelines for Dressing Selection

Appropriate dressing selection provides for exudate control, maintenance of a moist wound surface, and protection of the healing wound from trauma and bacterial invasion.<sup>14</sup> Guidelines for dressing selection can be summarized as follows:

**Wounds with moderate to large volumes of exudate:** These require absorptive dressings; good choices are calcium alginate dressings, hydrofiber dressings, and foam dressings.<sup>1,8</sup>

**Deep wounds:** The base of the wound can be lined with an alginate or hydrofiber and dry fluffed gauze can then be used to fill the wound bed. An adhesive waterproof foam cover dressing provides additional absorption and provides a waterproof outer surface. An alternative cover dressing is gauze and tape covered by a transparent adhesive dressing (e.g. OpSite, Polyskin, or Tegaderm).

**Shallow/superficial wounds:** An alginate or hydrofiber dressing can be used and secured with gauze/tape or wrap gauze; alternatively, a foam dressing can be used. If the wound is highly exudative, an alginate or hydrofiber can be applied and then covered with a foam dressing (or gauze) to provide additional absorption. Shallow exudative wounds can also be managed with a nonadherent “contact” layer such as an oil emulsion dressing, e.g. Curity Oil Emulsion or a porous nonadherent gauze, such as Adaptic covered with gauze<sup>2</sup> and secured either with wrap gauze or tape.

**Wounds with minimal exudate:** These require dressings that donate and retain moisture at the wound surface; a moist surface is critical to cell viability and cell migration. Good choices for dry wounds are liquid and solid hydrogels, transparent adhesive dressings and hydrocolloid dressings.<sup>1,8</sup>

**Deep wounds:** Dehisced abdominal incisions are a good example of deep wounds that are relatively dry. These wounds are typically best managed with a thin layer of wound gel followed by damp fluffed gauze and secured with a transparent adhesive dressing (OpSite, Polyskin, or Tegaderm).

**Shallow wounds:** These can be managed with solid hydrogel dressings (if available), hydrocolloid dressings, or nonadherent dressing such as Curity Oil Emulsion, Adaptic, or Xeroform secured with wrap gauze.

**Tunneled wounds:** Wide tunnels and areas of undermining can be managed with calcium alginate rope or hydrofiber rope dressings. Narrow tunnels should be managed with narrow wicking products that do not create the risk of retained dressing fragments. Good choices are Curity AMD antimicrobial packing strips, NuGauze, MeSalt ribbon, Curasalt and strips of silver-based foam.

**Infected wounds:** As discussed previously, wounds complicated by critical colonization

should generally be managed with antimicrobial dressings, such as cadexomer iodine, PHMB-impregnated dressings, or sustained release silver. Wounds associated with cellulitis require systemic antibiotic therapy, but some clinicians choose to treat topically as well with antimicrobial dressings. This is particularly beneficial in situations where the wound is poorly perfused.<sup>1,8,12,13</sup>

### Summary

In conclusion, effective management of any chronic wound requires correction of etiologic factors, systemic support for healing, and topical therapy to establish and maintain a clean wound bed and to prevent infection. Strategies for minimizing the risk of infection include meticulous clean technique, removal of necrotic tissue, effective management of exudate, and judicious use of antimicrobial dressings. In addition, wounds exposed to contaminants such as stool or urine should be routinely dressed with products that provide a bacterial barrier.

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\*In general, gauze is not the best choice for a primary dressing because gauze tends to stick to the wound bed, causing trauma on dressing removal. In addition, woven gauze products have a tendency to leave fibers in the wound bed.<sup>16</sup> If gauze is used, the nurse must be careful to moisten the gauze prior to removal and must select nonwoven gauzes that do not leave fibers behind in the wound bed.

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1. Identify principles of effective wound management and guidelines for dressing selection.
2. Explain indications and options for debridement of necrotic tissue.
3. Describe the effect of antimicrobial dressings on preventing SSIs.
4. List the interventions that help reduce SSIs

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1. Which of the following represents essential care for any patient with a wound?
  - a. Systemic antibiotics
  - b. Surgical debridement
  - c. Attention to causative factors
  - d. Antimicrobial dressings
2. Debridement is contraindicated for which of the following patients?
  - a. Patient with trochanteric pressure ulcer that is 70% necrotic
  - b. Patient with necrotic infected ulcer on heel
  - c. Patient with infected leg ulcer that is 60% necrotic
  - d. Patient with dry eschar on heel, no signs of infection, and no palpable pulses
3. Systemic antibiotics are indicated for which of the following?
  - a. Patient with sacral pressure ulcer and erythema and induration of surrounding tissue
  - b. Patient with trochanteric ulcer that is not granulating despite appropriate treatment
  - c. Ulcers in which there is necrotic tissue
  - d. All of the above
4. In selecting a dressing for a wound that is 6 cm x 5 cm x 4 cm and highly exudative, the BEST choice would be:
  - a. Saline moistened gauze + dry gauze changed twice daily and PRN
  - b. Gel soaked gauze + dry gauze changed daily and PRN
  - c. Calcium alginate dressing + foam cover dressing
  - d. Hydrocolloid dressing sized to extend 2" past wound edges
5. Critical colonization is best defined as:
  - a. The optimal balance between levels of bacteria and white blood cells
  - b. Bacterial invasion of surrounding tissue
  - c. Bacterial counts > 100,000 CFU/ml
  - d. Bacterial counts on wound surface that are high enough to interfere with wound healing
6. Which of the following represent signs of critical colonization?
  - a. Erythema and induration of surrounding tissue
  - b. Sudden deterioration in quantity or quality of granulation tissue
  - c. Non healing tunnel > 0.8 cm in depth
  - d. Wound that is healing slowly (10% per week closure rate)
7. Critical colonization is BEST managed with:
  - a. Sustained release antimicrobial dressing (silver, cadexomer iodine, or PHMB)
  - b. Two-week course of Dakin's soaked gauze dressings changed twice daily
  - c. Polysporin powder + dry gauze changed daily
  - d. Systemic antibiotics
8. Wound cultures are indicated for which of the following?
  - a. Heavily necrotic wound (wound in which >50% of wound bed is necrotic)
  - b. Diabetic foot ulcer that is clean but not granulating
  - c. Wound with evidence of critical colonization
  - d. Wound that is 30% necrotic, with erythema and induration of surrounding tissue
9. Strategies to prevent surgical site infections include all of the following except
  - a. Double gloving
  - b. Adherence to prophylactic antibiotic recommendations
  - c. Removing hair with a razor
  - d. Using flash sterilization for emergencies only
10. Challenges in preventing surgical site infections include
  - a. Finding an effective skin prep that is highly effective in killing microbes, tinted, quick drying without risk of fire and easy for a patient to remove
  - b. Controlling traffic in the OR
  - c. Both A & B
  - d. None of the above
11. A good indicator of a successful intervention is staff buy-in and engagement.
  - a. True
  - b. False
12. Process improvement changes that have been implemented in some hospitals to improve surgical antibiotic compliance include
  - a. Standardized order forms for ordering prophylaxis
  - b. Pharmacist managed prophylaxis
  - c. Integrated dispensing systems
  - d. All the above

Participant's Evaluation	Mark your answers with an X in the box identifying the correct answer(s).																																																							
<p><b>What is the highest degree you have earned (circle one) ?</b></p> <p>1. Diploma    2. Associate    3. Bachelor's 4. Master's    5. Doctorate</p> <p><b>Indicate to what degree did this program meet the objectives:</b> Using 1 = strongly disagree to 6 = strongly agree rating scale, please circle the number that best reflects the extent of your agreement to each statement.</p> <p>At the end of the session the participant will be able to:</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 80%;"></td> <td style="text-align: center; border-bottom: 1px solid black;">Strongly Disagree</td> <td style="text-align: center; border-bottom: 1px solid black;">Strongly Agree</td> </tr> <tr> <td>1. Identify principles of effective wound management and guidelines for dressing selection.</td> <td style="text-align: center;">1   2   3   4   5   6</td> <td style="text-align: center;">1   2   3   4   5   6</td> </tr> <tr> <td>2. 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