Anesthesia Protocol for Heel Pressure Ulcer Debridement

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ABSTRACT

Heel ulcers are clinically challenging. Limited subcutaneous tissue covering the calcaneus bone makes the heel vulnerable to pressure injury. Adequate debridement of fibrotic, infected, and necrotic tissue is essential for healing. The authors report a standardized anesthesia protocol using regional anesthesia with sedation rather than general anesthesia for heel debridement.

KEYWORDS: heel pressure ulcer, debridement, anesthesia

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INTRODUCTION

Pressure ulcers (PrUs), formerly known as bedsores, result from pressure and shear forces over the tissue causing breakdown in the skin.[1] Persons with limited activity or mobility that affects mechanical load on the tissues have increased risk for PrUs.[2] Older adults, persons with fractured hips or spinal cord injuries, persons with multiple factors, and acutely ill and intensive care unit (ICU) patients are at more risk of developing PrUs.[2]

In the United States, approximately 1.3 to 3 million people currently are living with PrUs.[1] Overall, the incidence of PrUs in the United States has dramatically increased. According to the Healthcare Cost and Utilization Project (HCUP) survey, there was a 78.9% increase in hospitalization with PrUs from 281,300 in 1993 to 503,300 in 2003.[3] In 2009, the overall prevalence rate in all US facilities was 12.3%; 11.9% for acute care, with 5% being facility acquired; and 11.8% in long-term care, with 3.8% being facility acquired.[4]

A PrU acquired at the hospital will increase both cost and the length of stay.[5] The length of stay of hospitalization for PrUs was 14.1 days, approximately 3 times longer than the length of stay of all other hospitalizations.[3] The financial cost of PrUs to the healthcare system is huge. The cost of hospitalization for PrUs was also much higher than hospitalization for other conditions—$16,800 compared with $9900.[6] In 1997, the annual cost of treatment for PrUs was between $5 billion and $8.5 billion[7]; in the latest data from the HCUP, it is now $11 billion.[3] The escalating cost of treating PrUs continues to burden the US government, with Medicare being the major payer of hospitalization related to PrUs.[3] In 2008, the Centers for Medicare & Medicaid Services stopped reimbursing hospital-acquired PrUs at a higher diagnosis-related-group rate.[8]

The human cost of PrUs is also substantial. The presence of a PrU could potentially lead to many other serious complications, such as nosocomial infections, osteomyelitis, septicemia, pain, and depression.[6,9] Some signs of infected PrUs are odor, pain, cellulitis, and drainage.[1,6] From 1990 to 2001, 0.4% (n = 114,380) of deaths in the United States were due to PrUs; about 40% were due to septicemia.[6,10]

One of the most serious complications of PrUs is sepsis. Sepsis occurs when aerobic and/or anaerobic bacteria enter the bloodstream through the open wound, leading to systemic signs and symptoms of serious infection.[11] Septic shock, an extension of sepsis, even with therapy, still has an extremely high mortality rate.[12]

Osteomyelitis is another serious complication of PrUs. According to the National Pressure Ulcer Advisory Panel,[2] a Stage IV PrU is defined as "full-thickness tissue loss with exposed bone, tendon, or muscle."[2] Typically, once a Stage IV PrU has occurred, bacteria can easily reach and infect the bone causing osteomyelitis.[2,6] Although many bacteria can be the cause of osteomyelitis, the more common pathogens are Enterobacteriaceae, *Staphylococcus aureus*, *Streptococcus*, *Pseudomonas*, and anaerobic bacteria.[6,13,14] If the patient does not have a fever or leukocytosis, then antibiotics before debridement are typically not needed.[1,6] Adequate debridement will usually remove the source of infection for osteomyelitis and sepsis.[15] Thus, balancing the need for thorough removal of affected tissue in Stage IV PrUs, managing the procedural pain of surgical

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debridement, and the potential risks of anesthesia must all be considered. Systemic antibiotics should be given after debridement for osteomyelitis.[6]

HEEL ULCERS

Pressure ulcers in adults typically develop at the sacrum, heel, trochanter, and ischium,[1,4,16] with the most common location being the sacrum. The rate of heel PrUs is rising quickly. In 1989, 38% of PrUs occurred at the sacrum, whereas the heel (the second most common site of PrUs) accounted for only 19% of all PrUs.[16] In 2005, sacral PrUs accounted for 28.3%, and heel PrUs were at 23.6%.[4] In fact, in a recent 2010 study, heel PrUs were actually the most common site at 26%.[17] Figure 1 depicts a necrotic heel PrU.

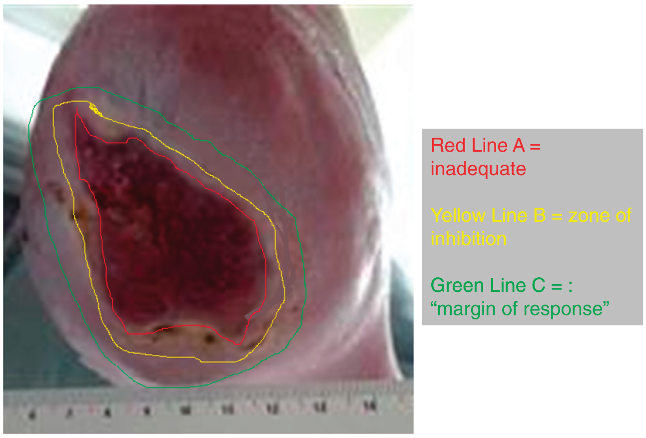
The heel includes the calcaneus, the largest bone in the foot.[18] It supports most of the body's weight and acts as a shock absorber. The calcaneus, with the Achilles tendon, is essential for proper ankle joint motion and ambulation.[19,20]

There are many risk factors contributing to the formation of heel PrUs.[21] Immobility is present in 87% of all heel PrUs.[7] The immobility leads to continuous pressure being applied to the heel. When external pressure exceeds capillary closing pressure, ischemia occurs and causes areas of cellular necrosis leading to PrUs.[22] The heel is especially vulnerable to pressure and ischemia because it is pointy and has little subcutaneous fat surrounding it so blood flow is easily suppressed with high pressure to the area.[20] Friction and shear forces are other mechanical risk factors for heel PrUs.[20,23] Old age and diabetes mellitus (DM) are 2 other patient risk factors for heel PrUs. With old age, the heel pad is less resistant to shock, the skin is less resilient, and blood flow is reduced.[20] Patients with DM often have peripheral vascular disease and neuropathy.[24] Arterial occlusive disease reduces blood flow to the heel causing cellular necrosis. Neuropathy impairs sensation and perception of mechanical stimuli including pressure to the region of risk.[25] In fact, heel ulcers occur in patients with diabetes 4 times more often than in those without diabetes.[20,26] Therefore, heel ulcer patients need a proper vascular assessment prior to debridement.

Stage IV heel PrUs with adequate blood supply need debridement to remove necrotic, fibrotic, and/or infected tissues and fluids to prepare for wound healing.[1,15] There are many types of debridement: sharp surgical, mechanical, enzymatic, larval, and autolytic. Adequate debridement of the wound edges is critical for removing nonfunctioning keratinocytes typically found at the nonmigrating edges of stalled chronic wounds.[27,28] In contrast with classic surgical teaching based on visual inspection, newer understanding of the science of the cells at the wound edges provides guidance for clinicians for the need for wider excisional debridement (Figure 1).[27,28]

Sharp surgical debridement is the fastest and most effective type of debridement.[1] Clinicians control the type and amount of tissue removed.[1] Sharp surgical debridement removes necrotic tissue, promoting wound bed preparation.[29] Laboratory evaluation of the tissue specimens is essential.[29] Pathological analysis not only provides the opportunity to diagnose malignancy such as basal cell or squamous cell carcinoma, but also can reveal fibrotic or infected tissue that may impair wound healing after inadequate debridement.

Figure 1.
NECROTIC HEEL



ANESTHESIA

After appropriate patient assessment and optimization, surgical debridement of heel PrUs can be performed either at the bedside or in the operating room. Regardless of the environment performed, the debridement needs to extend to the "margin of response" of the keratinocytes.[27,28] The line labeled "A" in Figure 1 represents the typical stalled edge of a PrU where keratinocytes are nonfunctioning and incapable of movement and wound closure. Research has shown that debriding to just this edge is not enough. Line "B" represents the full extent of the chronic wound. Debridement to line "C" is where the keratinocytes are capable of movement and performing their usual function of differentiation and wound epithelialization. Therefore, adequate debridement to this "margin of response" of the keratinocytes is typically much wider (line C) than most clinicians would initially think (line A). Using this biology of debridement will result in a much larger wound after debridement (Figure 2). Patients and their families need to understand that this is an expected surgical outcome.

Figure 2.
POST DEBRIDEMENT HEEL

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Because adequate debridement is potentially very painful in those not insensate, some type of anesthesia would be required to prevent reflex withdrawal and the autonomic stress response to injury. Surgery without antinociception is vivisection that can lead to myocardial infarction from increased mycocardial oxygen demand as well as posttraumatic stress disorder. If the debridement is performed in the operating room, then an anesthesiologist will be present to administer anesthesia and provide care to the patient before, during, and after the surgery.

The public perception about the risk of anesthesia and surgery may be out of proportion to improved safety even for high-risk patients. Although there are inherent risks to anesthesia, improved techniques, medications, and monitoring have made the anesthesia risks relatively low in the order of 1 in 10,000 cases in 1982.[30] These anesthesia risks have continued to improve with figures of 1 in 185,000 cases[31] reported in 1987 and 1 in 200,000 cases[32] in 1989. Patients with PrUs usually have multiple comorbidities that may increase their risk by an order of magnitude or more, depending on their underlying diseases.[33] This translates into higher risk scores as defined by the American Society of Anesthesiologists (ASA) (ASA 3 or 4). Therefore, the anesthesia provider needs to be knowledgeable and skilled in managing complex patients in the perioperative period. For example, patients with heart failure may have implantable cardiac devices that need interrogation prior to surgical intervention for wound debridement.[34] Figure 3 outlines the authors' heel PrU care algorithm.

Historically, for anesthesiologists, the postgraduate training after college and medical school has increased to at least 3 or 4 years after a clinical base of at least 1 year. More than 20% of board-certified anesthesiologists have either subspecialty fellowship training or at least 1 additional board certification. Subspecialization in anesthesiology allows for greater expertise, experience, and confidence than a general anesthesiologist.[35] This specialized training in anesthesiology for wound anesthesia is not yet available as opposed to an anesthesiologist specializing in cardiac, orthopedic, and pediatric surgery or certified subspecialties, such as critical care medicine and pain management.

During a surgical debridement, the anesthesiologist has various anesthesia techniques available, either regional or general anesthesia. Currently, there is no standard anesthesia technique for heel PrU debridement surgery. The choice has historically been the preference of the anesthesiologist in combination with the patient's wishes and comorbidities. Many patients want to "go to sleep and not feel any pain." This comment can be misinterpreted as requesting general endotracheal anesthesia, which may require neuromuscular blockade and inhalational anesthetics. Many patients, families, and surgeons may not realize that less sedation is required to induce sleep with a regional block compared with general anesthesia. Consequently, spontaneous ventilation can be maintained without the need for neuromuscular blockade or invasive airway management devices such as the laryngoscope and endotracheal tube. Regional anesthesia provides antinociception or pain relief without requiring sedation, although most patients have some anxiety. In contrast to obstetric anesthesia, where women in labor usually want to be awake during an abdominal delivery (cesarean delivery) under spinal or epidural anesthesia in order to experience the joy of new human life, wound patients commonly have fears of mutilation and chronic pain, which increase the likelihood of requiring deeper sedation as they do not want to see their wound debrided.

AN ANESTHESIA PROTOCOL

The objective of this article was to provide evidence from the authors' experience in a large academic urban medical center that successfully uses regional anesthesia during debridement surgery, leading to successful healing of heel PrUs (Figure 4). Regional anesthesia is a safe alternative to general anesthesia and potentially has fewer complications than general anesthesia. Regional anesthesia with sedation should be the default anesthetic technique, and general anesthesia should be used only as a backup if there are contraindications for regional anesthesia or if regional block is unsuccessful.

PREOPERATIVE EVALUATION

Before sharp surgical debridement, all patients must be evaluated preoperatively for disease characterization, risk stratification, and

Figure 3.
HEEL PRESSURE ULCER CARE PROTOCOL

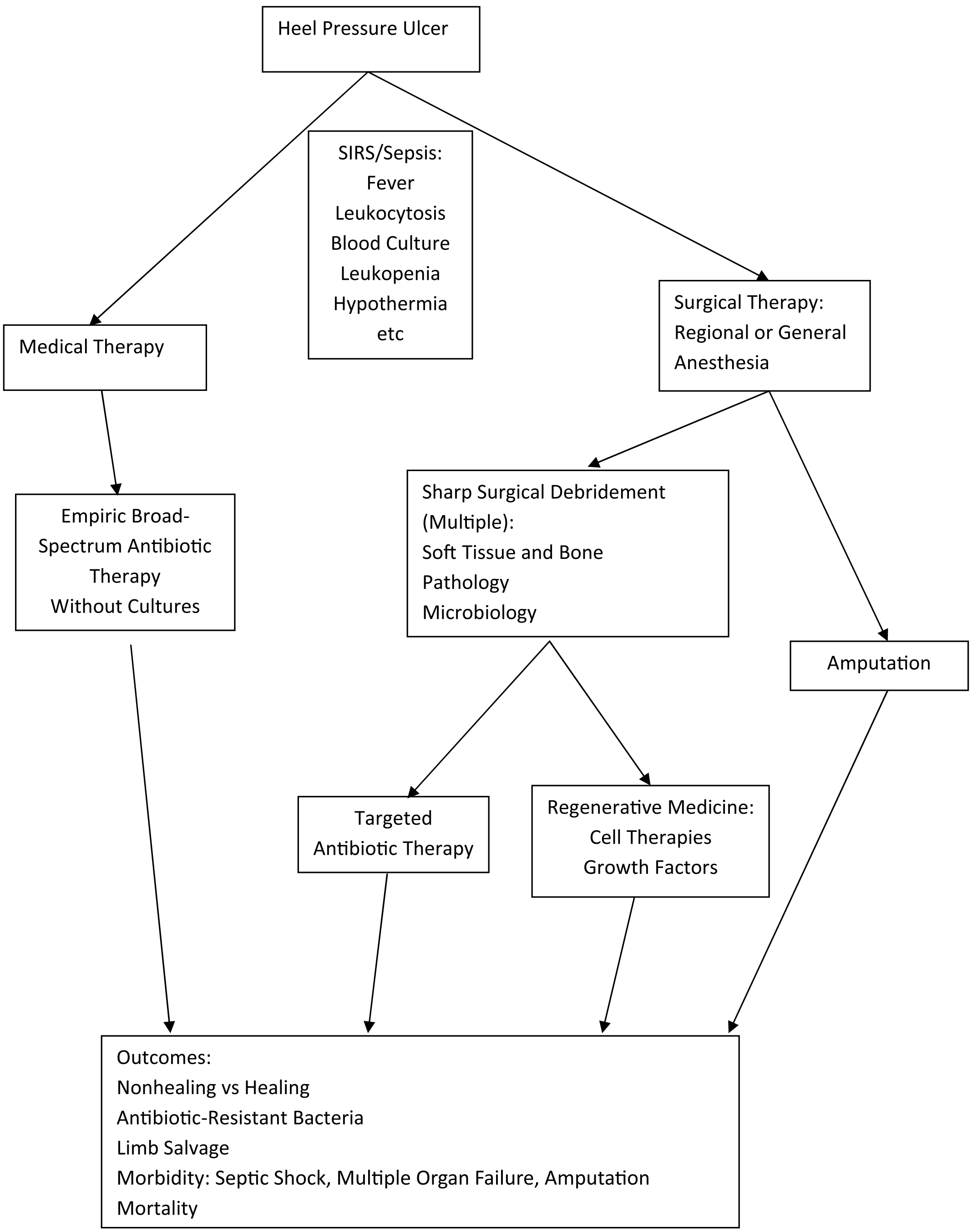

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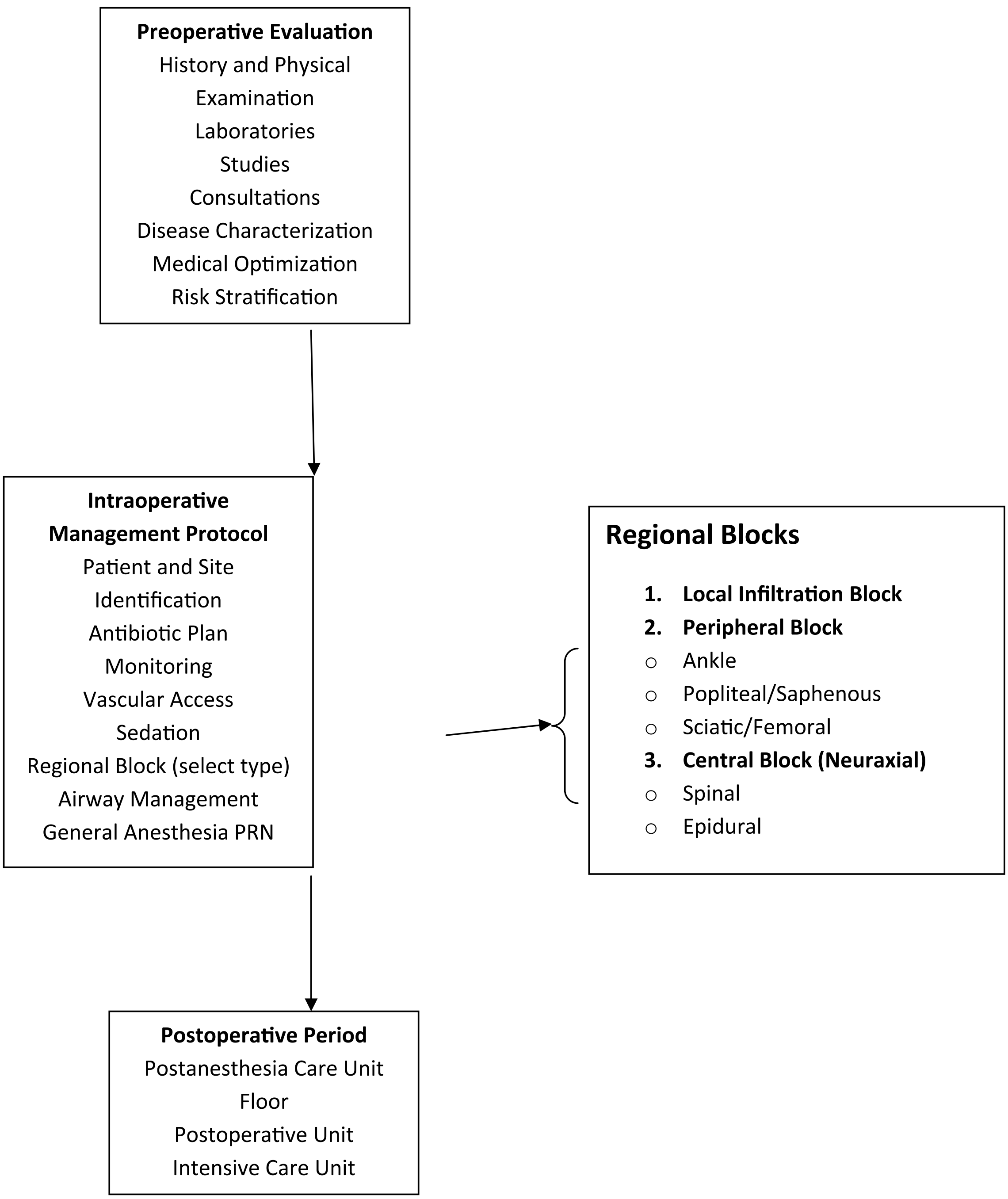
Figure 4.
WOUND ANESTHESIA PROTOCOL



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medical optimization to minimize the chance of undesirable perioperative outcomes. The anesthesiology staff initially meets with the patient to discuss all major issues, including anesthetic plan and potential risks, and to obtain consent for anesthesia.[36–39]

HISTORY AND PHYSICAL EXAMINATION

A history and physical examination (H&P) is done on all patients by the surgeon. In addition, depending on patient comorbidities, a consultation evaluation would include a focused H&P by the specialized consultant, such as a cardiologist, pulmonologist, and/or neurologist as indicated. Many groups and institutions utilize preoperative questionnaires to accumulate clinically relevant facts in a cost-effective, efficient manner. For a variety of psychological and social factors, the questionnaire can function as an adjunct, but not substitute, for the interview portion of the H&P. Some patients may fail to answer questions when asked verbally but are willing to mark a checkbox when waiting for the physician. Others lack the psychomotor or cognitive skills to read and answer questionnaires appropriately.[36–39] A typical interview includes the history of present illness, medical and surgical/anesthesia history, relevant family history, and other pertinent information, such as allergies, medications, toxic behaviors, concerns, and symptoms.[36–39]

The anesthesiologist will do a focused physical examination based on the history with emphasis on the airway, cardiovascular, pulmonary, and neurological systems, which may impact on regional and/or general anesthesia techniques. Because all anesthesia cases require vascular access for fluid and drug administration, veins and arteries are evaluated, and existing catheters are noted. Occasionally, peripherally inserted central catheter lines are inserted preoperatively in patients with ''bad veins.''[36–39]

A thorough evaluation should be done in all patients. Although regional anesthesia is the default choice for sharp surgical debridement, intubation and general anesthesia may be needed for a variety of expected or unexpected reasons. These reasons can include aspiration risk or apnea.

LABORATORY TESTS/STUDIES

A typical PrU patient is geriatric with multiple comorbidities.[33] At New York University hospital, more than 50% of patients who undergo PrU debridement surgery have diabetes.[40] Although young, healthy surgical patients require few laboratory studies, high-risk patients require a ''complete'' set of laboratory results based on the risk factors.

Basic laboratory values include complete blood count, routine serum chemistries, and renal function tests. Other laboratory screenings are done according to the comorbidities of the patient.[36–39] Studies such as electrocardiogram, chest radiograph, and pulmonary function testing are also often obtained as part of the preoperative evaluation.[36–39] Laboratory tests and studies should be performed prior to surgery as outpatient or inpatient with adequate time for identification and correction of significant abnormalities. On the other hand, the results should not be so remote that they fail to detect recent perturbations from normality. For example, a dialysis patient should have his/her electrolytes measured after the last dialysis, but before surgery.

CONSULTATION

In a 2004 national survey, the following problems were noted in patients who developed PrUs: cardiovascular (21%), respiratory (20%), gastrointestinal (12%), and neuromuscular (8%).[33] Medical specialists should be consulted for evaluation and optimization of patient comorbidities prior to surgery and anesthesia. The consultation is expected to be descriptive and informative. Although some medical consultants are expected to ''clear'' patients for surgery, the anesthesiologist ''clears'' the patient for the operating room based on the information available. Incomplete evaluation can lead to unnecessary cancellations and postponement of surgery, which has its financial, medical, and social costs. Effective communication and coordination are essential for successful preparation.[36–39]

For example, an implantable cardioverter-defibrillator device (ICD) is an electronic device used to prevent sudden cardiac death. All patients with an ICD need to be questioned prior to surgery about their device, and all devices need to be interrogated preoperatively.[34] Because the majority of surgeons and physicians, including most cardiologists, are not experts on the nuances of modern cardiac devices, a recent, if not immediately preoperative, device interrogation needs to be performed to minimize risk of device malfunction or patient harm from electrocautery or electrical therapy.[34] The device manufacturer and type of device need to be known.[34] A regimen should be prescribed by an electrophysiologist or corporate representative to the anesthesiologist for perioperative management that may include asynchronous mode, threshold adjustment, magnet placement, and/or transcutaneous defibrillator pad placement with real-time monitoring.[34,41–43]

DISEASE CHARACTERIZATION

Descriptive disease details need to be known before anesthesia to adjust anesthetic management and are best communicated by the physicians who follow the patient. For heel PrUs, the location of the ulcer might influence the types of regional anesthesia given. For example, there is a major difference between mild aortic stenosis and severe aortic stenosis as quantified by pressure gradients and valve areas. Similarly, trace tricuspid regurgitation is very different from severe tricuspid regurgitation associated with pulmonary hypertension. Patients with asthma with active wheezing are at higher risk than patients whose asthma is controlled with steroids and bronchodilators.

MEDICAL OPTIMIZATION

Patients should be medically optimized before surgery. Some patients are too sick to go to the operating room, whereas other patients are so sick that they need to go to the operating room. The surgeon is responsible for consulting the appropriate medical consultant required to get the patient in the best physical condition prior to surgery to minimize the risk of complications. The anesthesiologist is ultimately the professional responsible for clearing the patient for surgery in the operating room. For patients undergoing noncardiac surgery, the American College of Cardiology and American Heart Association have provided guidelines for cardiac evaluation and optimization, and the American College of Physicians has provided guidelines for pulmonary evaluation and optimization.[43–45] For example, β-blockers should be given to appropriate patients with coronary artery disease.

Before surgery, the patient is kept NPO, or nothing by mouth. Fasting is needed to prevent regurgitation and pulmonary aspiration during surgery.[46] The current guideline from the ASA on fasting policy for patients with normal gastrointestinal function is usually 8 hours. However, in certain cases and institutions, especially pediatrics, the 2-4-6-8 rule applies as follows: nothing 2 hours before anesthesia, only clear liquids up to 2 hours, breast milk up to 4 hours, light meal up to 6 hours, and unrestricted past 8 hours.[46] Meats and fried or fatty foods may prolong gastric-emptying time.[46] Patients with delayed gastric emptying or bowel obstruction/immotility may still have a ''full stomach'' even after 8 hours. When NPO becomes prolonged, maintenance intravenous fluids are administered. In addition, patients who have difficulty with coughing to clear secretions or dysphagia secondary to stroke or neuromuscular disease may also be at risk for aspiration pneumonia.

RISK STRATIFICATION

The ASA created the ASA status risk stratification classification system to classify the fitness of patients for surgery.[47] All patients are assigned an ASA status prior to surgery. There are 5 graded groups, each being worse than the previous one. A normal healthy patient would be graded ASA 1. The grade increases with systemic disease, especially end-organ damage. A surgical patient who needs the operation to live would be graded ASA 5.[47]

A typical wound patient for sharp surgical debridement in the operating room at the authors' major university hospital has an average ASA of 3.09 compared with an overall average of 2.03 for the faculty practice.[40] This risk stratification demonstrates that chronic wound patients, like vascular patients, enter the operating room with a higher than average risk of mortality and morbidity compared with other surgical patients.[40]

INTRAOPERATIVE PROTOCOL

Patient and Site Identification Plus Antibiotic Selection

Proper patient and site identification are part of all intraoperative protocols. This important component of safe patient care is well documented in the literature and needs to be included for wound patients requiring surgery (Figure 4).

Antibiotic selection and plan should be made prior to anesthesia. When previous culture results are available, the information should be used to select an antibiotic. Commonly, special antibiotics require time for acquisition from pharmacy and preparation for intravenous administration after dilution. Therefore, the timing of the initiation of antibiotic dosing with respect to incision time can be more reliable with early planning by the surgical team. In the absence of culture results, empiric antibiotics can be chosen based on the usual recommendations at the local institution in the context of the wound type and national guidelines. When the surgical team wants to postpone antibiotic administration until intraoperative cultures are obtained, that preference needs to be communicated with the anesthesia team to prevent antibiotic dosing prior to incision.

Monitoring

All surgical patients undergoing anesthesia must be continuously monitored to ensure safety and to detect potential complications. Vigilant monitoring begins with the start of anesthesia care and continues to the end of anesthesia care and recovery. Basic monitoring requirements are oxygenation, ventilation, circulation, and temperature.[48] Noninvasive monitoring includes pulse oximetry, electrocardiogram, noninvasive blood pressure, capnography, and temperature. Because anesthetics act on brain function, the electroencephalogram or EEG has been enhanced as a monitor by the bispectral (BIS) EEG technology.

BIS, especially when interpreted with EMG (electromyelogram) signals, can be very useful for drug titration during general anesthesia and/or regional anesthesia with deep sedation. Invasive monitoring (Foley, arterial line, central venous pressure, or pulmonary artery catheter) may be required occasionally when the additional information adds clinical value to the decision making. Glucose is monitored for control in patients with diabetes to prevent both hypoglycemia and hyperglycemia.

Vascular Access

Intravenous access is required for fluid replacement and drug delivery. Because patients are NPO for pulmonary aspiration prophylaxis, a fluid deficiency can lead to relative vasoconstriction in compensation for a mild volume contraction. Administration of hypnotics, analgesics, central blocks, and/or inhalational agents can cause vasodilation and potentially hypotension requiring fluid boluses and/or vasopressors. Antibiotics are administered intravenously. In addition, extensive debridements, especially in the presence of venous hypertension, infection, or coagulopathy, can result in blood loss requiring replacement of blood products, such as packed red blood cells, fresh frozen plasma, and platelets. The viscosity of blood products and the recommended rate of volume replacement necessitate adequate catheter size based on Poiseuille law. Therefore, large-bore peripheral or central venous catheters are recommended for cases with significant expected blood loss. Most sharp surgical debridements, especially in ambulatory patients, are brief, and blood loss is expected to be minimal; thus, a single peripheral intravenous line is usually sufficient. However, when intravenous infusions, such as propofol and/or remifentanil, are administered, a second intravenous line may be preferred for drug and fluid boluses to avoid an unintentional anesthetic bolus. For example, a propofol (10 mg/mL) infusion being administered via a 10-mL intravenous extension could potentially result in an extra 100-mg intravenous rapid bolus if a drug is pushed upstream to the point of fluid convergence. Consequently, the patient may become unexpectantly apneic or hypotensive with a fluid bolus. Minimizing the "dead space" in the tubing can reduce the risks if a single line is used.

Sedation

Regional block is often accompanied by intravenous anesthetic for their supratentorial effects on the cerebral cortex and limbic system. Intravenous anesthetics can provide somnolence, amnesia, and analgesia and reduce anxiety.[48] The following are common anesthetic agents used in combination to provide optimal patient-specific intravenous sedation: midazolam (benzodiazepines), fentanyl (opioids), propofol, ketamine, and/or dexmedetomidine.

Regional Block

The uses of sodium-channel blockers administered locally, peripherally, or centrally provide antinociception without depressing the brain and airway reflexes. The risk of hypotension with regional anesthesia is more favorable compared with general anesthesia.[40]

Although all anesthesiologists are proficient at providing general anesthesia and sedation for local anesthesia, peripheral blocks require knowledge of anatomy and technical skills that many providers nationwide may feel they lack. Advances in ultrasound imaging are available to replace and/or complement the use of nerve stimulation for peripheral nerve localization for drug deposition. Although recent studies suggest that ultrasound-guided techniques are the better choice with a higher success rate compared with nerve stimulation, the technical experience of the operators must be sufficient for fair comparison.[49–59] Many groups of anesthesiologists provide courses for regional anesthesia training to help bridge the gap in education.

For heel PrU sharp surgical debridement, several types of regional blocks are available, including the following:

- local infiltration blocks
- peripheral blocks
  - ankle block
  - popliteal/saphenous
  - sciatic/femoral
- central block
  - spinal
  - epidural

Although there are many sodium-channel blockers to consider, lidocaine is typically used for local infiltration blocks, whereas mepivacaine and/or bupivacaine is used for peripheral blocks. Spinal anesthesia is performed typically using bupivacaine or tetracaine with occasional intrathecal opioids. Epidural anesthesia in the operating room is performed using lidocaine, bupivacaine, or chloroprocaine. Postoperative epidural analgesia is provided with a low-concentration sodium-channel blocker such as bupivacaine with or without an opioid-like fentanyl or sufentanil.

Airway Management

Airway management is central and fundamental to anesthesia practice. The goals of airway patency, oxygenation, and ventilation must be fulfilled continuously, despite the risk of apnea and airway obstruction associated with anesthetic administration or sleep. When the oropharyngeal tone decreases in response to anesthesia, various maneuvers or devices need to be used to decrease upper airway resistance to allow ventilation. If spontaneous ventilation is impaired, positive-pressure ventilation using manual or mechanical ventilation must be instituted. Supraglottic or infraglottic airway devices are used when indicated.

Regional anesthesia requires less sedation and induces less respiratory depression compared with general anesthesia. When a patient is asleep with sedation or under general anesthesia, there is a loss of muscle tone. Airway patency must be maintained to prevent airway collapse. Under regional anesthesia, patients are usually able to maintain their own airways and achieve spontaneous ventilation. However, because of the respiratory depressing effects of some intravenous anesthesia under deep sedation, some form of airway interventions might be required.

General Anesthesia

General anesthesia should not be used unless regional anesthesia is not a viable choice, or the regional block has failed. For example, if a tracheotomy tube has already been placed in a patient prior to surgery, then general anesthesia might be the more suitable choice because inhalational agents can easily be delivered with spontaneous or controlled ventilation. However, inhalational agents alone do not provide postoperative analgesia. Opioids and/or sodium-channel blockade should be used for postoperative analgesia in the absence of neuropathy. Some potential contraindications of regional anesthesia are patient refusal, coagulopathy, infection at the site of injection, and allergy to local anesthetic.[59]

Emergence

Emergence begins as surgery is finishing. Inhalation and intravenous anesthetics are discontinued either abruptly or incrementally diminished. The drug concentrations decrease from elimination and clearance. The patient begins to emerge from the anesthetic state and physiologically return to the baseline state. The central and peripheral nervous systems normalize over minutes or hours, depending on the drugs and their pharmacokinetics. Some regional blocks using sodium-channel blockade provide antinociception beyond the duration of surgery. This benefit provides continual postoperative analgesic.

Postoperative Period

After surgery in the operating room, patients are transferred to the postanesthesia care unit (PACU) and monitored by specialized nurses until discharge criteria are met. They will then either be sent to the floor or discharged from the hospital. From time to time, patients bypass the PACU if discharge criteria are met or if the patient came from an ICU. Local infiltrative blocks with minimal sedation decrease time until recovered. When PACU holds occur, even patients who had general anesthesia can be recovered in the operating room by the anesthesia staff and allow PACU bypass. Patients need to be hemodynamically stable, comfortable, and neurologically appropriate with a patent airway and adequate ventilation in order to be discharged from the care of the anesthesiologist. For a patient with a heel PrU, pressure and friction should be off-loaded from the heel to prevent further damage and promote wound healing.

DISCUSSION

Every PrU should be aggressively treated during the early stages to prevent further tissue destruction. Patients undergoing heel PrU debridement surgery are often associated with multiple comorbidities. Performing a preoperative assessment and medically optimizing these patients for surgery are crucial to minimizing anesthesia risks.

The perception exists that risks of surgical debridement may outweigh the benefits of this treatment. However, surgical debridement at New York University hospital is very safe with minimal anesthesia-related complications.

There is very little literature concerning regional anesthesia during sharp debridement surgery. A review of existing literature and the authors' clinical experience[40] suggest that patients receiving regional anesthesia have a potentially improved outcome when compared with general anesthesia. In several studies, patients receiving regional anesthesia had less pain and received less analgesia.[56–59] The evidence appears to suggest no difference in complications and mortality between regional and general anesthesia.[56–59]

CONCLUSIONS

Adherence to the anesthesia protocol for sharp surgical debridement will be beneficial to patients. Preoperative disease characterization, risk stratification, and medical optimization are essential for safety. Surgeons and anesthesiologists need to work cooperatively, especially when caring for complex wound patients. On the one hand, the surgeon needs to appreciate the concerns of the anesthesiologist, particularly vascular access, airway management, and overall physical status, including cardiac, coagulation, and neurologic. On the other hand, the anesthesiologist needs to have an appreciation of the wound pathology, dermatomal distribution of the wounds, and regenerative medicine techniques, such as cell therapies and growth factors, acute and chronic pain issues, and psychosocial factors. In short, the entire wound team must work together to ensure that adequate wound bed preparation of the patient's necrotic heel is accomplished with the least amount of pain and risk. The authors believe that balancing debridement based on the science of the ''margin of response'' with pain control through anesthesia protocol that allows for thorough debridement can be achieved.

Based on our experience, the authors propose that regional anesthesia should be the default technique, and general anesthesia should be used only as a backup plan. Avoiding unnecessary endotracheal intubation has a variety of benefits, such as avoiding a potential sore throat or dental injury. However, successful endotracheal intubation prevents undesirable airway obstruction. Sodium-channel blockade for antinociception provides areflexia during surgery and improved postoperative function and analgesia compared with general anesthesia alone with more hemodynamic stability.

Successful regional anesthesia requires ongoing programmatic communication and cooperation between the surgeon and the anesthesiologist. Then, patients can be selected and psychologically prepared for effective regional anesthesia because all 3 participants need to be motivated and agreeable. When patients are requesting regional anesthesia with sedation during the preoperative visit, the anesthesiologist requires less effort to explain the advantages over general anesthesia without blocks.

More research is needed to answer biologically based questions about wound healing, but following the authors' stated protocol should minimize anesthesia-related complications. The authors' clinical experience suggests that although wound patients are sicker as defined by the ASA classification, anesthesia can be administered with a low number of complications so that adequate surgical debridement can occur. The authors propose that anesthesia outcomes in addition to wound healing outcomes be measured to estimate perioperative risk in chronic wound patients using standard epidemiological tools. ●

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