"State of Science in Wound Care Management"
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Part I. From "Potions" to Growth Factors---and Beyond

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A. Brief Overview of Wound Healing and Nursing Implications

Partial-thickness Wounds

- First phase is epithelial resurfacing, which usually occurs rapidly because there are epithelial cells throughout the wound bed. Injury and skin loss triggers accelerated rate of epithelial cell reproduction, which supports resurfacing. Epithelial migration occurs best across **clean moist** surface. Wound appearance goes from red and wet to pink and dry (new skin is pink in persons of all races.)

- Second phase is reestablishment of normal skin thickness and function; once wound is resurfaced, cells resume "usual operating procedure" and migrate vertically rather than laterally. This reestablishes normal thickness. As skin thickness is reestablished, skin gradually pigments to match surrounding skin. Need to protect wound with simple dressing (such as transparent adhesive or hydrocolloid) until pigmentation close to normal.

Full-Thickness Wounds

- **Inflammatory Phase**

Goal: Establishment clean wound bed. Wound cannot move into proliferative (rebuilding) phase until necrotic tissue eliminated and bacterial loads controlled

~In acute wounds (traumatic injuries, surgical incisions): injury causes bleeding, which activates clotting mechanisms. When clot breaks down, get release of growth factors (primary regulatory factors for wound repair). Growth factors attract WBCs (neutrophils and macrophages) to wound bed: WBCs break down necrotic tissue and phagocytize bacteria. End result: clean wound bed that supports repair.

~In chronic wounds (pressure ulcers, venous ulcers, etc.): no bleeding so no clot formation and no release of growth factors. May get prolonged inflammatory phase; may need debridement and use of antibiotics to establish clean wound bed.

•**Proliferative Phase**

Goal: Fill tissue defects with granulation tissue; resurface with new epithelium. (In open wound, also get contraction which minimizes size of defect.)

~Granulation: new tissue (scar tissue) composed of new blood vessels and newly synthesized connective tissue. New connective tissue synthesized by fibroblasts; requires adequate supply of protein, ascorbic acid, zinc, oxygen. Note fibroblasts damaged/killed by heavy concentrations of antiseptics. **Newly formed granulation tissue forms palpable "healing ridge" along incisions—should be palpable by day 5 – 7 postoperatively**

~Contraction: contractile proteins pull wound edges together (may be contraindicated over joints). Occurs only in open wounds, not closed incisions.

~Epithelialization: epithelial cells migrate across newly formed granulation tissue to establish closed wound/bacterial barrier. Note epithelial migration requires open wound edges/clean moist wound bed.

•**Maturation Phase**

Goal: Establish thin strong scar. Involves lysis of old collagen fibers/synthesis new collagen fibers. Continues for up to 2 years—"new" tissue never as strong as original. Note minimal tensile strength (increased risk for wound breakdown) lst 2 months post "closure"

B. Wound Care in 2004: Elements of Comprehensive Wound Care

•**Determine and correct causative factors**

~Pressure/Shear Injuries (deep ulcers over bony prominences; if pressure alone, ulcer will be round or slightly oval with no "tunneled" or "undermined" areas; if pressure + shear, wound will be deep, irregular, and tunneled ***)***

Appropriate offloading program (i.e., repositioning and support surfaces/ wheelchair cushions)
Measures to minimize sliding or to minimize "drag" (especially when there is evidence of shear): low friction surfaces, lift sheets, etc

~Friction Injuries: superficial skin damage on surfaces contacting bed surfaces or "rubbing" against other surfaces.
Use surface that reduces friction—use lift sheets; use heel and elbow protectors; consider transparent adhesive dressings or solid gel or hydrocolloid dressings for additional protection

~Venous Ulcers (leg ulcers caused by poor venous return—commonly located around ankle/lower leg; ulcer bed may be dark red or may have layer of slough; edema is common—pt may have hx of DVT or may be inactive).
Measures to correct chronic venous insufficiency (elevation; compression therapy)

~Ischemic Ulcers (leg ulcers caused by problems with arterial circulation--commonly located on toes, areas of foot exposed to pressure, or areas of trauma; ulcer bed typically fairly dry/frequently necrotic—pt usually has signs of chronic ischemia—diminished or absent pulses, thin skin, low ankle-brachial index)
Measures to optimize perfusion (smoking cessation; hydration; avoidance of cold, constriction, and caffeine; vascular consult re: revascularization if ABI < 0.6 or wound fails to improve with primary mgmt)

~Neuropathic Ulcers (leg and foot ulcers caused by painless trauma in patient with diminished or absent sensation—usually diabetic pt.)
Measures to prevent recurrent injury (e.g., offloading and callous reduction for plantar surface ulcers)

- **Systemic Support Measures**

~Nutritional Support
30 – 35 calories/Kg body wt/day
1.5 gm protein/Kg body wt/day (glutamine and l-arginine may be particularly important amino acids)
Multivitamin/mineral supplement
Zinc replacement for pt. who is known/thought to be zinc-deficient: 220 mg 1 – 3 x daily (short-term, i.e., weeks)
Should consider addition of oxandrin (Oxandrolone) for patient who has lost > 10 – 20% body weight and who fails to respond to standard nutritional therapy (if goal is wound healing). Oxandrolone is anabolic steroid that helps to drive amino acids into cells and has anti-catabolic effects

~Glucose control (critical to leukocyte function/may improve ability to synthesize collagen). Goal should be normoglycemia; critical to maintain serum glucose <180 to maintain normal WBC function

~Measures to maximize perfusion (edema control, pressure relief, etc.)

~Topical Vitamin A for patient on high dose steroids (> 30 – 40 mg/day); partially counteracts negative effects of steroids on repair. (Recommended dose: 25,000 – 100,000 IU daily)

Note*: If you are unable to correct causative factors, and/or unable to provide*

systemic support, must modify wound management goals to focus on comfort measures/prevention of wound deterioration (if possible) as opposed to wound healing

•Principle-based Topical Therapy (Slide)

~Principles:
Eliminate Impediments (Debride **necrotic tissue**, Identify and treat **infection**, Lightly pack **dead space**, Absorb **excess exudate)**

Maintain optimal environment: Keep wound **moist, insulated**, and **protected** (against infection and trauma)

D: Debride necrotic material
I: Identify and treat infection
P: Pack tracts and tunnels **lightly!**
A: Absorb excess exudates
M: Maintain moist wound surface
O: Maintain open wound edges
P: Protect healing wound from trauma/infection
I: Insulate wound

Appropriate topical therapy dependent on careful assessment of wound status; should include the following parameters:

Location (impact on cover dressing/need for bacterial barrier)
Dimensions and depth (in cm)
Presence and extent of undermining/tracking (use clock face to indicate location) Note wound depth and presence of undermining or tracking major factors in dressing selection.
Status of wound base (very important indicator of progress in healing—helps direct topical therapy): granulating? epithelializing? clean but not granulating? necrotic?)
Exudate (volume, color, odor)—**major** factor in dressing selection
Status of wound edges (open vs. closed)
Status of surrounding tissue (edema? cellulitis? maceration? etc.)
Wound stage (pressure ulcers only)

Debridement

*B**egin by debriding any necrotic tissue anytime the goal is repair and any time the wound is infected.*** (If goal is maintenance and wound is uninfected, may choose not to debride—if wound is ischemic, uninfected, and covered with dry eschar, debridement is contraindicated.)
Rule of Thumb: Trunk wound should generally be debrided unless pt is

terminal and wound is uninfected. Think twice about debriding foot wounds. **(Slides)**

Options for debridement: Surgical, enzymatic, chemical, autolytic

*Surgical: Fast; complete; converts chronic wound to acute wound

*Conservative Sharp Wound Debridement: removal of loose avascular tissue with scalpel/scissors (Wound Care Nurses and PTs usually covered to debride)—serial debridements can be used in conjunction with other methods of debridement to facilitate wound cleanup

*Enzymatic
--Must have MD order
--If wound covered with dry eschar, should either "crosshatch" the eschar or apply the agent to the periphery of the wound at the interface between viable and nonviable tissue
--Follow manufacturers' guidelines for use

*Chemical (Dakin's Solution)
--Controversial; provides bacterial control as well as supporting debridement
--Requires more frequent dsg changes (2 – 3 x/day) so may not be good option in Home Health

*Autolytic
--Must maintain layer of wound fluid at wound surface (avoid absorbing all of exudate)
--Requires normal WBC levels (WBC is one of primary active agents in wound fluid)
--Dry wound: need wet dressing or dressing that retains all of wound fluid; Exudative wound: need dressing that provides controlled absorption
--Good choice when there is limited amount of necrotic tissue

~Identify and treat any infection

Indications wound is infected:

- Infection involving surrounding tissue: erythema, warmth, edema, purulent drainage, etc.
- Infection confined to wound surface: sudden deterioration in wound surface; increased volumes of exudate; increased pain
- Infection involving bone: exposed bone; persistent nonhealing wound that "tracks" to bone

~Guidelines for effective swab culture (when correctly done, provides accurate data regarding infecting organism and effective antibiotics)

--Flush wound with N/S
--Select a 1-square cm area of **viable tissue**; swab with enough force to produce exudate
--Note: If wound surface dry, moisten swab with sterile N/S prior to obtaining culture

If wound tunneled or very foul-smelling, obtain both aerobic and anaerobic cultures

Options for bacterial control at level of wound surface (i.e., bacterial burden sufficient to interfere with repair process but no invasion of healthy tissue, i.e., no cellulitis).

--If wound both infected and necrotic, consider use of **Dakin's** solution for packing until wound is clean (some studies indicate that Dakin's solution 0.025% is effective against most bacteria and still noncytotoxic). If Dakin's solution is used, be aware of sensitivity to heat and light; need to obtain fresh solution daily or QOD. (Limited and contradictory studies)

--If wound infected or heavily contaminated but not necrotic, consider use of **Technicare** solution to cleanse wound in conjunction with daily dressing changes (has 24-hr residual activity). Do not pack wound with Technicare. (Technicare is broad spectrum microbicide—active agents are chloroxylenol and cocamidopropyl PG-dimonium chloride phosphate; effective against gram-negative and gram-positive bacteria, VREF, MRSA, and candida. Recommended use is two-minute soak + light scrub followed by thorough rinsing. 1-800-325-9681) (Limited studies)

--**Betadine *solution*** 1% or 10% also found to be safe and effective in some studies. (Limited and contradictory studies)

If antiseptic used, use only until wound clean.

--**Consider use of sustained-release antibacterial dressing** (especially appropriate for wounds being managed with less frequent dressing changes)

- *cadexomer iodine* (Iodosorb, Iodoflex)—sustained release form of iodine that helps to control bacterial loads without damaging good cells (strong safety data; need more efficacy data)

- Sustained release *silver dressings*—these dressings are toxic to bacteria but cause no damage to good cells, and bacterial resistance is not thought to be an issue (strong in vitro data; need more clinical data)
  Available in multiple forms—gels, foams, alginates, hydrofibers, etc.
  Note silver dressings provide prolonged bacterial control so can be used effectively under compression dressings designed to be changed on a weekly basis.

--**Systemic antibiotics** for wounds with invasive infection or wound with significant deterioration in status

--**Topical antibiotics** for wounds with no invasive infection and limited signs local infection

~Create/Maintain Open Wound Edges: Cauterize closed wound edges with silver nitrate to permit resurfacing of wound with new epithelium (need MD order) **or** refer patient to surgeon for excision closed wound edges/skin graft

~**Select appropriate dressing** to provide the following: obliteration of tracts/tunnels (drainage of retained fluid); absorption excess exudate; maintenance maintenance moist wound surface; bacterial barrier and protection against traumatic dressing removal; insulation of wound surface.

~Select primary dressing (wound contact layer) based on wound depth, presence of tracts or tunnels, and volume of exudate; select cover dressing based on volume of exudate and need for bacterial barrier (note cover dressing also provides insulation)

*__Deep__ or tunneled wounds that are **wet**: need primary filler dressing that is absorptive (e.g., calcium alginate rope, hydrocellular rope, ribbon gauze, absorptive gel strands, or damp gauze) + cover dressing that provides additional absorption + bacterial barrier (e.g., gauze/tape or adhesive foam)

*__Deep__ or tunneled wounds that are **dry:** need primary filler dressing that hydrates (e.g., amorphous gel + damp gauze) + cover dressing that maintains wound hydration (e.g., transparent adhesive or gauze/tape cover dressing)

*__Shallow__ wounds that are **wet**: need wound contact layer and cover dressing that absorbs and provides bacterial barrier (e.g., flat alginate or flat hydrocellular + foam or gauze cover; nonadherent contact layer such as Adaptic + gauze cover; adhesive foam cover dressing alone; hydrocolloid dressing)

*__Shallow__ wounds that are **dry**: need wound contact layer and cover dressing that provide/maintain hydration of wound surface and provide bacterial barrier (e.g., solid gel, nonadherent contact layer + gauze cover, transparent adhesive dressing, hydrocolloid dressing)

~Note most dressings provide passive support for wound healing by assuring adequate drainage of wound fluid, eliminating excess exudate, preventing dessication of wound surface, and preventing or reducing bacterial contamination. Most dressings do not actively manipulate the repair process, though

some have been shown (in lab studies) to stimulate cell migration.

- **Importance weekly assessments/modification tx plan as indicated**

Always compare current findings to findings over past two weeks to determine progress or lack of progress. Lack of progress: reevaluate and modify treatment plan as indicated!

3. Management of Nonhealing Wounds

Definition: Wound that fails to show measurable progress toward healing for 2 – 4 consecutive weeks despite appropriate management

Potential causes: persistence of causative factors; inadequate systemic support for healing; high bacterial counts/repetitive trauma to wound bed/ high volumes of exudates; **imbalance in mix of microscopic factors that normally regulate wound repair**

Guidelines for Management

- **Reevaluate current mgmt plan and modify as indicated**

- **Consider use of "active wound therapy"**

Definition active wound therapy: therapeutic dressing/treatment that is designed to actively manipulate the wound healing process

- **Review of some currently available active wound therapies:**

Negative Pressure Wound Therapy (VAC)

Description of Therapy: Porous sponge with implanted suction catheter cut to fit wound; secured with thin film dressing to provide a secure seal; connected to bedside suction unit that can be programmed to provide either continuous or intermittent suction at various levels of negative pressure (50 – 150 mm Hg). (Portable suction unit also available for ambulatory patient)

Theorized mechanisms of action: Eliminates pooled exudate while maintaining moist wound surface (elimination of chronic wound fluid may contribute to positive results); negative suction causes deformation of cells in wound bed, which apparently leads to activation of intracellular processes that contribute to neoangiogenesis and collagen synthesis—clinically evidenced by rapid development of well-vascularized wound bed and granulation tissue (in patients who respond to therapy). Increasing base of evidence/clinical data.

Most commonly used for deep exudative wounds, to promote granulation in viable wounds that are pale and slow to granulate, and to prepare wounds for surgical closure; contraindicated in wounds with exposed vessels.

Therapy is expensive and must be applied/maintained by clinician with expertise in application. Pain and bleeding with dressing removal are common problems; strategies for reducing pain and bleeding include use of less porous sponge, placement of contact layer between wound bed and sponge (particularly critical when there is only a thin layer of granulation tissue between organs and the sponge), premedication (also injection of topical anesthetic through tubing into sponge prior to dressing change).

Usual frequency for dressing change is Mon-Wed-Fri

Growth Factor Therapy

Theoretic basis for therapy: Growth factors now known to control the wound healing process; chronic wounds frequently associated with absence of bleeding so no stimulus for release of growth factors; chronic wound fluid found to have lower concentration of growth factors and higher concentration of inflammatory factors. Diabetic wounds also associated with low levels of growth factors.

Regranex Gel now available: contains platelet derived growth factor produced by recombinant DNA technology. Applied to clean noninfected wound once daily. Company recommends use in conjunction with comprehensive wound care program and only on clean noninfected wounds; primarily indicated for nonhealing wounds in diabetic patients-- patient must be compliant with offloading; glucose levels must be well-controlled; wound must be clean and perfused; and patient should have "failed" to respond to primary therapy under these conditions.

OASIS (dressing derived from submucosal layer of pig intestine): releases growth factors into wound bed

Hyalofil also now available—not a growth factor but provides hyaluronic acid, which supports collagen synthesis.

Dermagraft: bioabsorbable polyglactin mesh populated with newborn dermal fibroblasts that are capable of proliferating and secreting collagen, other structural proteins, and growth factors. Thought to promote healing by actually filling the wound with a collagen matrix that provides fibroblasts and growth factors to support the formation of granulation tissue. May be applied weekly for up to 8 weeks.

MMP Inactivators

Description of Therapy: MMPs (matrix metalloproteinases) are enzymes produced

by the body that are beneficial during the early phases of healing because they help create pathways that facilitate the movement of cells into the wound bed; however, high levels of these substances during the proliferative phase of repair can inactivate the growth factors and interfere with repair. Products now available that have been shown in vitro to "bind" and inactivate these inflammatory mediators. (Promogran by J & J)

4. Wound Management Under PPS

•Challenges/Issues

~Need for change in focus (from visits to outcomes-oriented wound management)

~Need for increased understanding of wound healing/wound management

~Ability to accurately assess wound status (differentiation between wounds that are clean but not granulating and wounds that **are** granulating; recognition closed wound edges; identification presence or absence of healing ridge). **Note importance early debridement to permit staging/promote healing**

~Ability to quickly identify wounds that are "off track/not responding" and to make appropriate recommendations (including use of active wound therapies *when indicated)*

~Ability to establish collaborative relationships with physicians and to effectively market "new improved" approach to wound management

•Strategies

~Hire wound care specialist (part time or fulltime)

~Educate staff regarding goals of care (wound healing or establishment stable wound and education caregiver regarding wound care; cost-effective wound care, i.e., visit frequency and wound therapies determined by wound status), physiology of wound healing and factors impacting on ability to heal, guidelines for wound assessment and wound management

~Establish wound care formulary and basic algorithms for topical therapy (reduces costs to agency, reduces confusion among staff and promotes consistency in care, facilitates marketing to physicians). **Note no evidence to date that one moist wound healing dressing provides significantly better outcomes than another; provides strong basis for appropriate use of formulary and algorithms.** In establishing formulary, need to look at *"cost-effectiveness"* of various products, not just "line item" cost. (For example, better to use a good quality alginate and waterproof foam dressing that effectively controls exudate and provides bacterial barrier for 2 – 3 days, thus reducing visit frequency, than to use a less expensive

dressing combination that requires more frequent dressing changes or that fails to provide an optimal wound environment)

~Market wound care program to physicians effectively. (Wound care specialist and formulary contribute to marketing). Key points to be made: agency's commitment to outcomes-oriented wound management; strategies undertaken by agency to strengthen wound management program, including staff development and formulary development; products on formulary—include rationale for selection with focus on maintenance positive wound environment; proposed algorithms for wound management, again with focus on rationale and evidence base; availability of wound care specialist; availability of active wound therapies and established guidelines for use. (Helps to provide references that support algorithms and guidelines for use of active wound therapies.)

Honestly address need to establish cost-effective wound management program but emphasize that the change to PPS has prompted a total reevaluation of the wound management program and that the focus has shifted to evidence-based care that is outcomes-oriented. Give specifics: explain that wounds in the inflammatory phase (necrotic and infected wounds) will be seen/monitored more frequently and that visit frequency will be tapered in response to progress in wound healing (point out that evidence supports *less frequent* dressing changes as beneficial to wounds in the proliferative phase, so long as exudate is controlled and clean moist wound surface is maintained—because each dressing change temporarily disrupts the wound surface and interrupts the formation of granulation tissue).

Emphasize that nurse managing the wound will be carefully monitoring progress in wound healing and that failure to progress or any deterioration will prompt reevaluation and MD notification/consultation.

Invite feedback!

~Determine how agency will respond to physicians who are unwilling to work within formulary/algorithm guidelines.

~Monitor outcomes (clinical and cost outcomes) and modify program accordingly.

Summary/Questions & Answers