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Chronic Wounds: A Nursing Approach to Effective Care

Ashwaq Mohammed Alshahrane[1], Malak Mohammed Aljohani[2], Tahani Hassan Abuillah[3], Farjah Ali Abishi[4], Majed MahliMutairan Alharbi[5], Sharifh Mohmmad Alasmari[6], Elham Mohammed Thubab[7], Fahad Nayidh Alotaibi[8], Noor Saeed Alotaibi[9], Shaia Sheliwih Alotibi[10], Taghreed Rumah Alotaibi[11], Issa Rabah Alrashidi[12], Fatimah Hussien Ibrahiem Alnakhli[13], Sarah Abdullah Alhayfani[14], Maalem Dhawi Alnafiai[15].

1. Nurse, Alourija Alawsat, Ministry of Health, Kingdom of Saudi Arabia. shwshw7345@gmail.com
2. Nurse, Alzahrh, Ministry of Health, Kingdom of Saudi Arabia. Malak300400@hotmail.com
3. Nurse, Alourija Alawsat, Ministry of Health, Kingdom of Saudi Arabia. alhaneeen2010@hotmail.com
4. Nurse, Alourija Alawsat, Ministry of Health, Kingdom of Saudi Arabia. farjah9932@gmail.com
5. Nursing technician, Al-Uraija Al-Awsat Health Center, Ministry of Health, Kingdom of Saudi Arabia. malharbi28@moh.gov.sa
6. Technician Nursing, Alourija Alawsat, Ministry of Health, Kingdom of Saudi Arabia. hodamoh24@gmail.com
7. Nursing Specialist, Abu Arish General, Ministry of Health, Kingdom of Saudi Arabia. rn.elham22@gmail.com
8. Nursing, Shqra General hospital, Ministry of Health, Kingdom of Saudi Arabia. Falotaibi171@moh.gov.sa
9. Nursing Specialist, Essam Phc in Rafaya Aljmsh, Ministry of Health, Kingdom of Saudi Arabia. nosalotibi@moh.gov.sa
10. Nurse, Rafaiaaljmsh, Ministry of Health, Kingdom of Saudi Arabia. Shaiasa@moh.gov.sa
11. Nursing specialist, RafayaAlgamsh Hospital (ER), Ministry of Health, Kingdom of Saudi Arabia. TaghreedrA@moh.gov.sa
12. Nursing Specialist, Madinah Health Cluster. iralrashidi@moh.gov.sa
13. Nursing, King Fhad hospital in Al Madinah Al Monawrah, Ministry of health, Kingdom of Saudi Arabia. A7la-fatoo@hotmail.com
14. Nursing Specialte, J2 AlMarwah PHC, Ministry of health, Kingdom of Saudi Arabia. sara_abdullah89@hotmail.com
15. Nursing technician, first health cluster, first Al-Shifa Health Center, Ministry of Health, Kingdom of Saudi Arabia. Looomme@hotmail.com

Abstract
Chronic wounds, which fail to heal within the expected timeframe, pose significant challenges to patients and healthcare systems worldwide. These wounds are classified into pressure ulcers, diabetic foot ulcers, venous leg ulcers, and arterial insufficiency ulcers, each requiring specialized treatment. Nurses play an indispensable role in chronic wound care, combining their knowledge of advanced wound care technologies, patient education, and multidisciplinary collaboration to improve outcomes. This paper explores the physiological aspects of wound healing, discusses the challenges in managing various types of chronic wounds, and highlights the importance of evidence-based nursing practices. Innovative approaches, such as nanotechnology and biologic therapies, offer promising advancements in chronic wound care, reinforcing the nurse's role in implementing these therapies. The findings underscore the critical need for continuous education and professional development for nurses in this evolving field.
Keywords: nurses, Chronic wounds, Wound healing, Wound dressings

Introduction

Chronic wounds are characterized as those that fail to progress through the typical stages of healing despite appropriate and active treatment, typically not healing within a period of 6 weeks (Atkin, 2019). These wounds present a substantial burden both on individuals and healthcare systems. The prolonged healing time, coupled with the associated medical challenges, places an immense strain on patients' quality of life, while also creating significant economic implications for healthcare systems (Sen et al., 2009). Due to their widespread occurrence, their adverse effects on patient well-being, and the escalating costs for medical management, chronic wounds are increasingly recognized as a major public health issue (Järbrink et al., 2017). These types of wounds are often referred to as "hard-to-heal" or "difficult-to-heal" wounds and are identified as failing to heal within a designated time frame, which can vary from 4 weeks to several months, depending on the underlying cause.

Chronic wounds are generally classified into four primary categories: pressure ulcers, diabetic ulcers, venous ulcers, and arterial insufficiency ulcers. The occurrence of these wounds is particularly prevalent in elderly populations, primarily due to the age-related decline in tissue repair mechanisms and the higher incidence of comorbid conditions such as cardiovascular diseases and diabetes mellitus, which complicate the healing process (Gould et al., 2015). These underlying health conditions further exacerbate the challenges in managing chronic wounds, making it essential for healthcare professionals to be proactive in addressing these issues.

Beyond the direct impact on patients, chronic wounds also create a significant financial strain on healthcare systems. The costs associated with the long-term care and treatment of these wounds can be substantial, particularly when advanced wound care treatments and extended hospital stays are required. Additionally, the economic burden extends beyond healthcare costs, affecting productivity within the workforce, as individuals with chronic wounds often experience a reduction in their ability to engage in daily activities and work, thus contributing to societal economic loss.

A variety of factors contribute to the persistence of chronic wounds, preventing the wound from undergoing the normal healing process. These factors include but are not limited to neuropathy, arterial insufficiency, venous stasis, lymphatic obstruction, pressure, trauma, persistent infections, non-healing burns, and autoimmune diseases. Local factors such as inadequate blood circulation, pressure ulcers, and infections may delay the healing process significantly, while systemic issues like uncontrolled diabetes and poor nutrition can also impair wound healing. Nurses play a crucial role in the management of chronic wounds, particularly in identifying and addressing these contributing factors. A thorough assessment and understanding of the underlying causes of chronic wounds are essential for formulating effective treatment plans.

The optimal management strategy for chronic wounds involves a multifaceted approach that first addresses any systemic factors contributing to the wound's persistence, followed by targeted interventions aimed at local conditions that may hinder healing. This approach emphasizes the importance of a comprehensive understanding of both systemic and local factors, as well as the use of appropriate dressings and wound care techniques tailored to the specific type and severity of the wound. Nurses, as integral members of the healthcare team, must possess a deep understanding of these factors and the various therapeutic options available to promote healing and prevent complications. Knowledge of wound care technologies, including advanced dressings, can greatly enhance the effectiveness of care and contribute to better clinical outcomes.

In summary, chronic wounds represent a significant challenge to both patients and healthcare systems due to their prolonged healing times and the multiple factors that can contribute to their persistence. As frontline healthcare providers, nurses must have a comprehensive understanding of the causes of chronic wounds and be equipped with the knowledge to implement effective wound care practices. Addressing both the systemic and local factors is crucial in promoting optimal healing and preventing complications, ensuring that patients receive the best possible care throughout the healing process.

Function of Skin

The skin plays a vital role in interacting with the external environment and is essential for maintaining homeostasis. It regulates thermoregulation and serves as a sensory organ for detecting external stimuli (Han, 2023; Wilkinson & Hardman, 2020). Acting as the primary defense mechanism, the skin prevents dehydration and shields internal structures from mechanical, chemical, thermal, and photic damage. This protective function extends to its role as an immune barrier, where it safeguards the body from pathogenic infections and supports beneficial microorganisms through the host-microbiota interaction (Han, 2023; Wilkinson & Hardman, 2020).

Wound Healing Process

The process of wound healing is divided into four distinct phases: hemostasis, inflammation, proliferation, and remodeling.

Hemostasis

Immediately following injury, blood vessels constrict to minimize blood loss and form a clot. Platelets become activated upon encountering collagen in the vessel walls, adhering to one another to form the clot. This clot serves to stop bleeding, protect the wound from bacterial invasion, and contain growth factors crucial for healing. Platelets also release chemical signals that attract immune cells to the wound site and produce antimicrobial substances to combat infection. Once sufficient clotting has occurred, the clotting process is tightly regulated to prevent the formation of excessive clotting(Scully et al., 2020).

Inflammation

Following injury, the natural inflammatory process is initiated, where necrotic cells and bacterial components activate immune cells, triggering inflammation. Various immune cells, including mast cells, Langerhans cells, T cells, and macrophages, are involved in this process. Neutrophils quickly migrate to the site of injury, where they phagocytize pathogens. As the number of neutrophils decreases after a few days, macrophages enter the wound, taking over the role of initiating tissue repair. Macrophages clear necrotic cells and pathogens while also regulating inflammation. Pro-inflammatory macrophages play a crucial role in combating infection, while anti-inflammatory macrophages promote tissue repair. Additionally, regulatory T cells with anti-inflammatory properties help reduce inflammation and accelerate the healing process (Zaidi & Green, 2019).

Proliferation

The proliferative phase of wound healing is characterized by the active participation of various cell types in wound closure, extracellular matrix (ECM) accumulation, and the formation of new blood vessels. Factors such as mechanical stress, hydrogen peroxide, pathogens, growth factors, and cytokines activate keratinocytes. This activation prompts keratinocytes to become more invasive and mobile, a process referred to as re-epithelialization. Keratinocytes work to cover the wound surface by secreting matrix metalloproteinases (MMPs) and generating new ECM proteins. Fibroblasts replace the initial fibrin-rich matrix with more mature ECM proteins and granulation tissue. Signals from platelets, endothelial cells, and macrophages guide fibroblasts in producing ECM proteins and differentiating into myofibroblasts. Angiogenesis, initiated by hypoxia, leads to the formation of new blood vessels. Endothelial cells proliferate, migrate, and form these new vessels, with vascular endothelial growth factor (VEGF) preventing endothelial cell apoptosis and supporting angiogenesis. Macrophages further facilitate new vessel formation by secreting proteases and chemotactic factors (Han, 2023).

Remodelling

The remodelling phase of wound healing involves the maturation of the ECM, which begins soon after injury and results in a mature wound rich in type I collagen. Initially, the fibrin clot accumulates, and fibroblasts replace it with hyaluronan, fibronectin, and proteoglycans. As healing progresses, fibroblasts produce more mature collagen fibrils. During this phase, type III collagen is gradually replaced by type I collagen, which significantly increases the strength of the wound. The remodelling of the ECM requires a precise balance between collagen degradation and synthesis, a process regulated temporally by MMPs. Increased expression of transforming growth factor-beta (TGF-β) and mechanical tension stimulate the differentiation of myofibroblasts. These myofibroblasts play a key role in promoting wound contraction, thereby accelerating the healing process. The wound-healing response culminates when macrophages, endothelial cells, and fibroblasts undergo apoptosis or are cleared from the injury site, leading to the formation of a scar (Scully et al., 2020).

TYPES OF CHRONIC WOUNDS

Chronic wounds are complex and persistent wounds that fail to heal within the expected timeframe, often due to underlying medical conditions or complications. This section explores four common types of chronic wounds: pressure injuries, diabetic foot ulcers, venous leg ulcers, and arterial ulcers. Each type is discussed in terms of its definition, stages, risk factors, and the scales used for risk assessment and healing evaluation(Frykberg & Banks, 2015).

Pressure Injuries

Definition and Stages

Pressure injuries, also known as pressure ulcers or bedsores, are caused by prolonged pressure or shear forces acting on the skin and underlying tissues, particularly over bony prominences. These injuries are classified into stages:

- **Stage 1**: Nonblanchable erythema of intact skin.
- **Stage 2**: Partial-thickness skin loss with exposed dermis.
- **Stage 3**: Full-thickness skin loss with possible exposure to fat.
- **Stage 4**: Full-thickness skin and tissue loss with exposure of bone, muscle, or tendon.
- **Unstageable**: Full-thickness skin and tissue loss that is obscured by slough or eschar.
- **Deep Tissue Injury**: Persistent, nonblanchable deep red, maroon, or purple discoloration.

Risk Factors

The primary risk factors for pressure injuries include immobility, inadequate nutrition, moisture due to incontinence, reduced sensory perception, shearing forces, and impaired blood flow (Gefen et al., 2020) or poor perfusion. Immobility impairs normal blood flow, leading to ischemia and cell death. Poor nutrition can affect skin integrity, while moisture may cause skin maceration.

Wound Assessment and Healing

Wound assessment and healing should be evaluated during each treatment and assessment session. Although healing scales were once used, the advent of digital photography has enabled wound assessment and documentation, allowing staff, patients, and families to track treatment outcomes over time.

Lower Extremity Ulcers

Diabetic Foot Ulcers

Definition and Stages

Diabetic foot ulcers (DFUs) are severe complications of diabetes mellitus, affecting approximately 15% of individuals with diabetes. They arise due to peripheral neuropathy, arterial disease, and minor trauma(Armstrong et al., 2017).

Risk Factors

The risk factors for DFUs include poor glycemic control, peripheral neuropathy, peripheral vascular disease, foot deformities, previous ulcers or amputations, and the duration of diabetes. Peripheral neuropathy results in the loss of protective sensation, causing patients to remain unaware of minor injuries that can develop into ulcers. Poor circulation further hinders healing, while hyperglycemia compromises immune function, increasing susceptibility to infection (Boulton et al., 2018).

Assessment and Healing Scales

- **Wagner Classification**: Grades ulcers from 0 to 5 based on the depth and involvement of tissue.
- **University of Texas Classification**: Stages ulcers based on depth, infection, and ischemia.

- **Diabetic Foot Ulcer Scale (DFUS)**: Assesses the impact of DFUs on the patient's quality of life.

Venous Leg Ulcers

Definition and Stages

Venous leg ulcers (VLUs) occur due to venous insufficiency, where the veins fail to effectively return blood, resulting in increased pressure and tissue breakdown. They are the most prevalent type of leg ulcer, representing 70% to 90% of cases.

Risk Factors

Risk factors for VLUs include a history of deep vein thrombosis, chronic venous insufficiency, obesity, prolonged standing, and age. Venous hypertension leads to fluid leakage, inflammation, and skin breakdown.

Assessment and Healing Scales

- **Venous Clinical Severity Score (VCSS)**: Assesses the severity of venous disease and the response to treatment (Kakkos et al., 2017).
- **CEAP Classification (Clinical, Etiology, Anatomy, Pathophysiology)**: Classifies ulcers based on clinical signs, etiology, anatomy, and pathophysiology.
- **Leg Ulcer Measurement Tool (LUMT)**: Tracks healing progress by evaluating wound size and appearance.

Arterial Ulcers

Definition and Stages

Arterial ulcers, also referred to as ischemic ulcers, arise from inadequate blood flow due to arterial occlusion or severe peripheral arterial disease, typically affecting the lower legs, toes, and pressure points.

Risk Factors

The risk factors for arterial ulcers include peripheral arterial disease, diabetes, hypertension, smoking, hyperlipidemia, and aging. Insufficient blood flow hampers healing and increases the risk of necrosis (Mayrovitz et al., 2023).

Assessment and Healing Scales

- **Ankle-Brachial Index (ABI)**: Measures the ratio of blood pressure in the lower legs compared to the arms.
- **Rutherford Classification**: Categorizes the severity of arterial disease from asymptomatic to severe ischemia with ulceration.
- **Wi-Fi Classification**: Assesses the severity of wounds, ischemia, and infection to guide treatment.

WOUND DRESSINGS

Wound care products are designed to provide a physical barrier that promotes healing and protects against infection. These products are chosen based on the type and condition of the wound bed and surrounding tissues, and they come in various forms.

Gauze/Bandage

Gauze or woven bandages have been used as dry wound dressings for many years. Cotton gauze is commonly preferred in wound care due to its moisture-absorbing properties, biocompatibility, and skin-friendly structure. However, traditional cotton gauze does not actively promote healing unless it helps maintain a moist wound environment while incorporating an antibacterial component. As a result, methods have been developed to enhance the properties of cotton gauze for more effective wound care. Modified gauze is easy to use and simple to apply, making it a practical choice for nurses. Cotton gauze remains a widely used, cost-effective wound dressing because of its accessibility, permeability, and high absorption properties.

Transparent Films

Initially, transparent film dressings were used to secure intravenous catheters, but their application expanded to include certain wound treatments. Transparent film dressings play a significant role in wound care by creating a sterile environment, particularly in areas like catheter insertion sites. These semipermeable film dressings are thin, flexible, transparent polyurethane sheets with an adhesive backing. They allow water vapor and gas to pass through but prevent bacteria and water from entering. While they have limited absorption capacity, they allow visibility of the wound bed and conform to body contours. Semipermeable film dressings are generally suitable for superficial wounds with minimal drainage, abrasions, partial-thickness wounds, sutured wounds, and donor sites for grafts. They are also applicable to granular wounds and areas exposed to friction. To avoid maceration, a protectant should be applied to the surrounding skin. However, these dressings should not be used on infected wounds, wounds with moderate to heavy drainage, or patients with sensitive skin (Atay & Yilmaz Kurt, 2021).

Hydrocolloids

Hydrocolloid dressings are composed of hydrophobic polymers, including gelatin, pectin, and carboxymethylcellulose, typically in the form of a gel or foam on a self-adhesive polyurethane film carrier. These dressings are ideal for mild to moderately exuding wounds and provide a moist healing environment. The colloid composition absorbs exudate and forms a gel at the wound site, helping to reduce pain and accelerate the healing process. Hydrocolloid dressings are commonly used for wounds like pressure sores and venous ulcers.

The colloid layer retains moisture at the wound site and prevents bacterial infections due to the bacteria-resistant feature of the outer layer. Furthermore, bacteria and debris are removed during dressing changes via gentle, painless mechanical debridement. Despite their benefits, hydrocolloid dressings may produce a foul odor, require daily dressing changes, and have been associated with allergic contact dermatitis. They are also not suitable for wounds that produce moderate to high levels of exudate (Rani Raju et al., 2022).

Hydrofibers

Hydrofiber dressings are moisture-retentive products made from soft, nonwoven sodium carboxymethylcellulose fibers that form a gel upon contact with wound fluid. These dressings possess a high capacity for absorbing exudate. The gel formed retains wound exudates through vertical absorption, thus maintaining a moist environment conducive to wound-bed healing. Fibrin accumulates between the dressing and the wound surface, acting as an adhesive that helps secure the dressing in place and prevents tissue growth into the dressing. This feature simplifies the application and removal process for both caregivers and patients, reducing pain during dressing changes. These dressings are particularly suitable for wounds that produce heavy exudate, minimizing the risk of infection. They are commonly used in the treatment of venous ulcers, diabetic foot ulcers, and surgical wounds (Rani Raju et al., 2022).

Foams

Foam dressings are comprised of two layers: a hydrophilic silicone or polyurethane-based foam layer that rests on the wound surface and a hydrophobic, gas-permeable backing designed to prevent leakage and bacterial contamination. Some foam dressings may require an additional secondary adhesive dressing. These dressings absorb exudate from the wound, create a moist healing environment, and help reduce the risk of infection while protecting the wound surface. Foam dressings exhibit antibacterial, anti-inflammatory, and re-epithelialization-promoting properties. They may not be suitable for wounds with minimal exudate, as they can cause the wound to dry out. Foam dressings are widely used for treating pressure ulcers, venous ulcers, and diabetic foot wounds (Han, 2023).

Alginates

Alginates are dressings made from natural complex polysaccharides derived from various species of algae. These dressings form gels when exposed to wound exudate due to their composition of calcium and sodium salts. Water-insoluble alginates form an amorphous gel that fills and covers the wound by exchanging calcium ions with sodium ions in the sodium-rich wound fluid environment. Alginates are available in different forms such as ribbons, beads, and pads, and their absorbent capacity depends on the type of polysaccharide used. These dressings are particularly effective for moderately to heavily exuding wounds such as diabetic foot ulcers, venous ulcers, and pressure sores due to their high absorbency. They can also be used as wound fillers for treating deep and hollow wounds. However, some disadvantages of alginates include the need for a secondary dressing to monitor the wound, the risk of excessive dryness in minimally exuding wounds, and the possibility of unpleasant odor. Thus, alginates are not recommended for dry wounds or those with minimal exudate (Barnea et al., 2010).

Antibacterial Dressings

Certain topical antimicrobial agents may provide potential benefits for specific patient populations. Below is a brief overview of the characteristics of some commonly used antimicrobial agents.

Iodine-based Dressings

Iodine-containing antiseptics have been widely used for many years due to their effective antimicrobial properties. Povidone-iodine (PVP-I), patented in the United States in 1952 and introduced for medical use, is a water-soluble compound consisting of polyvinylpyrrolidone (povidone) and elemental iodine, which are combined with hydrogen bonds. While povidone itself lacks antimicrobial activity, it facilitates the controlled release of free iodine. The concentration of free iodine in PVP-I solutions varies depending on the solution's strength, with the most commonly used concentration being 10% aqueous solution, though concentrations of 7.5%, 5%, 3%, and 2.5% are also available. Iodine is effective against a broad range of pathogens, including antibiotic-resistant bacteria, fungi, mycobacteria, viruses, spores, and protozoa. PVP-I dressings are more economical than cadexomer iodine and silver-based dressings and have a lower risk of inducing bacterial resistance (Zhang et al., 2021).

Silver-based Dressings

Silver has long been used in wound care for its ability to manage local infections. Traditionally, silver has been used in the form of metallic silver (e.g., silver foil), solution (e.g., silver nitrate), or cream (e.g., silver sulfadiazine). Recently, ionic silver (Ag1), the oxidized active form of silver, has garnered renewed interest for its use as a prophylactic antimicrobial agent in wound dressings due to its broad-spectrum antibacterial activity, which encompasses aerobic, anaerobic, gram-negative, and gram-positive bacteria, as well as yeast and fungi. Silver's antimicrobial mechanism involves interfering with the respiratory chain in the cytochromes of mycobacteria, disrupting the microbial electron transport system, and binding to DNA, thereby inhibiting DNA replication. There is limited evidence of emerging microbial resistance to silver (Barnea et al., 2010).

Honey

Honey exhibits broad-spectrum antimicrobial properties due to its high osmolarity and high hydrogen peroxide content. Medical-grade honey products are available in various forms, including gels, pastes, and adhesives, often impregnated in alginate and colloid dressings. Despite systematic reviews evaluating the efficacy of honey for wound healing, there is insufficient evidence to support its routine use across all wound types. Honey has shown potential benefits for certain types of wounds, such as burns, while its efficacy in treating chronic venous ulcers may be less significant.

Hydrogel Dressings

Hydrogel dressings are composed of 80% to 99% water or glycerin and are available in various forms, including sheets, gels, or impregnated gauze. These dressings are structured with hydrophilic substances and possess excellent moisturizing properties, making them suitable for wounds with low to moderate exudate production. Hydrogels are water-insoluble and can absorb fluid up to 10 to thousands of times their weight. This moisture retention is beneficial for maintaining a moist wound environment and assisting in the removal of necrotic tissue. Hydrogels are particularly effective for providing moisture to dry wounds and are commonly transparent, which allows for easy visualization of the wound beneath the dressing. These dressings are often used in wounds such as pressure sores, surgical wounds, burns, and radiation dermatitis, as they reduce pain and promote healing by maintaining a moist environment. However, they are not suitable for infected wounds or those with heavy exudate, as they absorb fluid slowly. Various hydrogel formulations have been developed, including those with antibacterial, antioxidant, and drug-eluting properties, further enhancing their therapeutic potential(Atay & Yilmaz Kurt, 2021).

Wound Contact Layers (WCLs)

Wound contact layers are frequently utilized as primary dressings for the management of both acute and difficult-to-heal wounds. These layers are placed in direct contact with the wound and surrounding tissue, helping to protect newly formed granulation and epithelial tissue, thus promoting wound healing. WCLs are typically thin, nonadherent gauze dressings impregnated with various compounds that minimize adhesion. Certain dressings, such as paraffin-impregnated gauze, may become dry over time, leading to adherence to the wound bed, which can cause trauma and pain upon removal. To mitigate this, modern WCL designs incorporate features that reduce these issues, such as proximity to tissue and the addition of moisturizing agents. These dressings serve as a barrier between the wound and the external environment while also facilitating gas and fluid exchange. This process helps remove wound exudate, which is absorbed into the overlying absorbent dressing, thus minimizing tissue damage caused by dressing removal and enhancing wound healing(Han, 2023).

Different Dressings

- **Paraffin or Vaseline-Impregnated Gauze**: These dressings provide protection by isolating the wound from external elements, maintaining moisture within the wound and preventing the edges from drying out. They are primarily used for superficial wounds such as surgical incisions, burns, and skin tears. Furthermore, paraffin gauze dressings simplify the process of applying additional dressings over the wound.
- **Barrier Creams and Dressings**: These dressings play a crucial role in protecting the skin from moisture and irritants, preventing skin irritation and wound formation. They are commonly used in conditions like bedsores and incontinence dermatitis. Barrier products strengthen the skin's protective function, reducing the risk of damage.
- **Collagen Dressings**: These dressings enhance tissue regeneration and accelerate the wound healing process. Collagen bio-adapts to the wound bed, promoting healing by stimulating cellular activity. They are widely used for various chronic and acute wounds, such as diabetic foot ulcers, pressure sores, and surgical wounds, as collagen production is often insufficient during the wound healing process.
- **Growth Factor Dressings**: These dressings promote cell proliferation and tissue repair, accelerating the wound closure process. By modulating biological processes involved in wound healing, growth factors increase cell motility and proliferation. These dressings are particularly beneficial for difficult-to-heal wounds such as burns, surgical wounds, and diabetic ulcers.
- **Hyaluronic Acid Dressings**: Hyaluronic acid dressings provide a moist healing environment while supporting tissue regeneration. Due to the high water retention capacity of hyaluronic acid, these dressings help maintain moisture at the wound surface.
- **Enzymatic Debridement Products**: These products specifically target collagen, protein, fibrin, and elastin within necrotic tissue. By cleansing the wound bed, enzymatic debridement promotes the formation of healthy tissue.

Effectiveness and Clinical Applications

In managing chronic wounds, clinical guidelines provide healthcare professionals with evidence-based practices and standardized treatment protocols. These guidelines, developed from extensive scientific research and clinical experience, emphasize the importance of regular wound assessments, including the evaluation of wound type, size, depth, exudate volume, and any signs of infection. Regular assessments are essential for monitoring the effectiveness of the treatment plan, with proper documentation through standardized methods. Cleaning the wound with sterile saline or antiseptic solutions reduces infection risks and facilitates healing. Necrotic tissue debridement, through surgical, autolytic, enzymatic, or mechanical methods, is critical for promoting wound healing. The choice of wound dressing should be based on the specific characteristics of the wound, including exudate amount, with dressings that maintain a moist healing environment being preferred. In cases of infection, antibiotic therapy and antimicrobial dressings should be used, with vigilant monitoring for infection signs. As a key component of person-centered care, both patients and caregivers should be actively involved in the wound care process and receive adequate education on wound management. Their roles in the management process should be emphasized, and adherence to treatment instructions should be ensured. Chronic wound care requires a multidisciplinary approach involving nurses, doctors, physiotherapists, and dietitians to optimize the patient's overall health and wound healing. Collaborative care, involving team-based wound management, is essential for optimizing healing outcomes and enhancing patient satisfaction. Telehealth services may be beneficial when appropriate(Barrientos et al., 2014; Kirkland-Kyhn et al., 2018).

FUTURE DIRECTIONS

With advancements in nanobiotechnology, nano-sized biomaterials are increasingly being utilized in the treatment of chronic wounds. These technologies are applied in areas such as scaffold construction, infection prevention, and the delivery of therapeutic substances. Nanotechnologies, including electrospinning, create biomimetic structures that replicate the natural skin environment and aid in the healing of difficult-to-treat wounds(Jiang et al., 2022). Some nano-scaffolds contribute to chronic wound healing by enhancing cell adhesion and migration. Metal nanoparticles, such as silver nanoparticles (AgNPs), are employed in antimicrobial therapies, but their accumulation can cause DNA and cell damage. Therefore, there is a need to develop nanomaterials that prevent infection without inducing toxicity(Kong et al., 2018). In the context of chronic wound healing, biomaterials capable of adapting to the constantly changing skin environment are being developed. These materials are also useful in dynamic wound care monitoring systems, due to their properties such as photothermal effects, chemo-dynamic effects, fluorescence, and thermo-sensitivity(Youssef et al., 2023). Biologic dermis grafts, which include autologous, allogeneic, and artificial dermis grafts, are effective in treating deep wounds. Dermis grafts produced through tumor engineering, using fibroblasts and adipose tissue-derived stromal vascular fraction cells, differ from traditional methods and promote faster healing. Fibrin glue serves as a cell delivery vehicle, providing significant advantages in microvascular anastomosis. This glue supports wound closure and reduces infection risks when it is enriched with antibiotics. Growth factor therapies, combined with advanced techniques like nanotechnology, real-time monitoring, and bioactive hydrogels, represent significant innovations in accelerating wound healing and promoting tissue regeneration. These therapies involve growth factors such as platelet-derived growth factor (PDGF), basic fibroblast growth factor (bFGF), and epidermal growth factor (EGF). Cell therapies, which utilize various cell types including fibroblasts, keratinocytes, and adipose tissue-derived stromal vascular fraction cells, are also contributing to wound healing. Complementary treatments, including nutritional support, electrical stimulation, ultrasound, and oxygen therapy, further aid the healing process and enhance the quality of life for patients. In recent years, many nanomaterials and techniques have been applied to repair chronic wounds. These technologies present innovative solutions, such as smart dressings with real-time monitoring and responsive capabilities. Future goals include the development of more sophisticated wound management systems based on nanobiotechnology. Additionally, innovations like 3D-printed micro-fat grafts and new staged excision techniques represent significant advances in reconstructive surgery.

Conclusion

Chronic wounds remain a pervasive public health challenge, necessitating comprehensive care strategies to enhance healing and improve patients' quality of life. Nurses, as key contributors to wound management, must possess a thorough understanding of the biological, systemic, and environmental factors that impact wound healing. By leveraging advanced technologies and evidence-based practices, nurses can optimize patient care, mitigate complications, and reduce healthcare costs. Furthermore, the integration of innovative treatments, including nanobiotechnology and biologic therapies, highlights the evolving landscape of chronic wound management. Empowering nurses through education and multidisciplinary collaboration is essential to address the complexities of chronic wounds effectively and ensure the delivery of high-quality, patient-centered care.

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