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Advanced Dressing Therapy of Diabetic Foot Ulcers in Wound Care Clinic Prevents Limb Amputation: A Case Report Study

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Abstract

The global prevalence of type 2 diabetes mellitus (T2DM) continues to rise significantly, with particularly concerning rates in Saudi Arabia. This increase has led to a proportional rise in diabetes-related complications, with diabetic foot ulcers (DFUs) representing one of the most challenging and potentially devastating consequences. This case report presents the successful implementation of advanced dressing therapy to prevent lower limb amputation in a patient with complex DFUs in a specialized wound care clinic. We document the case of a 65-year-old male with a 30-year history of T2DM who presented to the Emergency Department with a septic foot and peripheral vasculopathy complicated by a chronic wound. Following the patient's refusal of amputation, specialized wound care nurses implemented a comprehensive treatment protocol incorporating multiple advanced dressing techniques, including antibacterial solutions, autolytic debridement gels, charcoal-silver dressings, and protective absorption foam. The treatment strategy was systematically adjusted according to wound healing stages over six months of careful monitoring. The initial wound, measuring 8×10 cm with purulent discharge and necrotic tissue, showed remarkable improvement, with healthy granulation tissue emerging within three weeks of treatment initiation. Through the strategic use of advanced dressing products for wound bed preparation and matrix therapy with heparin sulfate solution during the maturation phase, complete wound healing was achieved with minimal scarring. This case demonstrates the potential of specialized wound care protocols in preventing amputation and achieving optimal healing outcomes in complex DFUs while highlighting the crucial role of dedicated wound care nurses in delivering comprehensive care.

Keywords: *Advanced wound dressing, Diabetic foot ulcer, Limb salvage, Wound care nurse, Wound healing stages, Mechanical debridement, Wound management, Case report, Saudi Arabia, Amputation prevention.*

Introduction

The global burden of type 2 diabetes mellitus (T2DM) has reached unprecedented levels, establishing itself as one of the most significant public health challenges of the 21st century. This epidemic has particularly affected Saudi Arabia, where the prevalence of T2DM stands at an alarming 25.4% of the population, positioning the country seventh among nations with the highest diabetes rates globally. This health crisis extends beyond individual patient care, creating substantial ripple effects throughout the healthcare system and society. In Saudi Arabia alone, the economic impact of diabetes-related complications has become a significant concern for healthcare planners and policymakers, with annual costs surpassing 17 billion Saudi Riyals. These expenses encompass direct medical costs, including hospitalization, medication, and ongoing care, and indirect costs, such as reduced productivity and early retirement due to disability [1,2].

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Diabetic foot ulcers (DFUs) stand out as particularly challenging complications of T2DM, representing a significant threat to patient well-being and healthcare resources. Contemporary epidemiological studies have revealed a stark reality: T2DM patients with a history of foot ulcers face a 40% higher morbidity rate compared to their counterparts without DFUs. This increased risk stems from a complex interplay of pathophysiological factors. Compromised peripheral circulation, often resulting from long-term hyperglycemia-induced vascular damage, significantly impairs the delivery of oxygen and nutrients to affected tissues. Diabetic neuropathy further complicates the healing process by reducing protective sensation and altering standard wound healing mechanisms. The combination of these factors creates an environment highly susceptible to infection, while the systemic effects of diabetes simultaneously impair the body's immune response. Additionally, the delayed tissue repair mechanisms characteristic of diabetic patients create a perfect storm of factors that can transform even minor wounds into chronic, non-healing ulcers [3–6].

The pathophysiology underlying DFUs reveals a complex web of interconnected metabolic, vascular, and neurological disturbances. Chronic hyperglycemia serves as the primary driver of these complications, initiating a cascade of detrimental effects throughout the body. Endothelial dysfunction, a hallmark of diabetic vascular disease, compromises blood vessel function and tissue perfusion. Reducing nitric oxide availability further impairs vascular function and wound healing potential. Meanwhile, increased oxidative stress at the cellular level damages proteins and genetic material, while impaired collagen synthesis weakens the structural integrity of healing tissues. These disturbances are compounded by a compromised immune response, leaving patients vulnerable to opportunistic infections and delaying natural healing [5–7].

The management of DFUs has traditionally followed a conservative path, often culminating in amputation when confronted with extensive tissue damage or persistent infection. However, this approach takes a heavy toll on patients physically and psychologically. Beyond the immediate loss of mobility and independence, patients who undergo amputation frequently experience a dramatic decrease in their quality of life. The psychological impact often manifests as depression, with studies indicating significantly higher rates of mental health challenges among amputees. Moreover, research has demonstrated higher mortality rates among diabetic patients who undergo lower limb amputation, with five-year survival rates comparable to some aggressive cancers. The financial burden of amputation and subsequent rehabilitation adds another layer of stress to an already challenging situation, with costs often extending well beyond initial surgical intervention [4,5,7].

In response to these challenges, a paradigm has shifted toward limb preservation strategies, particularly advanced wound care techniques. This evolution in treatment philosophy requires a comprehensive and proactive approach to care. Early intervention has emerged as a critical factor in successful outcomes, necessitating robust screening programs and rapid response protocols. The development of specialized wound care expertise has become increasingly important, with dedicated professionals trained in the latest evidence-based techniques. Advanced dressing technologies have revolutionized wound management, offering new possibilities for promoting healing and preventing infection. Regular monitoring and assessment provide crucial feedback for treatment modification, while patient education and compliance programs ensure active participation in the healing process [7,8].

This case report aims to contribute to the growing evidence supporting advanced dressing therapy as an effective alternative to amputation in complex DFU cases. Through a detailed analysis of our treatment approach, we highlight the critical role of specialized wound care nurses in implementing successful therapeutic strategies. Our experience demonstrates that with appropriate expertise, technology, and patient engagement, limb preservation is achievable even in challenging cases that might traditionally have been considered candidates for amputation. The implications of successful limb preservation extend beyond the individual patient, offering potential benefits in terms of healthcare resource utilization, quality of life outcomes, and long-term cost-effectiveness.

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Case Report

Patient Demographics and Medical History

The subject of this case report was a 65-year-old male who presented with a complex medical history that significantly impacted his wound-healing capacity. Most notably, the patient had been living with Type 2 diabetes mellitus for three decades, managing his condition through insulin therapy. This long-standing diabetes had already resulted in multiple complications before the current presentation. The patient's mobility and independence had been severely compromised by a previous cerebrovascular accident (CVA), which had left him in a bedridden state with right-sided hemiplegia. Further complicating his condition, the patient suffered from bilateral blindness, which significantly impacted his ability to perform self-care and monitor his condition. His medical history was particularly noteworthy for multiple previous amputations, including the left foot index finger, left ring finger, left extensive toe, and a partial amputation of the right forefoot, all of which were consequences of his diabetic condition. Interestingly, despite these significant complications, the patient had no documented history of hypertension, which often accompanies long-standing diabetes. This complex constellation of comorbidities presented substantial challenges for wound healing and necessitated careful consideration in developing an effective treatment strategy.

Initial Presentation and Clinical Assessment

On July 4, 2023, the patient was brought to the Emergency Department, presenting several concerning symptoms. The primary complaint centered around a septic foot condition complicated by peripheral vasculopathy. A non-healing wound on the right foot that had been present for approximately two months before the presentation was of particular concern. The patient reported significant pain and discomfort associated with the wound, and the condition had further compromised his already limited mobility. The chronicity of the wound, combined with the presence of infection and vascular compromise, raised immediate concerns about the potential need for aggressive intervention.

Comprehensive Diagnostic Evaluation

A thorough diagnostic workup was initiated to assess the full extent of vascular compromise and infection. The vascular assessment began with a Doppler ultrasonography examination of the right lower limb, which revealed diffuse atherosclerotic changes throughout the vessels, although notably, no significant hemodynamic stenosis was identified. CT angiography further investigated this finding, which provided a more detailed picture of the vascular status. The CT angiography demonstrated patent common femoral arteries, patent superficial, deep femoral arteries, and patent popliteal arteries bilaterally. However, the examination also revealed concerning findings of attenuated popliteal branches and reduced contrast filling in both the dorsalis pedis and posterior tibial arteries, indicating compromised peripheral circulation. The soft tissue evaluation component of the CT scan unveiled multiple concerning findings that painted a picture of severe infection and tissue compromise. The imaging revealed significant soft tissue thickening throughout the affected area, accompanied by pronounced edematous changes in the right foot. Particularly worrisome was the presence of abnormal enhancement at both the posterior and medial aspects of the foot, along with subcutaneous gas pockets that strongly indicated an active infectious process. The scan also showed early enhancement of subcutaneous veins, suggesting an inflammatory response, and revealed cortical irregularities in the right calcaneus, indicating possible bone involvement. Microbiological analysis was conducted through wound swab culture, identifying two significant pathogens: Escherichia coli and Klebsiella pneumonia. The presence of these organisms, particularly in combination, indicated a complex polymicrobial infection requiring targeted antimicrobial therapy.

Initial Treatment Protocol

Upon admission, a comprehensive initial treatment plan was immediately implemented. The first line of intervention involved surgical debridement to remove infected and necrotic tissue, followed by the institution of daily conventional dressing changes. The antibiotic regimen was carefully selected and dosage-adjusted considering the patient's renal function, consisting of a renal-adjusted dose of 2.25 mg

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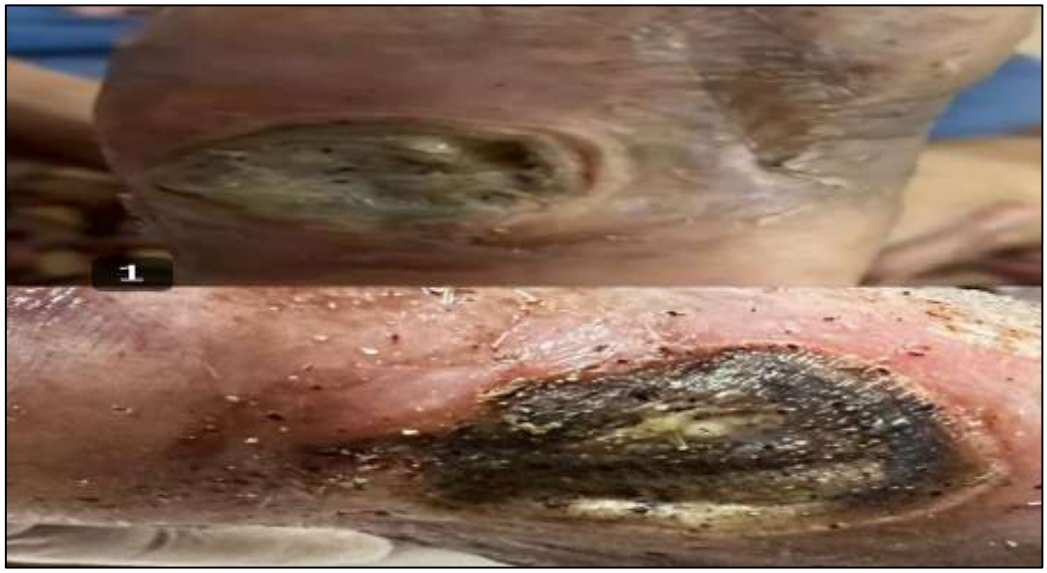
administered three times daily and Metronidazole 500 mg administered three times daily to provide broad-spectrum coverage against the identified pathogens.

Detailed Physical Examination Findings

The physical examination revealed the extensive nature of the wound and associated complications. The most prominent feature was a wide ulcer located at the base of the heel, with exposure to the underlying calcaneus bone. Active purulent discharge was noted from the wound site, and the surrounding tissues showed significant edema and hyperemia, with the inflammatory process extending up to the distal third of the right calf. Vascular examination revealed absent posterior and anterior tibialis pulses, while the popliteal pulse was notably diminished compared to the contralateral limb. The ulcer measured approximately 8 × 10 centimeters, with particularly concerning features including offensive yellow discharge and areas of black skin discoloration, as shown in Figure 1, indicating tissue necrosis. Interestingly, despite the extensive nature of the infection, the examination revealed an absence of local heat or tenderness, likely due to the patient's diabetic neuropathy. These comprehensive examination findings, combined with the results of diagnostic testing, provided a clear picture of a severely compromised limb with multiple risk factors that would traditionally have led to consideration of amputation. However, the patient's strong preference for limb preservation necessitated the exploration of alternative treatment strategies, leading to the development of an aggressive wound care protocol aimed at salvaging the affected limb.

Figure 1. First picture upon admission.



Advanced Wound Care Protocol and Treatment Outcomes

Protocol Implementation

Following the patient's informed decision to refuse amputation on July 5, 2023, the medical team initiated a referral to the specialized wound care clinic. This decision marked a pivotal moment in the patient's care trajectory, transitioning from conventional wound management to an advanced therapeutic approach. The comprehensive wound care protocol, which commenced on July 13, 2023, was strategically designed to progress through multiple phases, each tailored to address specific wound healing and tissue regeneration aspects.

Initial Phase (Weeks 1-3)

The initial phase of treatment focused on establishing optimal wound bed conditions and managing the heavy bacterial burden. A multi-modal approach was implemented, beginning with mechanical debridement

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using specialized polymer cloth. This advanced material was selected for its ability to remove devitalized tissue while effectively minimizing trauma to healthy tissue. The concurrent application of autolytic debridement gel complemented the mechanical debridement, facilitating the body's natural wound-cleaning mechanisms through selective enzymatic action. Incorporating Charcoal-Silver antimicrobial dressing served dual purposes: the activated charcoal component effectively managed wound odor and bacterial load, while the silver ions provided broad-spectrum antimicrobial activity. To maintain an optimal wound environment, a protective foam secondary dressing was applied and carefully selected to manage exudate levels while preventing maceration of surrounding tissue. After 3 weeks, the wound improved with minimal pus and slough, and granulation tissue appeared (Figure 2).

Figure 2. After 3 weeks, the granulation tissue started to grow.

Intermediate Phase (Months 2-3)

As the wound progressed to the intermediate phase, the treatment protocol evolved to address the changing needs of the healing tissue. Cadexomer Iodine was introduced as the primary antimicrobial agent, chosen for its sustained release properties and ability to maintain a sterile wound environment without cytotoxicity to regenerating tissue. The continued use of Charcoal-Silver dressing provided ongoing infection control while supporting granulation tissue formation. Advanced foam protection was maintained throughout this phase, with regular adjustments to accommodate changing exudate levels. A rigorous wound assessment and documentation schedule were implemented, including detailed measurements, photography, and tracking of tissue characteristics to monitor healing progression objectively. As the wound progressed to heal, the edges were approximated, indicating the start of the maturation phase. The dressing was performed with Normal Saline for irrigation, Iodine, and matrix therapy agent and covered with advanced Foam (Figure 3).

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Figure 3. In this stage, matrix therapy is used

Advanced Healing Phase (Months 4-5)

The advanced healing phase marked a transition to more sophisticated wound healing modalities. Regular Normal Saline irrigation was performed to maintain optimal moisture levels and remove debris without disrupting the delicate wound bed. Iodine application was continued but at modified concentrations appropriate for the maturing wound tissue. A significant advancement in this phase was the incorporation of matrix therapy agents, specifically selected to promote tissue regeneration and enhance healing quality. The advanced foam protection protocol was maintained with increased attention to pressure distribution and edge protection. Weekly wound measurements and standardized photography provided crucial documentation of healing progression and guided ongoing treatment modifications.

Final Maturation Phase (Months 5-6)

During the final maturation phase, the focus shifted to optimizing wound closure and minimizing scar formation. Matrix therapy continued with particular attention to promoting proper collagen organization and epithelialization. Moisture balance became increasingly critical, with dress selection and change frequency carefully tailored to maintain optimal hydration levels without risking maceration. Specific scar prevention strategies were implemented, including careful attention to mechanical forces across the wound and the use of appropriate dressing materials to minimize trauma during dressing changes. Regular assessments of wound closure continued, with particular attention to the quality of epithelialization and the integrity of surrounding tissue.

Treatment Outcomes and Progressive Improvement

The wound demonstrated remarkable improvement throughout the treatment period, with clearly documented progression through each healing phase. By week three, there was a notable reduction in purulent discharge, and the presence of slough had diminished significantly. Perhaps most encouragingly, initial granulation tissue formation was observed, indicating the establishment of a healthy wound-healing environment. The second month of treatment marked progress, with objective measurements showing a significant reduction in wound dimensions. The tissue quality also improved substantially, characterized by robust, healthy granulation tissue formation and a notable improvement in the condition of the peri-wound skin. These changes suggested successful management of the initial infection and establishment of optimal healing conditions (Figure 4).

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Figure 4. The wound has improved.

By the fourth month, the wound had progressed to show advanced edge approximation, a critical indicator of successful healing progression. The initiation of the maturation phase was evident through the appearance of organized epithelial tissue, and wound cultures returned negative results, confirming effective infection control. This period represented a crucial transition from active wound management to tissue repair and regeneration optimization.

The outcome at month six exceeded initial expectations, with complete wound closure achieved and minimal scarring present. The preserved limb function represented a particularly significant achievement, especially given the initial consideration of amputation. Maintaining negative culture status throughout the later phases of healing confirmed the success of the infection control measures implemented throughout the treatment protocol. This comprehensive wound care approach, characterized by careful phase progression and regular assessment of healing markers, demonstrated the potential for advanced dressing protocols to achieve optimal outcomes in complex DFUs (Figure 5). The success of this case underscores the importance of specialized wound care expertise and the value of a systematic, phase-based approach to wound management.

Figure 5. The wound healed, with a small scar.

Discussion

The successful outcome achieved in this case study demonstrates the effectiveness of a systematic, evidence-based approach to advanced wound care in managing complex DFUs. This discussion examines

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the key principles and strategies employed, their theoretical foundations, and their practical implications for clinical practice.

Advanced Wound Care Principles and Biofilm Management

Managing chronic wounds, particularly DFUs, requires a comprehensive understanding of wound biofilms and their impact on healing. Bacterial biofilms are present in approximately 60-80% of chronic wounds, significantly impeding the healing process through persistent inflammation and resistance to conventional treatments [9,10]. Our multi-modal approach to biofilm management aligned with current best practices identified in the literature. Using polymer cloth for mechanical debridement effectively disrupts established biofilm communities while minimizing trauma to healthy tissue [11,12]. Combining mechanical debridement with autolytic debridement gels represents a synergistic approach that has demonstrated superior outcomes compared to single-modality treatments. This finding is consistent with past studies, which reported significant improvements in wound bed preparation when combining mechanical and autolytic debridement techniques [13,14]. Incorporating Charcoal-Silver dressing provided additional antimicrobial action, with evidence suggesting that silver-based dressings can effectively reduce bacterial load while promoting wound healing [15,16].

Moisture Balance and Wound Environment Optimization

A fundamental principle in modern wound care is maintaining optimal moisture levels to support healing. Our protocol's success in achieving appropriate moisture balance was founded on evidence-based practices. The selection of advanced foam dressings was guided by their demonstrated ability to manage exudate effectively while maintaining an ideal wound environment. Regular assessment of exudate levels and appropriate adjustment of dressing change frequency proved crucial in preventing maceration and dedication of the wound bed. The protection of peri-wound skin, often overlooked in conventional wound care, received particular attention in our protocol. This approach is supported by past research, highlighting the importance of peri-wound skin health in promoting overall wound healing [17]. Implementing matrix therapy agents during the maturation phase, particularly those containing heparin sulfate, has shown promise in improving wound healing outcomes, especially in patients with compromised vascular status.

Infection Control and Antimicrobial Stewardship

Managing infection in DFUs requires a balanced approach between effective antimicrobial therapy and preserving wound healing potential. Our protocol incorporated regular wound cultures to guide targeted antimicrobial therapy, aligning with recommendations from international guidelines on diabetic foot infections. The bio-film-based wound care approach provided a framework for understanding and addressing the complex microbial communities present in chronic wounds [18].

Role of Specialized Wound Care Nurses

The success of this case underscores the critical role of specialized wound care nurses in managing complex wounds. Specialized wound care nurses contribute significantly to improved patient outcomes through their expertise in assessment, treatment implementation, and patient education [19,20]. Our experience confirms that wound care nurses serve as essential coordinators of care, facilitating communication between different healthcare providers and ensuring consistent application of treatment protocols. The comprehensive documentation and outcome measurement maintained throughout the treatment period provided valuable data for evaluating treatment effectiveness and guiding protocol adjustments. This systematic approach to wound care documentation aligns with current best practices and supports the development of evidence-based protocols for future cases.

Economic Implications and Healthcare Resource Utilization

In this case, the successful limb salvage achieved has significant economic implications beyond the immediate healthcare setting. Recent economic analyses have demonstrated that preventing lower limb

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amputation in diabetic patients can result in substantial cost savings for healthcare systems. Direct and indirect costs associated with diabetic foot amputations in Saudi Arabia are considerable, with implications for healthcare systems and patient quality of life [21,22]. Reducing hospitalization costs, preventing amputation-related expenses, and decreasing the need for long-term care represent significant economic benefits. Moreover, the improved quality of life outcomes achieved through limb preservation has important implications for patient productivity and social participation [21,22].

Study Limitations and Future Directions

While this case report demonstrates successful outcomes, several limitations must be acknowledged. While valuable for detailed analysis of intervention effectiveness, the single case report design limits the generalizability of findings to broader patient populations. The lack of a control group prevents direct comparison with conventional treatment approaches, and the limited follow-up period may not capture potential long-term complications or wound recurrence.

Future research directions should address these limitations through

Several critical research directions warrant exploration to advance our understanding of DFUs management. Large-scale prospective studies incorporating diverse patient populations are essential to validate the effectiveness of advanced dressing protocols across different demographic groups, comorbidity profiles, and wound characteristics. These studies should be complemented by well-designed randomized controlled trials that systematically compare various wound care approaches, particularly evaluating novel dressing materials and innovative treatment combinations. The economic dimension of wound care must also be thoroughly investigated through comprehensive cost-effectiveness analyses that quantify the financial benefits of advanced wound care strategies compared to conventional approaches, including direct medical costs and indirect societal expenses. Additionally, extended follow-up studies are crucial to evaluate long-term outcomes and monitor recurrence rates, as the durability of treatment success remains a critical concern in diabetic foot care. Finally, there is a pressing need for detailed quality-of-life assessments that examine the multifaceted impact of limb preservation on patients' physical functioning, psychological well-being, social engagement, and overall life satisfaction. These assessments should employ validated instruments to measure outcomes across various domains of patient experience, providing a more complete understanding of the comprehensive benefits of successful wound healing and limb salvage.

Conclusion

Several critical research directions warrant exploration to advance our understanding of DFUs management. Large-scale prospective studies incorporating diverse patient populations are essential to validate the effectiveness of advanced dressing protocols across different demographic groups, comorbidity profiles, and wound characteristics. These studies should be complemented by well-designed randomized controlled trials that systematically compare various wound care approaches, particularly evaluating novel dressing materials and innovative treatment combinations. The economic dimension of wound care must also be thoroughly investigated through comprehensive cost-effectiveness analyses that quantify the financial benefits of advanced wound care strategies compared to conventional approaches, including direct medical costs and indirect societal expenses. Additionally, extended follow-up studies are crucial to evaluate long-term outcomes and monitor recurrence rates, as the durability of treatment success remains a critical concern in diabetic foot care. Finally, there is a pressing need for detailed quality-of-life assessments that examine the multifaceted impact of limb preservation on patients' physical functioning, psychological well-being, social engagement, and overall life satisfaction. These assessments should employ validated instruments to measure outcomes across various domains of patient experience, providing a more complete understanding of the comprehensive benefits of successful wound healing and limb salvage.

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Consent: The patient's guardian signed consent for photographic training and research, and a copy of written consent was obtained from the author.

Ethical Approval: We got approval from Jazan Ethics Committee Approval No. 2478 on 19/11/2024.

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