LECTURE 4

WOUNDS.CLASSIFICATION.WOUNDS HEALING. INFECTED WOUNDS

I.Actuality of theme.

Wound treatment has been an important aspect of physician care throughout the ages. From the Smith Papyrus in 1700 BC to the latest medical journals, various methods are described to manipulate wounds to speed healing. Wound care is particularly important to primary care physicians such as emergency-room physicians, dermatologists, internists, and family doctors all of whom experience a high frequency of wound-care problems in their practice.

Tremendous advancements have been made in understanding the processes of wound healing. The cell types and the order in which they appear in the wound have been established; many growth factors and their functions have been elucidated. Despite the advances in understanding the science of wound healing, many more steps have yet to be discovered and elucidated. The frontier of this field includes the prevention of hypertrophic and keloid scar formation and, ultimately, any visual remnant of the wound. Understanding how the body repairs damaged tissue and what factors influence the wound healing process helps the surgeon ensure an acceptable outcome from surgery.

Wound infections remain a major source of postoperative morbidity, accounting for about a quarter of the total number of nosocomial infections. Today, many of these infections are first recognized in the outpatient clinic or in the patient's home due to the large number of operations done in the outpatient setting. This leads to errors in establishing the true incidence of their occurrence but undoubtedly decreases the overall real cost and length of hospital stay. The pathogens implicated in the development of wound infections remain largely the human microorganisms from the exogenous environment and the endogenous organ microflora. Many perioperative factors have been identified that increase the incidence of the development of postoperative wound infection. Avoidance of these factors as well as the appropriate use of perioperative antibiotic prophylaxis has decreased the incidence of wound infection. Understanding of pathogenesis, prevention and treatment of wound infection is very important for each surgeon.

II. Aims of lecture:

Educational:

- To describe the history of wound management (β=I);
- To give for the students the scientific basis of wound care and to study to apply this understanding to patient care (β=III);
- To elucidate the modern classification of wounds (β=II);
- To reveal the essence of pathogenesis of wound infection (β=III);
- To expound the biology of wound repair (β=II);

- To describe in clinical terms necrotic tissue, granulation tissue, re-epithelialization, contraction and remodeling processes (β=I);
- To give for the students the knowledge of the wound healing model and to study to apply this knowledge in the clinical decision making process (β=III);
- To characterize the common factors and conditions which complicates wound repair (β=II);
- To study the sudents perform correlation betwen previously learned knowledge of the normal wound healing model with knowledge of common factors which complicate wound repair (β=III);
- To expound the therapeutic approaches in wound care (general and local treatment different types of wounds) (β=II);
- To study the students the main principles of evidence-based medicine according the subject of lecture (β= IV).

Educative:

1.To study the students to establish the psychological contact with patients with postoperative wound complication and their relatives .

2. To educate for students sense of responsibility for every prescription, research, procedure, manipulation or surgery, for a health and renewal of capacity of patient, for the rightness of adequate estimation of the common state of patients and grant of timely effective treatment.

III. Plan and organization of structure of lecture

№	Basic stages of lecture and their maintenance	Aims are in the levels of abstraction	Type of lecture, methods and facilities of activation of students, equipment	Division of time
1	Preliminary stage. Determination of educational aims and motivation.		Items I, II	5%

2	**Basic stage. Teaching of lecture's material** History of wound management; Classification of wounds; Wound assessment, Wound healing; Treatment options for all types of wounds.	 I II II III III	Type of lecture – thematic (with controversial elements – critical analysis of results of meta-analyses, randomized controlled, trials, guidlines which are devoted for the problem of wound treatment and healing). Facilities of activation of students are a questions, controversial situations, illustrative material	85%
3	Final stage (resume of lecture, general conclusions, answers to the possible questions, task for students for preparation for practical classes)		List of literature, question, task for students	10%

IV. Subject of a lecture

History of wound management

The ancient Egyptians were the first civilization to have trained physicians to treat physical aliments. Medical papyri, such as the Edwin Smith papyrus (circa 1600 BC) and the Ebers papyrus (circa 1534 BC), provided detailed information of management of disease, including wound management with the application of various potions and grease to assist healing. Hippocrates used vinegar to irrigate open wounds and wrapped dressings around wounds to prevent further injury. His teachings remained unchallenged for centuries. Galen was first to recognize that pus from wounds inflicted by the gladiators heralded healing. Unfortunately, this observation was misinterpreted, and the concept of pus preempting wound healing persevered well into the eighteenth century. The link between pus formation and healing was emphasized so strongly that foreign material was introduced into wounds to promote pus formation-suppuration. The concept of wound healing remained a mystery, as highlighted by the famous saying by Ambroise Paré, "I dressed the wound. God healed it". The scale of wound infections was most evident in times of war. During the American Civil War, necrotizing infection of soft tissue and tetanus accounted for over 17,000 deaths. Because compound fractures at the time almost invariably were associated with infection, amputation was the only option despite a 25-90% risk of amputation stump infection. Koch first recognized the cause of infective foci as secondary to microbial growth in his nineteenth century postulates. Semmelweis demonstrated a 5-fold reduction in puerperal sepsis by hand washing between performing postmortem examinations and entering the delivery room. Joseph Lister and Louis Pasteur revolutionized the entire concept of wound infection. Lister recognized that antisepsis could prevent infection. In 1867, he placed carbolic acid into open fractures to sterilize the wound and prevent sepsis and hence the need for amputation. In 1871, Lister began to use carbolic spray in the operating room to reduce contamination. However, the concept of wound suppuration persevered even among eminent surgeons, such as John Hunter, 1728-1793. World War I resulted in new types of wounds from high-velocity bullet and shrapnel injuries coupled with contamination by the mud from the trenches. Antoine Depage (Belgian military surgeon, 1862-1925) reintroduced wound debridement and delayed wound closure and relied on microbiological assessment of wound brushings as guidance for the timing of secondary wound closure. Alexander Fleming performed many of his bacteriological studies during WWI and is credited with the discovery of penicillin. As late as the nineteenth century, aseptic surgery was not routine practice. Sterilization of instruments began in the 1880s as did the wearing of gowns, masks, and gloves. Halsted introduced rubber gloves to his scrub nurse (and future wife) because she was developing skin irritation from the chemicals used to disinfect instruments. The routine use of gloves was introduces by Halsted's student J. Bloodgood. Penicillin first was used clinically in 1940 by Howard Floery. With the use of antibiotics, a new era in the management of wound infections commenced. Unfortunately, eradication of the infective plague affecting surgical wounds has not ended because of the insurgence of antibiotic-resistant bacterial strains and the nature of more adventurous surgical intervention in immunocompromised patients and in implant surgery.

Wound classification

A **wound** is a disruption of normal anatomic structure and function. Wounds can be classified in many ways, by acute or chronic, by cause (e.g., pressure, trauma, venous leg ulcer, diabetic foot ulcer), by the depth of tissue involvement, or other characteristics such as closure (primary or secondary intention). Wound depth is classified by the initial level of tissue destruction evident in the wound: superficial, partial-thickness, or full-thickness.

Open

Open wounds can be classified into a number of different types, according to the object that caused the wound. The types of open wound are:

- Incisions or incised wounds - caused by a clean, sharp-edged object such as a knife, a razor or a glass splinter. Incisions which involve only the epidermis are legally classified as cuts, rather than wounds.
- Lacerations - irregular wounds caused by a blunt impact to soft tissue which lies over hard tissue (e.g. laceration of the skin covering the skull) or tearing of skin and other tissues such as caused by childbirth. Lacerations may show bridging, as connective tissue or blood vessels are flattened against the underlying hard surface. Commonly misused in reference to injury with sharp objects, which would not display bridging (connective tissue and blood vessels are severed).
- Abrasions (grazes) - a superficial wound in which the topmost layers of the skin (the epidermis) are scraped off, often caused by a sliding fall onto a rough surface.
- Puncture wounds - caused by an object puncturing the skin, such as a nail or needle.
- Penetration wounds - caused by an object such as a knife entering the body.
- Gunshot wounds - caused by a bullet or similar projectile driving into or through the body. There may be two wounds, one at the site of entry and one at the site of exit.

Closed

Closed wounds have fewer categories, but are just as dangerous as open wounds. The types of closed wounds are:

Contusions - (more commonly known as a bruise) - caused by blunt force trauma that damages tissue under the skin

Hematoma - caused by damage to a blood vessel that in turn causes blood to collect under the skin

Crushing injuries - caused by a great or extreme amount of force applied over a long period of time.

Acute Wounds When a surgeon makes an incision or the skin is otherwise cut, an acute wound is created. By definition, an acute wound is acquired as a result of trauma or an operative procedure and proceeds normally in a timely fashion along the healing pathway with at least external manifestations of healing apparent in the early postoperative period without complications. Acute wounds are usually successfully managed with local wound care. Surgically created wounds include all incisions, excisions, and wounds that were surgically debrided. Nonsurgical wounds include all skin lesions that occurred as a result of trauma (e.g., burns, falls), as a result of an underlying condition (e.g., leg ulcers), or as a combination of both.

Chronic Wounds

Wounds that fail to heal in the anticipated time frame and often reoccur are considered chronic wounds. These wounds are visible evidence of an underlying condition such as extended pressure on the tissues, poor circulation, or even poor nutrition. Pressure ulcers, venous leg ulcers, and diabetic foot ulcers are examples of chronic wounds. Successful management of chronic wounds demands treatment of the whole person, meticulous local wound care, an understanding of the wound healing process, a working knowledge of modern wound dressings, and correction and management of the patient's underlying condition.

Wound healing progresses through a number of highly interdependent stages in an attempt to not only repair but also to compensate for the loss of function which has occurred as a result of the loss of tissue integrity.

Wound Assessment

Whether chronic or acute, an accurate and quantitative assessment of the wound is crucial to help decide appropriate treatments and evaluate the effectiveness of the plan of care. Assessment and documentation of the outcome of wound care interventions are increasingly important in today's healthcare environment. Generally, it is best to quantify observations, (i.e., indicate size in centimeters) and correlate assessment to the total wound area by providing the percentage (%) of the total. For example: 15% of the wound bed contains necrotic tissue.

Wound depth

The terms superficial, partial-thickness, and full-thickness refer to wound depth. The deeper a wound, the more tissue that needs to be replaced or repaired and the longer it will take to heal.

Superficial Wounds

When a wound is superficial, as is the case in most abrasions and blisters, only the epidermis is affected and has to be replaced. A truly superficial wound does not bleed and heals within a few days.

Partial-Thickness Wounds

A partial-thickness wound does bleed, because the epidermis and part of the dermis are no longer present or have been affected. If left uncovered, a blood clot will cover the wound and a scab will form. The missing tissue will then be replaced, followed by regeneration of the epidermis. A partial-thickness wound can take from several days to several weeks to heal, depending on the patient and the wound treatments chosen.

Full-Thickness Wounds

A full-thickness wound involves the epidermis and the dermis. The underlying fatty tissue, bones, muscles, or tendons may also be damaged. If full-thickness wounds cannot be sutured, the healing process will create new tissue to fill the wound, followed by regeneration of the epidermis. The full-thickness wound takes substantially longer to heal than does a partial-thickness wound, sometimes as long as several months.

One of the most important differences between partial-thickness and deep, full-thickness wounds is that in partial-thickness wounds not all hair follicles have been destroyed. Because hair follicles are surrounded by epidermal cells, small islands of epidermis remain in the wound bed of partial-thickness wounds. Thus, even though the epidermis may have been destroyed, the "islands" of epidermal cells in the wound bed will help the wound replace the epidermis more quickly than in a full-thickness wound, where the epidermal cells have to migrate in from the edges of the wound.

<u>Surrounding skin</u>
A wound assessment should include an evaluation of the skin surrounding the wound. Whether acute or chronic, sutured or not sutured, the condition of the periwound skin provides vital information relating to the status of the wound. When the periwound skin is red, it may be the result of prolonged pressure; it may indicate ongoing or chronic inflammation or irritation from contact with feces or urine; or it may merely be evidence of increased blood supply to the area as part of the early healing process. Redness, tenderness, warmth, and swelling of the surrounding skin are also the classic clinical signs of an infection. If the surrounding skin is light colored but pink, it may be newly formed epithelium. However, if the skin is white or gray, it is likely that maceration has occurred. In addition to looking for signs of maceration, inflammation, and infection in leg ulcers, look at the surrounding skin for information about the etiology of the wound itself.

<u>Wound size</u>
The length and width and/or area of the wound as well as wound depth should be measured regularly. One way to measure length and width is by using a disposable measuring guide or ruler calibrated in centimeters that should be discarded after each use. Wound length can represent the longest area of tissue breakdown, whereas wound width can represent the narrowest area of tissue breakdown. Alternatively, the "head-to-toe" measurement may be called length and the "side-to-side" measurement called width. Even though the surrounding skin may appear healthy, it should not be included in the measurement. Another method of measuring the wound is to use a clear plastic sheet to trace the wound margins.
An acetate sheet, a clear measuring guide, or even a clear plastic bag can be used for this purpose. A plastic bag has the advantage of consisting of two sides eliminating the need to clean the contaminated area; rather, it can be cut off and thrown away. Using a permanent marker while holding the plastic in place, trace the edges of the wound. Mark the location of the wound in relation to the patient; for instance, write "H" at the head and "T" at the toe to help compare subsequent tracings.

<u>Measuring Length and Width</u>

Save the tracing and put it in the chart or calculate/measure the area and document the findings. To record length and width measure the tracing. To record area, use 1.0 or 0.5 cm grid paper. Put the tracing on the paper and count the number of cross-points that fall completely within the ulcer area. These methods of measuring wound size have been found to be reliable and valid. They take less than 1 minute to complete and less than 1 minute to calculate.

Measuring Depth

It is also important to determine wound depth. This measurement can be determined using a sterile swab. Insert the sterile swab into the wound, gently probing to find the deepest point. Place a gloved forefinger on the swab where it reaches skin level and, after removal, place it next to a measuring guide calibrated in centimeters.

Note the wound depth, date, and approximately where in the wound the measurement was obtained. Remember that insertion of any object into a wound may cause trauma, and particles may remain in the wound bed if cotton swabs are used.

Wound edges

While measuring wound depth, probe the wound edges to assess whether or not there is any undermining of the wound margins or tunneling. Undermining presents as a space between the surrounding skin and the wound bed (i.e., the skin is not attached to the underlying structure). Record the extent of the "pocket" in centimeters, as well as the percentage of the wound margin involved. Undermining is most common in deep pressure ulcers and dehisced wounds. When undermining or tunneling is present, it is important to monitor the healing process to make sure that the wound is healing "from the bottom up," (i.e., premature wound closure needs to be prevented).

If the wound edge is not well-defined, that is, if it is difficult to see where the wound ends and the surrounding skin starts, re-epithelialization may be taking place. If the wound edge is very well-defined and epithelial cells have actually migrated down to and around the wound edge, this may be indicative of a long-standing chronic wound. This rounded and inward turned edge will halt wound closure and should be debrided by a physician or wound care specialist.

Wound bed

To evaluate the condition of the wound bed, assess for:

Necrotic tissue (usually black and hard, sometimes soft with a tinge of yellow)

Fibrinous tissue or slough (yellowish and threadlike denatured proteins that cannot be removed when rinsing)

Granulation tissue (red, beefy tissue that may bleed easily)

Note whether or not there is any debris or other foreign materials (e.g., suture remnants) and quantify your findings.

Other wound characteristics that should be assessed include the odor of the wound and the amount, and color and consistency of exudate.

Lab Studies:

Staining methods: The simplest, and usually the quickest, method involves obtaining a Gram stain for infective organisms. Staining for fungal elements can be obtained at the same time.

Culture techniques: Most laboratories routinely will culture for both aerobic and anaerobic organisms. Fungal cultures can be requested. Isolation of single colonies allows further growth and identification of the specific organism. Sensitivity testing then follows mainly for aerobic organisms.

Newer techniques

Tests for antigens from the organism through enzyme-linked immunoassay (ELISA) or radioimmunoassay

Detection of antibody response to the organism in the host sera

Detection of RNA or DNA sequences or protein from the infective organism by Northern, Southern, or Western blotting, respectively

Polymerase chain reaction (PCR) is a sensitive assay to detect small amounts of microbe DNA.

Imaging Studies:

Ultrasound can be applied to the infected wound area to assess whether any collection needs drainage.

The Centers for Disease Control and Prevention (CDC) Wound Classification System applies descriptive characteristics to predict the degree of microbial contamination at the time of surgery. The four classifications are:

Class I/Clean: An uninfected surgical wound in which no inflammation is encountered and the uninfected respiratory, alimentary, genital, or urinary tract is not entered. In addition, clean wounds are primarily closed and, if necessary, drained with closed drainage. Surgical incisional wounds that occur after nonpenetrating (*i.e.*, blunt) trauma should be included in this category if they meet the criteria.

Class II/Clean-contaminated: A surgical wound in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, surgical procedures 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.

Class III/Contaminated: This includes open, fresh, accidental wounds. In addition, surgical procedures with major breaks in sterile technique (*e.g.*, open cardiac massage), gross spillage from the gastrointestinal tract, and incisions in which acute, nonpurulent inflammation is encountered are included in this category.

Class IV/Dirty-infected: This 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 postoperative infection were present in the surgical field before the surgery.

All four categories of wound classification should receive the same sterile and aseptic techniques to prevent exposure to microorganisms from another patient or from personnel.

WOUND HEALING

Wound healing is a continuum of complex interrelated biological processes at the molecular level. Healing is divided into the following phases for descriptive purposes: inflammatory phase, proliferative phase, and maturation phase.

The inflammatory phase commences as soon as tissue integrity is disrupted by injury; this begins the coagulation cascade to limit bleeding. Platelets are the first of the cellular components that aggregate to the wound, and, as a result of their degranulation (platelet reaction), they release several cytokines (or paracrine growth factors). These cytokines include platelet derived growth factor (PDGF), insulinlike growth factor-1 (IGF-1), epidermal growth factor (EGF), and fibroblast growth factor (FGF). Serotonin is also released, which, together with histamine (released by mast cells), induces a reversible opening of the junctions between the endothelial cells, allowing the passage of neutrophils and monocytes (which become macrophages) to the site of injury. This large cellular movement to the injury site is induced by cytokines secreted by the platelets (chemotaxis) and by further chemotactic cytokines secreted by the macrophages themselves once at the site of injury. These include transforming growth factor alpha (TGF-alpha) and transforming growth factor beta (TGF-beta). Consequently, an inflammatory exudate that contains red blood cells, neutrophils, macrophages, and plasma proteins, including coagulation cascade proteins and fibrin strands, fills the wound in a matter of hours. Macrophages not only scavenge but they also are central to the wound healing process because of their cytokine secretion.

The proliferative phase begins as the cells that migrate to the site of injury, such as fibroblasts, epithelial cells, and vascular endothelial cells, start to proliferate and the cellularity of the wound increases. The cytokines involved in this phase include FGFs, particularly FGF-2 (previously known as basic FGF), which stimulates angiogenesis and epithelial cell and fibroblast proliferation. The marginal basal cells at the edge of the wound migrate across the wound, and, within 48 hours, the entire wound is epithelialized. In the depth of the wound, the number of inflammatory cells decreases with the increase in stromal cells, such as fibroblasts and endothelial cells, which in turn continue to secrete cytokines. Cellular proliferation continues with the formation of extracellular matrix proteins, including collagen and new capillaries (angiogenesis). This process is variable in length and may last several weeks.

In the maturation phase, the dominant feature is collagen. The dense bundle of fibers, characteristic of collagen, is the predominant constituent of the scar. Wound contraction occurs to some degree in primary closed wounds but is a pronounced feature in wounds left to close by secondary intention. The cells responsible for wound contraction are called myofibroblasts, which resemble fibroblasts but have cytoplasmic actin filaments responsible for contraction.

Healing by primary intention

Surgical wounds may heal by primary intention, delayed primary intention or by secondary intention. Most heal by primary intention, where the wound edges are brought together (apposed) and then held in place by mechanical means (adhesive strips, staples or sutures), allowing the wound time to heal and develop enough strength to withstand stress without support. The goal of surgery is to achieve healing by such means with minimal oedema, no serous discharge or infection, without separation of the wound edges and with minimal scar formation. On occasion, surgical incisions are allowed to heal by delayed primary intention where non-viable tissue is removed and the wound is initially left open. Wound edges are brought together at about 4-6 days, before granulation tissue is visible. This method is often used after traumatic injury or dirty surgery.

Healing by secondary intention

Healing by secondary intention happens when the wound is left open, because of the presence of infection, excessive trauma or skin loss, and the wound edges come together naturally by means of granulation and contraction .

Experimentally as well as clinically it has been shown that a delay in wound closure of four to five days increases the tensile strength of the wound as well as resistance to infection. In clinical practice, delayed healing has been used successfully in cases of severe incisional abscesses, mainly after laparotomy. Another benefit of delayed closure is the cosmetic result after healing. The appearance of a wound after a delay of four to five days is comparable to that of primary closure. A wider scar follows late closure (after 10-14 days), although this is cosmetically much better than the result obtained after the healing of an open granulating wound.

The wound continuously undergoes remodeling to try to achieve a state similar to that prior to injury. The wound has 70-80% of its original tensile strength at 3-4 months postoperative.

Important local factors affecting wound healing are:.

1.Infection. It is the most common local cause for prolonged healing. All wounds are contaminated postoperatively by resident bacterial flora, however clinical infection occurrs when a critical number of pathogenic organisms are present. Bacteria prolong healing by activating the alternate complement pathway and detrimentally exaggerating and prolonging the inflammatory phase of wound healing. They also elaborate toxins and proteases that can be damaging to cells. Finally, they compete for oxygen and nutrients in the wound milieu. Lactic acid is produced in this hypoxic state, that further stimulates the release of damaging proteolytic enzyme. Formation of excessive devitalised tissue, increased tension in the wound, hematoma and seromas, foreign bodies in the wound, all these factors predispose for bacterial secondary infection. All these can be avoided by proper surgical techniques.

2.Surgical technique. The rough handling of tissue or the use of inappropriately bulky instrumentation can lead to crushed skin edges and subsequent devitalization of tissue, leading to increase in inflammatory reaction and risk of secondary infection with increased scarring. Wound closed with inappropriately reactive suture material may increase the chances of a foreign body reaction and subsequent infection. Skin sutures tied too tightly may lead to tissue ischaemia and predispose to infection.

3.Haematoma formation. Excessive bleeding and the formation of a hematoma within the wound not only can mechanically disrupt the wound closure but also can serve as an excellent culture medium for microorganisms.

4.Foreign body reaction.A foreign body in the wound serves as an appropriate surface for the activation of the alternate complement pathway and the generation of a prolonged inflammatory response, which interferes with the subsequent stages of wound repairs. Wounds containing foreign materials are characterised by low pH and low PO2. These factors significantly slow down wound repair. 5.Tissue ischaemia. Local factors such as foreign bodies, infection or strangulating sutures significantly slow healing by promoting tissue ischemia. Local hypoxia is detrimental to cellular proliferation, resistance to infection and collagen production. The cumulative effect is delayed healing.

6.Topical medications and dressings.Occlusive or semiocclusive dressings promote faster reepithelization. They may also alter certain aspects of dermal repair. They also provide the moist environment needed for optimal wound repair, they may also help to prevent bacterial invasion andwound infection.Local medicaments applied to the wound may affect wound repairs. Even the bases in which these agents are compounded may accelerate or diminish the rates of epithelization. Triamcinolone acetonide ointment (0.1%) nitrofurazone, benzoyl peroxidase cream, silver sulfadiazine ,neosporin ointment are examples of the drugs that affect epidermal migration.

Systemic factors include age, malnutrition, hypovolemia, poor tissue perfusion, obesity, diabetes, steroids, and other immunosuppressants.

Wound management

The first step in wound management is assessment of the overall stability of the patient. Obvious open wounds can detract attention from more subtle but potentially life-threatening problems. After initial assessment, the animal should be stabilized. First aid for the wound should be performed as soon as safely possible. Active bleeding can be controlled with direct pressure. A pneumatic cuff, instead of a tourniquet, should be used in cases of severe arterial bleeding; the cuff should be inflated until the hemorrhage is controlled. Use of a cuff avoids neurovascular complications that can be associated with narrow tourniquets.

The wound must be protected from further contamination or trauma by covering it with a sterile, lint-free dressing. The delay between examination and definitive debridement should be minimized to decrease bacterial contamination. If the wound is infected, a sample should be collected for culture and sensitivity testing. Antibiotic therapy should be instituted in all cases of dirty, infected, or puncture wounds. A broad-spectrum bactericidal antibiotic, eg, a first-generation cephalosporin, is generally recommended pending culture results. Analgesia is also indicated for pain relief.

Wound Lavage:

Irrigation of the wound washes away both visible and microscopic debris. This reduces the bacterial load in the tissue, which helps decrease wound complications. Assuming the solution is nontoxic, the most important factor in wound lavage is use of large volumes to facilitate the removal of debris. The use of antibiotics in the lavage fluid is controversial.

The ideal lavage fluid would be antiseptic and nontoxic to the healing tissues. Although isotonic saline is not antiseptic, it is the least toxic to healing tissue. Surgical scrub agents should not be used because the detergent component is damaging to tissue. Dilute antiseptics can be used safely. Chlorhexidine diacetate 0.05% has sustained residual activity against a broad spectrum of bacteria, while causing minimal tissue inflammation. However, gram-negative bacteria may become resistant to chlorhexidine. Stronger solutions of chlorhexidine are toxic to healing tissue. Povidone-iodine 1% is an effective antiseptic, but it has minimal residual activity and may be inactivated by purulent debris.

Debridement:

After wound preparation and hair removal, debridement can be performed. Skin and local tissue viability should be assessed. Blue-black, leathery, thin, or white skin are signs associated with nonviability. Necrotic tissue should be sharply excised. The debridement may be done in layers or as one complete section of tissue. Tissues that have questionable viability or are associated with essential structures such as neurovascular bundles should be treated conservatively. Staged debridement may be indicated.

After initial inspection, lavage, and debridement, a decision must be made whether to close the wound or to manage it as an open wound. Considerations include the availability of skin for closure and the level of contamination or infection. If the wound is left open, it should be managed for optimal healing.

Wound Closure:

Although primary closure is the simplest method of wound management, it should be used only in ideal situations to avoid wound complications. Wounds may be closed with suture, staples, or cyanoacrylate. Clean wounds that are properly debrided usually heal without complication. With a primary closure, the layers should be individually closed to minimize “dead space” that might contribute to seroma formation. The types of suture and suture patterns used depend on the size and location of the wound and on the size of the animal.

Primary closure may not be appropriate for a grossly contaminated or infected wound. If closure is a suitable goal, it may be delayed until the contamination or infection is controlled. The wound can be managed short-term as an open wound until it appears healthy. At that time, the wound can be safely closed with minimal risk of complications. The time between initial debridement and final closure vary according to the degree of contamination or infection. Minimally contaminated wounds may be closed after 24-72 hr. Longer periods may be required for heavily infected wounds.

Wounds that are closed >5 days after the initial wounding are considered to be a secondary closure. This implies that granulation tissue has begun to form in the wound before closure.

Open Wound Management:
When a wound cannot or should not be closed, open wound management (ie, second-intention healing) may be appropriate. Such wounds include those in which there has been a loss of skin that makes closure impossible or those that are too grossly infected to close. Longitudinal degloving injuries of the extremities are especially amenable to open wound management. Open wound management enables progressive debridement procedures and does not require specialized equipment (such as may be needed with skin grafting). However, it increases cost, prolongs time for healing, and may create complications from wound contracture.

Open wound management is based on repeated bandaging and debridement as needed until the wound heals. Initially, wet-to-dry dressings are used. These dressings help with mechanical debridement at every bandage change. Until a granulation bed forms, the bandage should be changed at least once daily. In the early stages of healing, the bandage may need to be changed as often as twice daily. After granulation tissue develops, the bandage should be changed to a dry, nonstick dressing so the granulation bed is not disrupted. Both the granulation bed and the early epithelium are easily damaged, and disruption of the granulation bed delays wound healing.

Drains are used to direct fluid out of a wound or body cavity. Passive drainage techniques require gravity or capillary action to draw fluid from the wound or cavity. Penrose drains are soft, flat, commonly used passive drains made from latex. These drains must be placed in gravity-dependent locations to ensure proper function. A firmer drain can be constructed from a red rubber or silicone tube. A double lumen or sump drain allows fluid to drain through the outer lumen and air to enter from the inner lumen. Active drains require some type of negative pressure to pull fluid from the wound. Red rubber or silicone drains can be used with a closed system and low-pressure suction maintained with the intermittent use of low-pressure pumps or handheld rechargeable devices. The use of active, closed-drain systems decreases the likelihood of ascending infection that can be associated with passive drains. Drains should be left in place until the draining fluid decreases in quantity and no longer appears purulent. The fluid can be evaluated by cytologic examination.

Bandage.
The goals of bandaging include limiting hemorrhage, immobilizing the area, preventing further trauma or contamination of the wound, preventing wound desiccation, absorbing exudate, and aiding in mechanical debridement of the wound. When constructing bandages, several principles must be followed to avoid complications. The bandages should be sufficiently padded, applied evenly and snugly, composed of 3 layers (primary, secondary, and tertiary), and placed to avoid traumatizing the newly formed granulation tissue or epithelium.
The first or primary layer directly contacts the wound to allow tissue fluid to pass through to the secondary layer. The first layer may be adherent or nonadherent. A

nonadherent bandage is usually a fine mesh, nonstick material and is indicated when a healthy granulation bed has developed. This layer prevents tissue desiccation and causes minimal trauma. An adherent bandage uses a wide mesh material allowing tissue to become incorporated into the bandage. This tissue is then removed with the bandage change. Adherent bandages are classified as dry to dry, wet to dry, or wet to wet based on the composition of the primary layer. Dry-to-dry bandages consist of dry gauze applied to the wound. The bandages are painful to remove but enable excellent tissue debridement. Wet-to-dry bandages are made with saline-moistened gauze placed directly on the wound. They are also painful to remove but result in less tissue desiccation than dry-to-dry bandages. Wet-to-wet bandages tend to damage the tissue bed by keeping it too moist.

The secondary layer of a bandage absorbs tissue fluid, pads the wound, and supports or immobilizes the limb. This layer is frequently composed of cast padding or roll cotton. The tertiary layer functions to hold the primary and secondary layers in place, provide pressure, and keep the inner layers protected from the environment. This layer is composed of adhesive tape or elastic wraps.

V. Materials of activation of students

(questions, tasks, controversial situations, illustrative materials and other).

VI. Materials of selftraining of students on the topic of lecture: literature, questions, tasks.

Literature

1.Черенько М. П., Ваврик Ж. М. Загальна хірургія з анестезіологією, основами реаніматології та догляду за хворими. –К.: Здоров'я, 2004. –616 с.

2. Гостищев В. К. Общая хирургия Учебник для медицинских вузов. 4-е изд.,перераб., доп. и испр.- М.: ГЭОТАР-Медиа,2006.- 832 с.

3. Петров С.В. Общая хирургия Учебное пособие. 3-е изд.,перераб. и доп. – М.: ГЭОТАР-Медиа, 2007 – 768 с.

4.Al-Abdullah T., Plint A., Fergusson D. Absorbable versus nonabsorbable sutures in the management of traumatic lacerations and surgical wounds: a meta-analysis //Pediatr Emerg Care.- 2007.- Vol.23, N5. – P.339-344.

5. Clinical Guide: Wound Care (Clinical Guide) by Cathy Thomas Hess //Publisher: Lippincott Williams & Wilkins; 5 Spi edition (August 1, 2004).- 544 p.

6. Henry M., Moss R. Primary versus delayed wound closure in complicated appendicitis: an international systematic review and meta-analysis //Pediatr Surg Int. –2005.- Vol.21,N8.- P.625-30.

7. Moore Z., Cowman S. Effective wound management: identifying criteria for infection //Nurs Stand.-2007.- Vol 21-27, N21(24).- P.68- 72.

8. Sabiston Textbook of Surgery //by Courtney M. Townsend, R. Daniel Beauchamp , B. Mark Evers, Kenneth Mattox.-Saunders; 17 edition (June 11, 2004).- 2416 p.

9. Schwartz's Principles of Surgery, 8/e (Schwartz's Principles of Surgery)// by F. Charles Brunicardi , Dana K. Andersen, Timothy R. Billiar, David L. Dunn, John G. Hunter , Raphael E. Pollock .- McGraw-Hill Professional; 8 edition (October 14, 2004).- 2000 p.

10.Ubbink D., Vermeulen H., Lubbers M. Local wound care: evidence-based treatments and dressings //Ned Tijdschr Geneeskd.- 2006 .- Vol.150,N21. – P.1165-1172.

11.Vermeulen H., Ubbink D., Goossens A. et al. Systematic review of dressings and topical agents for surgical wounds healing by secondary intention //Br J Surg.- 2005 Vol.92, N6. – P.665-672.

12.Wound Care Essentials: Practice Principles by Springhouse , Sharon Baranoski , Elizabeth A. Ayello.- Lippincott Williams & Wilkins (September 1, 2006) .- 432 p.

13. Wound Management: Principles and Practice by Betsy Myers .- Prentice Hall; Pap/Cdr edition (January 21, 2003) 448 p.

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