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CHRONIC WOUND MANAGEMENT – TRADITIONAL AND CONTEMPORARY THERAPEUTIC APPROACHES

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ABSTRACT

Chronic wounds are a significant clinical and socioeconomic burden, causing major health concerns and associated costs in terms of quality of life. Conventional solutions like debridement, gauze dressings, systemic antibiotics and offloading continue to be widely used due to their accessibility and low cost, although they may not be adequate for advanced or long-standing cases. This manuscript reviews and contrasts traditional and novel management techniques in chronic wound care. Advanced dressings providing a moist environment, negative pressure wound therapy (NPWT) and bioengineered matrices provide better healing, reduced infection risk, and lower long-term costs than other conventional approaches. Smart dressings incorporating biosensors and emerging therapies, such as nanomedicine, stem cells and growth factors, also have great promise, but require large-scale validation. Conventional strategies continue to be useful in initial and less complicated wounds but modern, individualized, and multi-disciplinary care is becoming more important in achieving better outcomes. Integrating both approaches, following EWMA and NICE guidelines, appears most effective to deliver on innovation, accessibility and cost-effectiveness in chronic wound care.

Material and method: This study employed a narrative review approach based on the analysis of recent scientific publications, international guidelines (EWMA, NICE), and clinical trial results comparing traditional and modern strategies for the management of chronic wounds.

KEYWORDS

Chronic Wounds, Debridement, Advanced Dressings, Smart Dressings, Negative Pressure Wound Therapy, Bioengineered Matrices, Infection Management, EWMA, NICE

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1. Introduction

Chronic wounds pose a complex problem for contemporary medicine and the healthcare system, as their presence substantially compromises patients' quality of life and entails considerable treatment costs. Traditional methods remain widely used due to their high availability and relatively low cost. However, they have certain limitations and are increasingly proving insufficient in cases of advanced disturbances in the healing process. To address these challenges, new therapeutic methods have been developing in recent years, focusing on supporting or restoring the body's natural healing mechanisms. The aim of this paper is to compare and contrast the effectiveness, safety, and outcomes of traditional and modern wound care in order to determine which approaches are most suitable for the successful treatment of chronic wounds.

2. Overview of Chronic Wounds

Chronic wounds differ from acute wounds as they fail the normal stages of wound healing – coagulation, inflammation, proliferation, and remodeling – often halting in the inflammatory phase or failing to proliferate [1]. The inability to resolve inflammation and move to the phase of healing and growth are compounded by diabetes, vascular disease, and immobility [2].

From a biological perspective, the local wound environment is unable to promote healing and is hypoxic, alkaline, and highly concentrated in lactate. Levels of oxygen tension in chronic wounds (5-20 mmHg) are markedly lower than healthy tissue (30-50 mmHg), thus, the process of collagen synthesis and angiogenesis is significantly reduced [5]. Chronic wounds show an alkaline pH of 7.15-8.90, therefore, the ability to destroy bacterial infections is low and protease activity high, causing excessive degradation of the ECM [5]. The average level of lactate in chronic wounds is above 7 mM, as opposed to healthy tissue with 1-3 mM, therefore fibroblast activity and granulation tissue cannot occur [5].

With regard to infection, although a plethora of microorganisms are found in chronic wounds, the most commonly found pathogen is S. aureus [6]. Clinical assessment of infection based on signs and symptoms has an accuracy of only 32-58% [6–7]. One factor that can lead to increased bacterial growth in chronic wounds is biofilm formation. In chronic wound care, pathogenic biofilms have been shown to be detrimental to healing and are an emerging challenge in the treatment of chronic wounds [6]. The presence of biofilms has been linked to delayed wound closure and increased antibiotic resistance [6]. Many wounds present clinical manifestations suggestive of infection; however, the lack of laboratory confirmation hinders the implementation of optimal treatment [7]. Therefore, the use of quantitative bacterial cultures and molecular techniques is important, as they can improve the detection and management of infections.

The presence of chronic wounds is an increasing economic burden on healthcare and is linked to frequent readmissions, increased duration of inpatient hospitalizations, increased number of emergency department visits, and elevated outpatient visits, all requiring more staff [3]. For example, the United States government spends 25 billion (USD) annually on the treatment of chronic wounds in 6.5 million patients. Additional indirect costs come in the form of lost time at work, decreased productivity, caregivers, as well as disability and rehabilitation expenses [2]. The cost of chronic wound care depends on the type and severity of the wound. For example, the estimated cost to heal one diabetic foot ulcer is almost $50,000 [2].

Chronic wounds impact patients financially, physically, emotionally, and socially. Current studies show that most chronic wound patients have experienced pain, decreased mobility, and frequent infections, requiring constant wound care and leaving patients with limited independence [4]. Emotional impact also arises, as patients reported being in a low mood and feeling sad and frustrated due to the failure of healing and the chronic nature of their wound [4]. The majority of these individuals also reported feeling depressed and having low self-esteem [4]. Approximately two-thirds of patients identified that having a chronic wound added costs for medical supplies, healthcare visits, and reduced earnings or benefits [4]. Most patients were isolated and lacked a strong social network, with the lack of ability to function or participate in daily activities being a major factor in their social withdrawal [4].

3. Traditional Pathways to Wound Care

Conventional management of chronic wounds consists of debridement, conventional dressing, antibiotics, and offloading. The use of these methods is a routine clinical practice, particularly in initial management, since they are relatively cheap and highly accessible [10–11]. Despite their potential to benefit, efficacy in complicated and advanced wounds still lags.

3.1 Debridement

Removal of necrotic and infected tissue is one of the mainstays of chronic management of wounds. Surgical debridement is the most common technique (sharp debridement) because it allows the removal of devitalized tissue and is associated with the decrease of bacterial load, which, in turn, can promote healing [11]. Alternatives exist, including enzymatic or autolytic methods, but they are slower and are less effective. Effective debridement should be repeated and performed by skilled clinicians; inadequate debridement markedly reduces chances of wound closure.

3.2 Conventional Dressings

Conventional gauze and cotton dressings are ubiquitous as they are relatively inexpensive and readily available. Their role is to protect the wound from mechanical trauma and contamination [10]. Yet, they have inherent limitations: they do not provide a moist healing environment, their absorbency is poor, and they also tend to stick to the wound surface which increases trauma and pain when removed [11]. Therefore, the sole application of conventional dressings causes delayed healing and reduces patient comfort. Nevertheless, they continue to be widely used at clinical settings, especially in low-resource countries.

3.3 Antibiotic Therapy and Antiseptics

Infected chronic wounds can be treated with systemic antibiotics, but the recommendation is to only use them in the presence of clinically established infection or when there is microbiological evidence to support their use [12]. Routine use of antibiotics should not be applied for chronic wounds. In addition, topical antiseptics, like iodine, chlorhexidine and silver-based preparations, may be used to lower bacterial load [11].

3.4 Prevention of Offloading and Pressure Ulcers

Therapy includes offloading, especially in diabetic foot ulcer care. Special footwear, orthoses, pressure-relieving mattresses and cushions are typical. Effective pressure ulcer prevention is also central to chronic wound management and includes systematic assessment of risk factors, regular repositioning of patients, treating the skin, and nutritional practices [13,16]. According to estimates, up to 70% of all pressure ulcers can be prevented appropriately by prophylaxis and patient and staff education [13].

3.5 Summary

The conventional methods of wound management: debridement, standard dressings, antibiotics, and offloading are all used extensively to support wound treatment; yet, they are at a minimum time and place in clinical practice essential for everyday care. Its common benefit is accessibility and little cost. But their effectiveness for advanced wounds is curtailed. Modern dressings and therapies are shown to achieve increased rates of healing via clinical studies and meta-analyses [14–15]. Guidance from scientific societies like EWMA and NICE suggests limiting the use of gauze dressings and implementing wound healing therapies providing a moist wound-healing environment [15–17].

4. Contemporary Methods for Wound Care

Current methods of chronic wound treatment have been developed that go beyond the traditional uses of debridement and gauze dressings. They have a purpose not only to promote the faster closure of the wound but also to enhance the quality of life for patients and to decrease the burden on the healthcare service providers.

4.1 Smart and Modern Dressings

One of the important innovative applications is by way of dressing that provides a moist wound healing environment to the patient, that can facilitate cell migration and the process of re-epithelialization (in contrast to gauze) [18]. These are hydrocolloids, hydrogels, foams and alginates, depending on the wound characteristics (dry versus exudative). Clinical studies and meta-analyses have shown that these dressings promote healing faster with better patient comfort compared to traditional methods [11,14]. A new direction is emerging with so-called smart dressings, powered by biosensors that monitor pH, temperature, exudate levels and bacterial presence. Such dressings can transmit real-time data and thus to healthcare providers or patients, providing personalized therapy and early infection detection [5,18,19]. Results so far have been promising, however, widespread adoption is limited by cost, technology complexity, and the lack of large-scale clinical trials [6].

4.2 Antimicrobial Elements

Contemporary dressings often include antimicrobial agents like silver, iodine, or bioactive peptides [19]. Therefore, they are designed to restrict bacterial colonization and aid in infection control, especially in wounds that can be contaminated with S. aureus or Pseudomonas aeruginosa [2,7]. On the contrary, guidance states long-term use of antiseptics is discouraged due to the risk of cytotoxicity and antimicrobial resistance [12].

4.3 Negative Pressure Wound Therapy (NPWT)

Negative Pressure Wound Therapy (NPWT) is one of the most widely investigated contemporary methods. In this technique, a foam dressing attached to a suction system within the wound is applied, resulting in a wound where the pressure has been exposed to a suction mechanism encouraging both granulation as well as removal of excess exudate, in a manner that is conducive to preventing an infection from developing [21–22]. NPWT has been shown in randomized controlled trials to reduce healing time for lower-limb ulcers and postoperative wounds as well as the number of surgical procedures needed [20]. Cost evaluations indicate that although the cost of devices is high, this therapy decreases total treatment costs by about 25-30% due to shorter length of hospital stay and fewer complications [22].

4.4 Biological Products and Tissue Engineering

In addition, a major development of wound care is the incorporation of biological products such as extracellular matrices, skin grafts, and bioengineered skin substitutes [23–24]. These materials form a scaffold for patient cells to migrate into, supporting angiogenesis and fibroblast proliferation. Ovine-derived matrices have also been shown in clinical situations to significantly decrease the area of chronic wounds that have not responded to other interventions [23]. Nevertheless, such limitations include the high costs, complicated production processes, and regulatory hurdles (FDA, EMA).

4.5 Experimental Therapies

Newer therapies that are in the preclinical or early clinical stages are nanotechnology, stem-cell therapy, or growth factors applications [8–9]. Nanomaterials could help in the introduction of drugs, antibiotics and regenerative factors selectively to wound site. Stem-cell therapy may be capable of supporting the wound cell migration and remodeling of the extracellular matrix, application of growth factors could also promote angiogenesis and the vascularization of the wound bed [1,24]. But still, these systems need to be examined for safe treatment, effective treatment, and economy before they can be incorporated in a clinical setting.

4.6 Summary

Clinical results are shown to benefit dramatically from the modern method of wound treatment, ranging from advanced sensor-enabled dressings and intelligent care to NPWT through to bio-based products or experimental therapies. Despite the evidence of their effectiveness, key barriers remain: high costs, very limited accessibility and the scarcity of large randomized clinical trials. Striking a balance between innovation, in cost-effective and affordable ways and practical access to everyday healthcare, can help drive ongoing development.

5. Conclusions

Chronic wounds present a significant clinical, social and economic burden on the global healthcare system by exposing patients to complications, leading to high healthcare system costs in the general population [1–4]. Treatment based on standard techniques such as surgical debridement, gauze dressings, systemic antibiotics and offloading is still the mainstay of the first-line therapy. They are cost-effective, abundant, good at less complex, ealy-stage wounds [10–13]. However, the evidence shows that these strategies alone will not be adequate for the management of the large, complex, or long-standing chronic wounds where delayed healing and complications are prevalent [11,14]. Advanced dressings that keep wound spaces moist, Negative Pressure Wound Therapy (NPWT), bioengineered matrices, and cellular alternatives are new solutions that have proven to be more effective in many clinical scenarios. Super modern dressings foster hydration, decrease the risk of infection and hasten the re-epithelialization and smart dressings with biosensors improve immediate wound monitoring as well as personalized aid [5,18,19]. NPWT drastically decreases healing time, lowers complication rates, and decreases treatment costs, although at a higher cost at the outset [20–22]. Extracellular matrix implants and engineered skin substitutes represent biological products, which act as scaffolds for cell migration and angiogenesis, have demonstrated favorable results for wounds that were unresponsive to other methods [23–24]. New approaches, including nanomedicine, stem cell therapies, and growth factor delivery, are the next evolution in wound management. Earlier interventions indicate their potential to clear obstacles, involving impaired angiogenesis and microbial resistance, but are still experimental and have not been validated in large long-term, randomized clinical trials [8,9,24]. A comparison between traditional and modern therapy methods shows a major point: conventional techniques still have their place as the backbone of treatment, but modern and individualized treatment practices tend to promote better healing levels, decreased infection chances, increased patient satisfaction, and long-term economy of the care [14,25]. Both approaches should be considered complementary for therapy to fit into the individual patient’s specific needs, wound traits and healthcare system infrastructure. Priorities for the future are developing standardized diagnostics and outcome measures, performing appropriate economic assessments, and implementing evidence-based interventions consistent with international directives such as those of EWMA and NICE [15–17]. In addition, barriers like high costs, limited accessibility and varying clinical expertise levels must be alleviated to support equitable access to advanced therapies [2–3]. Further research on the molecular and cellular mechanisms behind wound healing mechanisms would also be essential for future research to establish more precise targeted therapeutic strategies [1,7,8]. Ultimately, chronic wounds are best managed through a multidisciplinary, evidence-based strategy that leverages benefits of both old versus new techniques. Finding a balance of innovation, accessibility and affordability will be critical — especially with aging populations, including growing chronic wounds. There will be both continued research and systemic support and clinical education, to ensure that these patients reap the full power of modern wound-healing strategies, yet retain the practical cornerstones of traditional care.

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