REVIEW ARTICLE

A Review on Exploring Current Marketed Formulations for Effective Wound Healing

Reetoo Yadav[a], Lalit Mohan Nainwal[a], Nidhi Tiwari*[a]

*[1]KIET School of Pharmacy, KIET Group of Institutions, Delhi-NCR, Ghaziabad-201206, Uttar Pradesh, India

[2]KIET School of Pharmacy, KIET Group of Institutions, Delhi-NCR, Ghaziabad-201206, Uttar Pradesh, India

[3]KIET School of Pharmacy, KIET Group of Institutions, Delhi-NCR, Ghaziabad-201206, Uttar Pradesh, India

***Address correspondence to:**

Nidhi Tiwari, M.Pharm., PhD (P)

Assistant Professor

KIET School of Pharmacy, KIET Group of Institutions,

Delhi-NCR, Ghaziabad-201206, Uttar Pradesh, India

Abstract

Wound management is a crucial aspect of healthcare, with many formulations available to promote effective healing. These include hydrogels, foams, films, hydrocolloids, antimicrobial dressings, and bioengineered skin substitutes designed to enhance wound healing, prevent infections, and improve patient outcomes. Several marketed wound care products, such as dressings, films, Nu-Gel, and Purilon Gel, have been developed to support dermal regeneration and wound management. This comprehensive review explores the currently available marketed formulations for wound healing, analyzing their composition, benefits, limitations, and clinical effectiveness. It covers various wound care products, including dressings, films, Nu-Gel, Purilon Gel, and Curagel, as well as additional resources like SAF-Gel, foams, and hydrogels, which play a vital role in minimizing wound complications. Furthermore, the review examines a decade of advancements in wound management, highlighting innovations, treatment outcomes, and future directions. An ideal wound dressing should promote healing while preventing contamination, and numerous commercial formulations aim to fulfill these criteria. Commonly used primary and secondary dressings include Vaseline gauze, Xeroform, Urgotul, Silver sulfadiazine, Tegaderm, Burn Shield, Multisorb, Polyskin, Bio-occlusive, and Purilon Gel. This review categorizes marketed wound care formulations and provides insights into their clinical applications and future perspective research, ultimately serving as a valuable resource for researchers and healthcare professionals seeking evidence-based solutions for wound management.

Key Words: Wounds healing, Regeneration, Marketed formulations, Dressings

Running Title: Marketed Wound Healing Formulations

1. Introduction

The skin is the body's largest and outermost organ, serving as a protective barrier against microbial invasion, dehydration, and osmoregulation [1]. However, it can sustain damage due to various factors such as burns, trauma, infections, and diseases like diabetes, leading to the formation of acute or chronic wounds [2]. Every year, millions of individuals suffer from wounds, placing a significant burden on public healthcare systems. While minor wounds can naturally heal on their own [3]. Wound dressings are crucial in covering wound sites, preventing secondary injuries from external stimuli, and activating the body's endogenous healing mechanisms [4]. Traditional wound dressings, such as gauze, Tegaderm, and silver sulfadiazine (SSD), have been widely used to protect wounds and promote healing [5,6.] However, these conventional formulations often have limitations in maintaining an optimal healing environment. In contrast, modern wound dressings incorporate advanced polymer-based systems with multifunctional properties that enhance wound healing efficiency. A wound is defined as an injury that disrupts the continuity of the skin, tissues, and mucous membranes. Compared to acute wounds, chronic wounds are more challenging to manage due to delayed healing, persistent inflammation, and abnormal tissue repair, often necessitating surgical intervention or tissue removal [7]. For many years, traditional wound dressings such as Comfeel, Tegaderm, and gauze have been commonly used to keep wounds clean and prevent bacterial infections. However, these dressings tend to adhere to the wound surface and fail to maintain the necessary moist environment for healing[8.] Modern wound dressings have been developed to address these challenges with improved biocompatibility, degradability, pain relief, and moisture retention. Unlike conventional dressings that simply cover wounds, modern formulations actively facilitate the healing process by supporting cell regeneration and tissue repair [9]. Several marketed wound care products are currently used in clinical practice, including Vaseline gauze, hydrogels, foams, Comfeel, Burn Shield, Polyskin, Urgotul, Multisorb, Xeroform, and Bio-occlusive dressings [10]. Due to their enhanced ability to promote healing, modern dressings have become the preferred choice for wound care and treatment. The rapid advancements in technology have also led to the development of novel biomaterials for wound management [11]. However, certain limitations still exist, including complex manufacturing processes, quality assurance challenges for biological materials, and the need for further validation of their clinical efficacy [12.] Therefore, extensive research and trials are necessary to assess the effectiveness of these advanced wound dressings in real-world applications [13.] Wound dressings are widely utilized to accelerate and facilitate skin tissue repair [14]. Marketed formulations are available in various forms and compositions, including Burn Shield, foams, hydrogels, and Comfeel, and their selection depends on the nature and severity of the wound [15,16.] Over time, research on wound healing has evolved significantly. Studies have demonstrated that dry wound healing poses several disadvantages, including the formation and accumulation of exudate, frequent dressing changes, and an increased risk of re-injury, all of which prolong the healing process [17,18] Wound dressings play a fundamental role in wound care by creating a moist healing environment, which supports the growth of healthy cells and facilitates tissue regeneration [19.]

1.1. Types of Dressings

Wound dressings play an important role in the healing process by protecting wounds from infection, absorbing exudate (fluid), and promoting a moist environment that supports tissue regeneration. However, ideal dressings for burn wounds are still under development, and existing options often fail to provide complete healing without requiring surgical intervention or intensive daily wound care [20]. The goal of effective wound treatment lies in promptly cleaning the wound after exposure to a harmful agent. This can be achieved through either a surgical approach or a conservative method, depending on the severity of the injury. Currently, various types of wound dressings are available on the market, offering a range of solutions tailored to different wound conditions [21].

a) **Passive dressing:** Passive dressings are a type of wound dressing used to protect and promote the healing of wounds. They are called "passive" because they do not actively contribute to the healing process beyond providing a protective barrier and creating an environment that supports healing. Passive dressings do not contain active ingredients or substances like antibiotics, growth factors, or other components that directly stimulate wound healing[22].

b) **Interactive dressings:** Interactive dressings are advanced types of wound dressings that provide protection and actively engage with the wound environment to promote healing. These dressings are designed to respond to changes in the wound's conditions and adjust accordingly to enhance the healing process. Interactive dressings often have unique properties, such as controlling moisture balance, providing antimicrobial protection, or stimulating tissue regeneration **[23].**

c) **Advanced interactive dressings:** Advanced interactive dressings are an innovative category of wound care products designed to engage with the wound environment to enhance healing. These dressings go beyond basic moisture and infection control by incorporating cutting-edge technologies and materials that respond to changes in wound conditions. The goal of advanced interactive dressings is to accelerate the healing process, reduce complications, and improve patient outcomes by providing a more dynamic, personalized approach to wound care [24]**.**

The various commercially available wound dressings are shown in Figure 1.

2. Marketed formulations for wound healing

2.1. Vaseline Gauze (VG)

Vaseline gauze is a fine mesh, absorbent gauze impregnated with Vaseline, designed to create a moist environment that promotes wound healing [25]. It serves as a primary dressing alongside a secondary dressing such as gauze, Comfeel, or Duoderm, which helps absorb exudate. The Vaseline layer prevents the secondary dressing from adhering to the wound site, reducing

trauma during dressing changes [26]. Vaseline gauze dressings are impregnated in many clinical settings with topical antimicrobial agents. They are commonly used for treating various conditions, including skin wounds, nasal bleeding, and acute hemorrhagic rectal ulcer (AHRU) in the distal rectum [27,28, 29, 30]. However, these dressings tend to dry over time, leading to a loss of the moist wound environment. Additionally, they are associated with complications such as infection, pain, and blood oozing from the donor site during dressing changes [31]. Melolin and collagen sheets have been explored as alternative donor site dressings to address these limitations. Studies have shown that compared to Vaseline gauze, these materials offer better pain management, faster re-epithelialization, and lower infection rates [32, 33]. Vaseline gauze is widely used in clinical practice due to its moisture-retention properties, pain reduction benefits, and ability to prevent synechia formation. It is non-toxic and has been effectively used in the treatment of burn wounds [34]. The dressing is particularly suitable for minor burns, skin donor areas, tunneling wounds, areas with sutures or staples, cuts, abrasions, skin grafts, skin tears, circumcision sites, umbilical bandages, and wounds with light exudate [35]. To enhance patient comfort and optimize wound coverage, Vaseline gauze dressings are often customized to match the size and shape of the wound in each case [36].

2.2. Xeroform

Xeroform is a medical dressing designed to promote healing and protect wounds. It is commonly used for split-thickness donor sites due to its affordability, ease of application, consistent healing rate, and low infection risk. Xeroform dressings consist of a non-adherent gauze that is coated with a mixture of petroleum and 3% bismuth tribromo phenate, providing both antimicrobial and protective benefits[41]. The combination of paraffin and gauze creates a non-stick surface that keeps the wound moist while absorbing exudate, making it suitable for various types of wounds, such as surgical incisions, abrasions, minor burns, and particularly partial-thickness wounds [42, 43]. Additionally, Xeroform dressings are commonly used in reconstructive surgeries, cultured keratinocytes, and applications involving Integra bi-laminate skin substitutes and allografts [44, 45]. Xeroform dressings are an essential tool in the management of a wide variety of wounds, including burns, surgical incisions, abrasions, and chronic wounds. Their non-adherent and antimicrobial properties, combined with their ability to maintain a moist wound environment, promote faster healing and reduce the risk of infection [46]. Xeroform is a versatile dressing that adapts to various clinical needs, offering excellent patient comfort and effective wound care. With their cost-effectiveness and easy application, these dressings continue to be a reliable choice for both healthcare professionals and patients in wound healing [47,48, 49]. A unique case report highlighted the successful closure of a broncho-pleural fistula (BPF) in a 61-year-old patient following the insertion of a piece of Xeroform dressing. This marked the first documented use of Xeroform to address a large BPF in an acutely decompensating patient, showcasing its versatility and potential for diverse clinical applications [50, 51]. One of the primary benefits of Xeroform is its non-adherent property, meaning it does not stick to the wound, thus facilitating painless dressing changes. Its antiseptic and antibacterial qualities help prevent infection, while its ability to maintain a moist wound environment promotes faster healing [52,53, 54]. The dressing is designed to be applied to open wounds, ensuring trauma-free removal, and it is composed of highly absorbent material that

helps keep the wound dry and clean [55, 56]. Moreover, Xeroform conformably fits wound contours, enhancing patient comfort while supporting optimal healing conditions [57, 58.] Effective wound care using Xeroform requires careful evaluation of wound size, depth, and exudation levels. These factors help determine the appropriate dressing size and quantity. Xeroform dressings should be applied directly to a cleansed and dried wound surface, where their petrolatum base fosters a moist healing environment. Dressing changes should be scheduled based on the wound condition, with frequent changes required if the dressing becomes soiled, causes pain, or shows signs of infection [59, 60]. The Xeroform dressing's ability to stay in place for extended periods, often up to several days, reduces the frequency of dressing changes, promoting convenience for both healthcare providers and patients [61]. It is available in various sizes to accommodate different wound shapes and is especially effective on skin tears, donor sites, lacerations, burns, abrasions, and skin grafts [62].

2.2.1. Types of Xeroform Dressings

2.2.1.1. Xeroform Occlusive Dressing

This dressing helps maintain a moist environment by preventing air from reaching the wound. It is impregnated with petroleum and 3% bismuth tribromo phenate, offering bacteriostatic protection. Xeroform occlusive dressing is ideal for skin grafts, newly sutured wounds, lacerations, abrasions, and minor burns, as well as for wounds requiring mild medication and deodorization [63].

2.2.1.2. Xeroform Non-Occlusive Dressing

Unlike the occlusive version, this non-occlusive dressing allows the wound to breathe, promoting natural exudate transfer to a secondary dressing. It is suitable for chronic wounds, partial-thickness burns, donor and recipient sites, abrasions, and tunneling wounds, offering bacteriostatic and deodorizing effects through its 3% bismuth tribromo phenate content [64].

2.2.1.3. Xeroform Petrolatum Dressing

This variant is impregnated with 3% bismuth tribromo phenate and petrolatum, providing a waxy coating that creates an occlusive and non-adherent surface. It is appropriate for minimally draining wounds, surgical incisions, first and second-degree burns, lacerations, and donor sites. Its deodorizing action helps reduce wound odor while promoting a moist environment [65].

2.2.1.4. Xeroform Oil Emulsion Dressing

Designed for lightly to heavily exuding wounds, the oil emulsion dressing conforms to the wound bed, providing compression therapy. It benefits deep and shallow wounds and may promote faster healing than other treatments like silver sulfadiazine cream. Studies have shown that this dressing helps in the quicker healing of burn wounds, leading to smaller graft sizes and potentially reducing the need for multiple dressing changes [66, 67] .

2.3. Urgotul

The technology lipido-colloid dressing promotes faster tissue regeneration and wound healing by promoting fibroblast proliferation in burn cases. UrgoTul is a technology lipido-colloid dressing that contains both hydrophilic and lipophilic matrices incorporated with silver sulphadiazine (3.57%), which acts as an antimicrobial agent and as a source of silver nanoparticles. UrgoTul is a non-occlusive dressing consisting of a flexible, thin sheet of pure polyester gauze impregnated with silver nanoparticles embedded in a mixture of hydrocolloidal polymers (usually carboxymethyl cellulose) and petrolatum [68]. It is non-greasy to the touch, pliable, and marketed in a single, sterile, peel-open sachet in packs of 10 dressings and comes in sizes 10 cm x 10 cm and 15 cm x 20 cm. Urgotul is marketed in three variants: UrgoTul SSD (dressing containing silver sulphadiazine), Urgotul Ag (dressing containing silver nanoparticles), and Urgostart (dressing containing silver sulphadiazine and nano-oligosaccharide factor). All the marketed Urgotul variants are effective against a wide spectrum of microorganisms and are found to be particularly effective against Gram-negative bacteria such as Pseudomonas aeruginosa and Escherichia coli due to the presence of silver nanoparticles and silver sulphadiazine components [69]. Urgostart is the first dressing a part of the drug tariff that incorporates the Nano-OligoSaccharide Factor (NOSF), a new compound aimed at improving wound closure by inhibiting matrix metalloproteinase (MMP) activity[70]. It is a sterile, EC class IIb medical device developed and produced by Urgo Laboratories in Dijon, France.UrgoTul efficiently promoted and fastened the epithelialization in a 3-month-old large open granulating wound formed after compound fracture of tibia and fibula in an 89-year-old female patient who sustained a typical ‘bumper injury.’ Urgotul was applied twice weekly and covered with padding and bandage. UrgoTul had excellently covered the wound epithelialization over 6 weeks [71]**.** UrgoTul displayed complete wound healing in an 88-year-old female patient with rheumatoid arthritis suffering from heat-damaged skin and was on steroid therapy when applied with bandage and changed twice weekly for 5 weeks [72]**.** Urgo Algoplaque is a sterile, high-performance dressing for use in treating deep exudative wounds. The dressing of Urgo Algoplaque is made up of a semi-permeable polyurethane sheet consisting of carboxymethylcellulose hydrocolloid particles exclusively dispersed in an adhesive elastomer matrix [73]**.** Due to the dressing’s permeability to water and bacteria, it provides superior protection to the wound. The Hydrocolloid dressings absorb wound exudate and form a colloid gel, creating favourable conditions for the healing process (moisture, temperature, pH) [74]**.**

2.4. Silver sulfadiazine

Silver sulfadiazine (AgSD) is a topical antimicrobial agent widely used in the treatment of burns and chronic wounds. It is a combination of silver, which possesses broad-spectrum antimicrobial properties, and sulfadiazine, an antibiotic from the sulphonamide class. The dual-action of AgSD makes it a preferred treatment option for preventing and managing infections in burn wounds and other skin injuries [75, 76]. The antimicrobial activity of silver sulfadiazine is primarily attributed to the release of silver ions, which interact with bacterial cell walls, leading to bacterial cell death. The silver component of AgSD exhibits a broad-spectrum activity,

effective against both Gram-positive and Gram-negative bacteria, and is rarely associated with the development of resistance [77]. The sulfadiazine component further enhances its efficacy by inhibiting bacterial folic acid synthesis, which is essential for bacterial growth [78]. One of the key advantages of AgSD over alternative treatments like silver nitrate (AgNO3) is its ability to avoid electrolyte imbalances and prevent the conversion of nitrate to nitrite, a process that can contribute to toxicity in burn patients [79]. AgSD also eliminates the problem of environmental staining that occurs with AgNO3, providing a cleaner and more effective solution for wound care. Moreover, several published reports documented that AgSD has a good safety profile, with fewer side effects like leukopenia, allergic reactions, and methemoglobinemia [80, 81,82]. Silver sulfadiazine is primarily indicated for the treatment of second and third-degree burns, where infection prevention is critical to improving outcomes and reducing the risk of sepsis[83]. It is applied topically to the affected area and is often used in conjunction with other wound care strategies, such as proper wound debridement and fluid management. The drug's ability to reduce microbial load on burn wounds helps accelerate the healing process and decreases the need for more invasive interventions [84]. Despite its widespread use, the clinical efficacy of AgSD has been a subject of debate. While studies suggest that AgSD plays a critical role in the prevention of burn wound infections, some studies have shown that its use can be associated with adverse effects, including delayed wound healing due to the formation of a pseudoscalar layer that impedes tissue regeneration [85]. Moreover, frequent dressing changes are required because the rapid release of silver ions can cause discomfort, especially in paediatric patients, where the potential for pain and anxiety is heightened [86]. One of the major challenges in using silver sulfadiazine is its potential for systemic absorption when applied to large burn areas, leading to silver accumulation in the body, which may cause argyria (a permanent bluish-gray discoloration of the skin) in rare cases [87]. Additionally, allergic reactions to sulfadiazine, particularly in patients with sulfa allergies, can complicate its use [88]. Furthermore, the propylene glycol component in AgSD can contribute to a hyperosmolar state when applied to burn wounds, which may exacerbate the patient's condition if not properly managed [89]. In some cases, the appearance of discoloured areas on burn wounds treated with AgSD can mimic the signs of severe infection, leading to potential misdiagnosis and delayed treatment. Although these discolorations typically resolve with continued treatment, they can sometimes complicate the clinical assessment of wound status [90]. In chronic wounds, bacteria often exist in biofilms, which are protective clusters of bacteria encased in a self-produced matrix that is resistant to conventional antimicrobial treatments. AgSD is effective against planktonic bacteria, but its efficacy in eradicating biofilm-associated infections, such as those caused by Pseudomonas aeruginosa, remains an area of concern [91]. Newer studies suggest that silver nanoparticles and nanosuspensions of silver sulfadiazine may offer improved penetration and biofilm disruption, enhancing the agent's antimicrobial activity in chronic wounds [92]. Recent studies have explored the combination of silver sulfadiazine with other natural agents, such as honey, to optimize wound healing outcomes. Honey has been shown to possess antimicrobial, anti-inflammatory, and wound-healing properties, which complement the effects of silver sulfadiazine [93]. The chemical debridement provided by honey, along with its ability to create a viscous barrier that prevents microbial invasion, has made it a promising adjunct to AgSD in burn and wound care [94]. This combination therapy could provide a more holistic approach to burn care, potentially reducing infection rates and promoting faster tissue regeneration. While silver sulfadiazine is

generally considered safe for use in burn wound care, there are concerns regarding its toxicity [95]. In animal studies, AgSD nanosuspensions have shown a median lethal dose (LD50) indicative of potential acute toxicity. Therefore, careful monitoring of patients, especially those with extensive burns, is recommended to avoid systemic silver accumulation and to minimize the risk of adverse effects [96]. Silver sulfadiazine remains a cornerstone in the management of burn wounds and infected skin lesions due to its broad-spectrum antimicrobial activity, ease of use, and cost-effectiveness. However, its clinical application is not without challenges. The formation of a pseudoscalar layer, the potential for systemic silver absorption, and the need for frequent dressing changes are notable limitations [97]. Moreover, the emergence of bacterial biofilms in chronic wounds highlights the need for more advanced formulations of silver sulfadiazine, such as nanosuspensions, to improve efficacy. Despite these challenges, silver sulfadiazine continues to be a vital tool in the treatment of burn wounds, and ongoing research into combination therapies and novel formulations promises to enhance its clinical utility in the future [98].

2.5. Tegaderm

Tegaderm dressings have gained widespread recognition in the medical field due to their versatility, effectiveness, and ease of use. Manufactured by 3M, these transparent film dressings serve a variety of purposes, including wound protection, catheter site maintenance, and post-surgical dressing applications [99]. It is composed of a thin, flexible, and waterproof material that allows the skin to breathe while providing a protective barrier against contaminants, bacteria, and moisture. Surgical site infections are a common concern in vascular procedures, particularly for groin incisions [100]. Data from various medical facilities indicate a wide range of infection rates for groin wounds following open lower extremity revascularization, with reported rates varying between 4% and 31%. However, most studies suggest an incidence rate of 5% to 10% [101]. Groin incision infections pose significant risks in vascular surgery, especially due to the proximity of prosthetic grafts to the skin. The groin's location near the gastrointestinal and genitourinary systems further increases the likelihood of infection, particularly in critically ill and elderly patients [102]. Additionally, many patients struggle with dressing changes, which require semi-sterile conditions, daily replacements, and necessary medical supplies [103]. An optimal dressing for such patients should be cost-effective, require minimal changes, and be water-resistant. Previous studies documented that a combination of Tegaderm and Dermabond is used for wound dressing. This technique is unique in that Tegaderm is applied directly onto the patient's skin [104]. This method allows the dressing to remain intact for up to two weeks, as opposed to detaching after two days. The secure seal of the dressing makes it water-resistant, while its transparent nature facilitates continuous monitoring for drainage or signs of infection [105]. Another study reported the use of Tegaderm chlorhexidine gluconate securement dressings at central venous and arterial catheter insertion sites. These dressings enhance monitoring, provide antiseptic protection, and lower the incidence of catheter-related bloodstream infections and local site infections compared to standard semipermeable transparent dressings. Integrating this product into current care protocols is highly recommended [106]. For critically ill adults requiring central venous or arterial catheters in intensive or high-dependency care settings, the adoption of Tegaderm securement

dressings could generate significant cost savings for the National Health Service (NHS) in England, estimated between 4.2 million and 10.8 million annually [107]. Tegaderm Advanced dressings provide a waterproof adhesive solution for peripheral venous access. These dressings maintain adhesion for several days, and to date, no cases of contact eczema have been reported in association with their use. In cases where patients have transitioned from alternative adhesive systems to Tegaderm Advanced, the risk of contact eczema has been effectively eliminated. Since its initial use in April 2019, Tegaderm Advanced has been a successful alternative for preventing skin irritation in sensitive areas [108]. The exact formulation of Tegaderm I.V. advanced remains undisclosed, and the manufacturer has not provided information regarding its adhesive composition. However, it is suspected that acrylates may not be part of the formulation. The adhesive is well-tolerated, easy to apply and remove, and remains effective for over seven days without causing eczematous reactions [109].

Tegaderm transparent dressings serve multiple purposes, including covering and protecting catheter sites and wounds, maintaining a moist environment for wound healing, serving as a secondary dressing, providing a barrier over at-risk skin, and securing medical devices to the skin. They also facilitate autolytic debridement by maintaining a moist wound environment [110]. Tegaderm dressings have established themselves as a superior option in wound care due to their durability, transparency, and infection-prevention capabilities. They are particularly beneficial in hospital settings for securing catheters, protecting surgical sites, and promoting faster wound healing [111]. Despite minor limitations, their advantages outweigh potential drawbacks, making them a preferred choice among healthcare providers and patients alike. In addition, Tegaderm dressings are breathable and waterproof and act as a shield against bacteria, viruses, blood, and bodily fluids [112 , 113.]

2.6. Burnshield

Burnshield Hydrogel is a sterile, trauma-relieving gel formulated for the emergency treatment of burns, scalds, and sunburns. This hydrogel is impregnated into foam dressings and supplied in a foil pouch, ensuring ease of application. With its high-water content, Burnshield absorbs and dissipates heat, providing immediate cooling relief and minimizing skin damage [114]. The gel appears white to off-white initially but turns transparent upon application, allowing for continuous wound monitoring. It is non-stick and will not adhere to the wound, ensuring pain-free removal [115]. Additionally, Burnshield is non-toxic, non-irritant, and safe for use on children. Designed for versatility, Burnshield dressings can be used to treat burns on the hands, feet, and face, and circumferential injuries [116]. As a sterile hydrogel, Burnshield provides a protective barrier against infection and minor trauma. It is suitable for all types of burns, including first, second, and third-degree burns, particularly in the critical early stages when burn severity can rapidly progress. The hydrogel is most effective when applied within the first 24 hours of a burn injury [117].

Burnshield Hydrogel is a fast-acting burn treatment designed to quickly absorb and dissipate heat, effectively stopping the burning process while minimizing skin damage and reducing the risk of shock [118]. Its transparent, non-adherent formulation allows for easy wound assessment without sticking to injured skin. The hydrogel is enriched with natural tea tree oil, providing a

soothing, non-toxic cooling effect for minor burns, scalds, and sunburns [119]. With a high water content, it rapidly cools the affected area, limits tissue damage, and helps prevent infection. Additionally, Burnshield Hydrogel rehydrates dressings and can be easily applied to hard-to-reach areas, offering immediate pain relief [120]. Packaged in sterile, single-use sachets, it is a convenient first-aid solution ideal for emergency use, particularly for children and individuals with sensitive skin. Its non-stick, water-resistant formulation ensures easy application while maintaining a protective barrier against further damage and infection [121]. The hydrogel-infused dressings provide antiseptic benefits, minimizing the potential for long-term skin damage when applied promptly. Widely trusted by emergency responders for over two decades, Burnshield is also a staple in home first-aid kits. Prompt burn treatment is essential in preventing deeper tissue damage and complications, making Burnshield a reliable choice for comprehensive burn care [122]. Its advanced formulation, consisting of water, polymers, and cooling agents, effectively lowers burn temperature, prevents further injury, and creates a barrier against dehydration and infection. Frequently used alongside other burn treatments, Burnshield Hydrogel enhances the healing process and optimizes recovery for minor burns, sunburns, and thermal injuries [123].

2.7. Multisorb

Multisorb Swabs are crafted from a viscose/polyester blend, offering a soft-textured, non-woven structure that minimizes linting and reduces the risk of wound contamination. Unlike traditional gauze, these swabs maintain a low-lint profile, ensuring a safer wound care experience [124]. Multisorb Non-Woven Swabs offer an optimal balance of softness, absorbency, and low-linting properties, making them a superior alternative to traditional gauze. Their ability to absorb 40-65% more fluid than conventional options ensures effective exudate management, contributing to a cleaner and safer wound healing process [125]**.** Their superior absorbency helps maintain a clean, dry wound environment, reducing the risk of infection and promoting faster healing. It offers multiple medical properties, including

Wound Cleansing – Gently cleanses wounds while being soft on surrounding tissue.

a) Skin Protection – Acts as a protective barrier against external contaminants.
b) Secondary Dressing – Enhances wound coverage and protection [126].

Multisorb Swabs are available in both sterile and non-sterile packaging, catering to various medical and healthcare needs, including wound dressing, skin protection, and secondary dressing support. Their exceptional absorbency, combined with a lightweight and conformable structure, makes them an ideal choice for post-surgical wounds, ulcers, burns, and abrasions, ensuring faster healing and reduced infection risk [127].

2.8. Polyskin

Polyskin Transparent Dressings are advanced wound care solutions designed to provide a protective barrier while ensuring breathability for optimal healing. It is made from a thin polymer film coated with a hypoallergenic adhesive, These dressings are ideal for IV sites, donor sites, burns, ulcers, and sutures [128]. Their transparent, semi-permeable design allows for

oxygen and moisture vapor transmission, maintaining a balanced healing environment while preventing the entry of water, bacteria, and other contaminants [129]. Featuring a patented two-tab delivery system, Polyskin dressings enable one-handed aseptic application, making them easy to use in both clinical and home settings [130]. The acrylic adhesive ensures strong adhesion in both wet and dry conditions, reducing the need for frequent dressing changes [131]. Additionally, rounded edges help prevent roll-up, further extending the wear time, which ranges from 2 to 7 days [132]. With enhanced wet adhesion properties, these dressings provide secure attachment in moist environments, making them particularly effective for wounds with exudate [133]. Their breathable yet impermeable structure acts as an effective barrier against bacteria and fluid contaminants, ensuring wound protection while promoting healing [134]. Polyskin Transparent Dressings offer a simple, effective delivery system, providing ease of application, long wear time, and superior wound protection, making them an excellent choice for wound management in various medical applications [135 ,136.]

2.9. BioClusive Transparent Dressing

BioClusive Transparent Film Dressing is designed to facilitate the exchange of oxygen and moisture vapor while safeguarding minor wounds, cuts, and other injuries. This dressing acts as a protective barrier against bacteria and viruses that are 27 nm or larger, reducing the risk of contamination and infection [137, 138]. It is made from a thin, transparent polyurethane film and coated with a hypoallergenic acrylic adhesive. BioClusive dressings offer flexibility, comfort, and ease of application, making them suitable for both primary and secondary wound care [139], [140]. The waterproof nature of the dressing allows patients to shower without removing the dressing, while its semi-permeable design maintains a moist wound environment that promotes healing [141]. The dressing's rounded edges help prevent roll-up, ensuring it stays securely in place for extended wear [142]. It is available in various sizes, such as 10 cm x 12 cm, 15 cm x 20 cm, and 20 cm x 30 cm, providing options for different wound care needs [143]. BioClusive is particularly effective for wounds with low to no exudate, such as minor burns, donor sites, superficial pressure areas, leg ulcers, post-operative wounds, cuts, and abrasions [144, 145]. It is also widely used for securing catheters and other access devices, offering a reliable, breathable, and bacteria-resistant solution [146]. Featuring an easy stretch removal mechanism, BioClusive minimizes skin irritation and can be repositioned if it accidentally sticks to itself during application. Its three-tab delivery system provides enhanced control, making it user-friendly and simple to apply [147], [148]. The dressing's transparency enables continuous monitoring of the wound without the need for frequent removal, reducing disruption to the healing process [149]. BioClusive Plus, a variant of the dressing, is tailored for non-exuding or lightly exuding wounds, offering exceptional adhesion even in moist environments. It is commonly used for catheter fixation, reducing shear and friction forces, and serving as a secondary dressing [150], [151]. Its biocompatible, hypoallergenic adhesive minimizes the risk of allergic reactions, making it suitable for a wide range of patients [152]. With its combination of flexibility, durability, waterproof protection, and bacterial resistance, the BioClusive Transparent Film Dressing is a versatile and essential solution for effective wound management in both clinical and home care settings [153, 154].

2.10. Purilon® Gel

Purilon Gel is a mild, sterile hydrogel formulated from natural ingredients without additives, making it a safe and effective solution for wound debridement. It is designed for necrotic and sloughy wounds, including leg ulcers, pressure ulcers, non-infected diabetic foot ulcers, and first- and second-degree burns. it plays a crucial role in moisturizing necrotic tissue while simultaneously absorbing excess exudate, slough, and debris. This dual-action property helps create an optimal healing environment and supports autolytic debridement [155]. With its thick, cohesive consistency, Purilon Gel remains in place, preventing leakage and maceration, even after absorbing wound debris. The accordion-style applicator ensures a controlled, sterile, and simple one-handed application, making the dressing process more efficient. Additionally, its high viscosity and cohesive nature allow for easy removal without disrupting the wound bed, enabling gentle debridement throughout the healing process [156].

By providing superior hydration and absorptive properties, Purilon Gel facilitates the natural breakdown and removal of necrotic tissue, ultimately accelerating wound healing. Recommended for use on necrotic and sloughy wounds, including leg ulcers, pressure ulcers, non-infected diabetic foot ulcers, and burns, it should always be used in combination with a secondary dressing for optimal results [157]. Formulated with purified water, sodium carboxymethylcellulose, and calcium alginate, Purilon Gel ensures an ideal balance of hydration and absorption, promoting a moist wound environment that supports faster and more effective healing. Its sterile, natural composition makes it suitable for long-term use without causing irritation or complications [158]. With gentle yet powerful debriding action, easy application, and high efficacy, Purilon Gel is a trusted choice for effective wound management in both clinical and home care settings [159].

2.11. Opsite

Opsite, developed by Smith & Nephew, is a widely used brand of hydrocolloid dressings designed to protect and promote healing in minor wounds, cuts, burns, abrasions, and donor sites from split-thickness skin grafts. These dressings maintain a moist environment, accelerating epithelialization while reducing the risk of infection [160]. Traditionally, paraffin gauze dressings were used for donor sites, but semipermeable self-adhesive dressings like Opsite have gained popularity due to their ability to minimize discomfort and enhance the healing process. Despite these claims, no double-blind studies have been conducted to evaluate their effectiveness [161]. Opsite is a thin, transparent, elastic polyurethane film with an adhesive coating that permits the passage of oxygen, water vapor, and carbon dioxide while preventing bacterial contamination and liquid ingress [162]. It has proven beneficial for partial-thickness burns and donor sites, as clinical and experimental studies suggest that maintaining a moist wound environment significantly improves healing. A prospective trial was conducted to compare the effectiveness of Opsite with the standard Jelonet dressing for outpatient burns, further supporting its advantages in wound management [163]. Several specialized variants of Opsite cater to different wound care needs. Opsite Flexigrid incorporates a flexible backing for easier application and includes a wound measurement tool, making it particularly useful for pressure sores, abrasions, lacerations, skin grafts, donor sites, burns, and scalds [164]. Another

version, Opsite Plus, initially introduced as Post Opsite, features a low-adherent contact layer combined with a semipermeable film, minimizing skin irritation while ensuring optimal conformability, particularly for difficult-to-dress areas. The adhesive is latex-free, reducing the risk of allergic reactions [165]. Opsite dressings offer multiple benefits, including moisture vapor permeability, which prevents skin maceration by allowing excess exudate to evaporate [166]. The highly conformable film enables extended wear for up to seven days, reducing the frequency of dressing changes and minimizing nursing workload [167]. Additionally, its waterproof and bacteria-resistant properties allow patients to bathe without compromising the dressing's integrity [168]. The transparent material facilitates wound monitoring without the need for removal, and a printed grid on the film assists in precise trimming [169]. Other variations, such as Opsite Visible, feature a transparent film with a see-through absorbent pad, making it ideal for moderately exuding wounds, including surgical incisions, lacerations, and abrasions [170]. Opsite also offers a transparent, skin-safe medical tape designed to secure non-adhesive bandages or gauze in place [171]. Overall, Opsite has set a high standard in wound care by providing optimal healing conditions while reducing patient discomfort and healthcare workload [172, 173].

2.12. Nu-Gel Hydrogel with Alginate

Nu-Gel Hydrogel with Alginate is an advanced wound care product designed to create a moist wound-healing environment, facilitating natural autolytic debridement. By donating moisture to the wound bed, it supports rehydration while the alginate component enhances absorption, effectively managing exudate [174]. This transparent, amorphous hydrogel contains sodium alginate, which gently and efficiently debrides necrotic tissue and fibrinous slough, supporting all stages of the healing process [175]. The hydrogel is particularly effective in softening and hydrating eschar, promoting the dissolution of scabs, and accelerating wound recovery. Its unique formulation ensures prolonged wear time, improving patient comfort and optimizing the healing process [176]. Designed for easy application, Nu-Gel's ampoule and concertina packaging allow precise, one-handed usage, reducing product wastage and enhancing usability in clinical settings [177]. Indicated for chronic wounds, Nu-Gel is widely used for debridement, desloughing, and rehydration. The combination of its hydroactive gel and sodium alginate ensures an optimal balance between hydration and absorption, making it effective in managing granulating and epithelializing wounds [178, 179]. Clinical studies have demonstrated its superior performance in comparison to other hydrogel products, highlighting its ability to maintain an ideal wound environment for enhanced healing [180, 181]. As an innovative wound care solution, Nu-Gel Hydrogel with Alginate provides a comprehensive approach to wound management by effectively rehydrating and softening scabs, loosening fibrinous deposits, and supporting the natural healing process. Its ability to regulate moisture and absorption makes it an essential dressing for a variety of wound types, ensuring optimal care throughout the healing stages [182, 183].

2.13. Curagel

Curagel Hydrogel Wound Dressings is a hydrogel wound dressing. Designed to protect the wound and provide a moist environment. Clear gel permits a visual inspection of the wound

without removing the dressing[184]**.** Viscosity concentration medical grade hydroxypropyl methylcellulose in 2.0ml pfs. Its high viscosity and elastic behavior give it unique rheological properties to maintain the anatomical spaces of the CuraGel. It is a truly high-viscosity solution containing a new formula of 2.0% or 2.4% Plus High anterior segment during ophthalmic procedure [185]**.** To achieve the maximum zero shear rate viscosity while permitting unhindered manipulation during surgery, the viscosity of this product has been modified. CuraGel comes in 2.0% and 2.4% Plus. Blister and double-pouch packaging with high viscosity [186]**.**

2.14. XCell Hydrogel

XCell Hydrogel is a type of advanced wound care product that is primarily used for managing moderate to heavily exudating wounds. It is often utilized in the treatment of chronic and acute wounds, including diabetic ulcers, pressure ulcers, venous leg ulcers, and surgical wounds [187.] XCell Hydrogel is designed to provide a moist wound environment, which is crucial for promoting faster healing and reducing pain [188]. It consists of a complex moisturizing mixture of natural ingredients, which includes hyaluronic acid, trehalose (a moisture-retentive agent), and phytoceramide. This complex provides a feeling of immediate moisturization and retains moisture for long-lasting effects [189]**.** Its hydrogel technology helps the skin absorb the active ingredients of the dressing more effectively and gives an immediate cooling sensation to the wound [190].

2.15. Silver Alginate Fiber Gel (SAF- Gel)

Silver Alginate Fiber Gel (SAF- Gel) is a topical wound care product that combines silver and alginate (a natural absorbent material derived from seaweed) for enhanced wound healing and infection control. SAF Gel is a versatile option for wounds that need both antimicrobial protection and the ability to absorb significant amounts of exudate [191]. It is typically used in treating moderate to heavily exudating wounds, including chronic wounds like diabetic foot ulcers, venous leg ulcers, and pressure sores, and acute wounds such as surgical wounds, burns, and trauma wounds [192].

2.16. PermaFoam

PermaFoam is a single-use, non-medicated, sterile, polyurethane foam-based dressing. The polyurethane top layer is permeable to water vapour and possesses the unique hydrophilic pore structure that facilitates high capillary effect, making quick transportation of wound exudate and maintaining a sterile and balanced moist wound environment [193, 194].This promotes granulation tissue growth and permits autolytic debridement [195]. PermaFoam's capillary structure reduces the chance of maceration at the borders of the incision [196]. Polyacrylate glue was incorporated to provide an adhesive nature to the dressing [197]. It is marketed in various shapes and sizes. It is recommended for moderate to highly exudating chronic as well as acute wounds like diabetic foot ulcers, incisions, leg ulcers, donor sites, pressure ulcers grade II to IV, and abrasions [198]. The PermaFoam Concave wound dressing is designed to treat the heel and elbow. It is easy to apply, has a hypoallergenic adhesive film around the edges, and offers safe adhesion [199].

2.17. Duoderm

The hydrocolloid, moisture-retentive Duoderm dressing is applied to both partial and full-thickness wounds that produce exudate. It differs from other marketed regular hydrocolloid dressings due to its special Convatec hydrocolloid formulation [200]. Duoderm Dressing is recommended for leg ulcers, pressure ulcers, traumatic injuries, acute wounds donor sites, and burns with partial thickness [201]. Smaller superficial and profound partial-thickness burns can be successfully treated with Duoderm hydrocolloid dressing [202]**.** Duoderm dressings are available in two categories: (i) DuoDerm Extra Thin dressing and DuoDerm Signal dressing [203]. The Duoderm Dressings have an ultra-thin design, which allows them to conform closely to the contours of the body, providing a discreet and comfortable fit. This makes it ideal for use on visible areas such as the face and hands, where both appearance and flexibility are paramount [204]. The thin profile of the dressing ensures that it adheres well without causing discomfort or restricting movement, making it suitable for active individuals and areas prone to friction [205]. Duoderm Extra Thin is a hydrocolloid dressing that is recommended for wounds that exude very little fluid. The gel-forming substances gelatin and carboxymethyl cellulose form the inner hydrocolloidal layer, which absorbs the watery exudate released by the wound to aid wound healing. The outer waterproof layer of Duoderm hydrocolloid dressing is made of polyurethane foam or film. This outer layer protects the wound from bacteria, dirt, and other objects. Because these dressings can be kept in place for up to a week, they usually don't need to be changed as frequently as other dressings unless they're saturated, filthy, or smell bad [206]. As it is waterproof, bathing and washing can be done after this type of dressing**.** The dressing removal is usually painless because it doesn't stick to the wound [207].

2.18. Comfeel

Comfeel Plus is a transparent hydrocolloid dressing used in the management of low to moderately exudating wounds, such as superficial burns, leg ulcers, donor sites, skin abrasions, pressure ulcers, superficial partial-thickness burns, and surgical wounds [208, 209]. Comfeel Plus is a semi-permeable hydrocolloid dressing that contains calcium alginate to improve its ability to absorb low to moderate exudate levels. The top outer layer is made of semi-permeable polyurethane. It can serve as both a primary and secondary dressing [210]. The hydro-colloidal layer comprises alginates, and the outermost layer comprises polyurethane and polyethylene, which help protect the wound from microbial contamination [211].

2.19. Allevyn

Allenyn is an antimicrobial hydrocellular foam-based highly absorbent and non-adhesive dressing comprising of waterproof and breathable polyurethane film [212, 213]. The dressing resists water and bacteria and is recommended for wounds with moderate to heavy exudation. The dressing is appropriate for use on delicate and sensitive skin, including epidermolysis bullosa wounds, if the contact layer is non-adherent [214]. The hydro-cellular structure makes it possible for the wound to be moist and won't adhere to the surface of the wound [215]. The vapour permeable film helps in reducing the maceration of wound and peri-wound. It can be applied

to wounds of any body part at an uncomfortable location. This foam can be applied with the help of a specific heel cup dressing, which is simple to apply and remove [216]. The advantage of this dressing is that it can be used for a variety of acute and chronic wounds, including those that are challenging to wrap. Allenyn is available in different sizes and shapes and can be cut down in different shapes to fit various body shapes or wound shapes. Allevyn Ag dressings are intended to control exudate in chronic wounds that are susceptible to infection, showing indications of a local infection, or when healing is being slowed down by a probable rise in bacterial colonisation. It consists of an absorbent hydrocellular foam layer that contains silver sulfadiazine, a perforated wound contact layer, and a highly breathable top film [217].

2.20. Tegasorb

Tegaderm is a brand name for a type of medical adhesive film dressing that is used to cover and protect wounds, surgical sites, or skin that needs to stay clean and dry. Leg ulcers and donor sites are only two examples of the wounds that can be treated using 3M Healthcare's Tegasorb, a soft and highly absorbent advanced hydrocolloid dressing [218]. Tegaderm hydrocolloid dressings aid in wound care by two ways: (i) the hydrocolloid adhesive's inner layer absorbs exudate quickly, giving it a far higher absorbency over the first 48 hours than the top competing dressing [219]. (ii) the permeable outer film layer not only has outstanding absorbency but also continuously maintains a high rate of moisture vapour transmission. When combined, these characteristics offer a cost-effective use period of up to seven days, minimize the possibility of harming healthy peri-wound skin, and guarantee the ideal moist wound environment [220]. This cutting-edge hydrocolloid composition is recommended for burn wounds, surgical wounds, pressure ulcers, and partial and full-thickness wounds, including pressure sores and chronic leg ulcers with moderate to heavy discharge and exudate [221]. As the dressing's polysaccharide particles swell, they absorb exudate and form a soft gel. The hydrocolloid is covered with a layer of Tegaderm film dressing that extends to the edge of the dressing to protect the wound from contagious infections. This also allows full usage of dressing up to one week and prevents edge rolling or exudate leakage from the wound, thus improving the exudate quality management. Tegasorb dressing is available in various shapes, such as oval, square, and sacral-shaped dressings. Square dressings can be sculpted or trimmed to fit specific wound areas [222]. According to *in vitro* experiments, the dressing won't accelerate bacterial growth when serum is present [223]**.** Tegasorb usage is not advised for wounds deeper than 1.5 cm or undermining more than 1 cm to 1.5 cm [224]. Additionally, full-thickness burns, wounds with exposed muscle, bone, or tendon, or wounds with eschar covering more than 50% of the wound should not be dressed with this dressing [225]. From black necrotic tissue to the epithelializing wound, it can be used at any stage of wound healing and promotes a moist environment for wound healing [226]**. Table 1.** depicted different types of dressings (marketed formulations) available commercially for wound management.

Conclusion

At present, there are thousands of surgical wound dressings available in the market. This results in significant confusion for the treating physician in selecting the appropriate dressing material

for wound care. No dressing product is inherently better than another. The selection of the right dressing material should depend on the specific type of wound. The cost of the dressing should be considered, and local innovations ought to be promoted to make the use of dressing materials more affordable and readily available.

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Conflict of interest

The authors declare that there is no conflict of interest.

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Figure Legend

Figure 1: Various commercial marketed wound dressings [20]

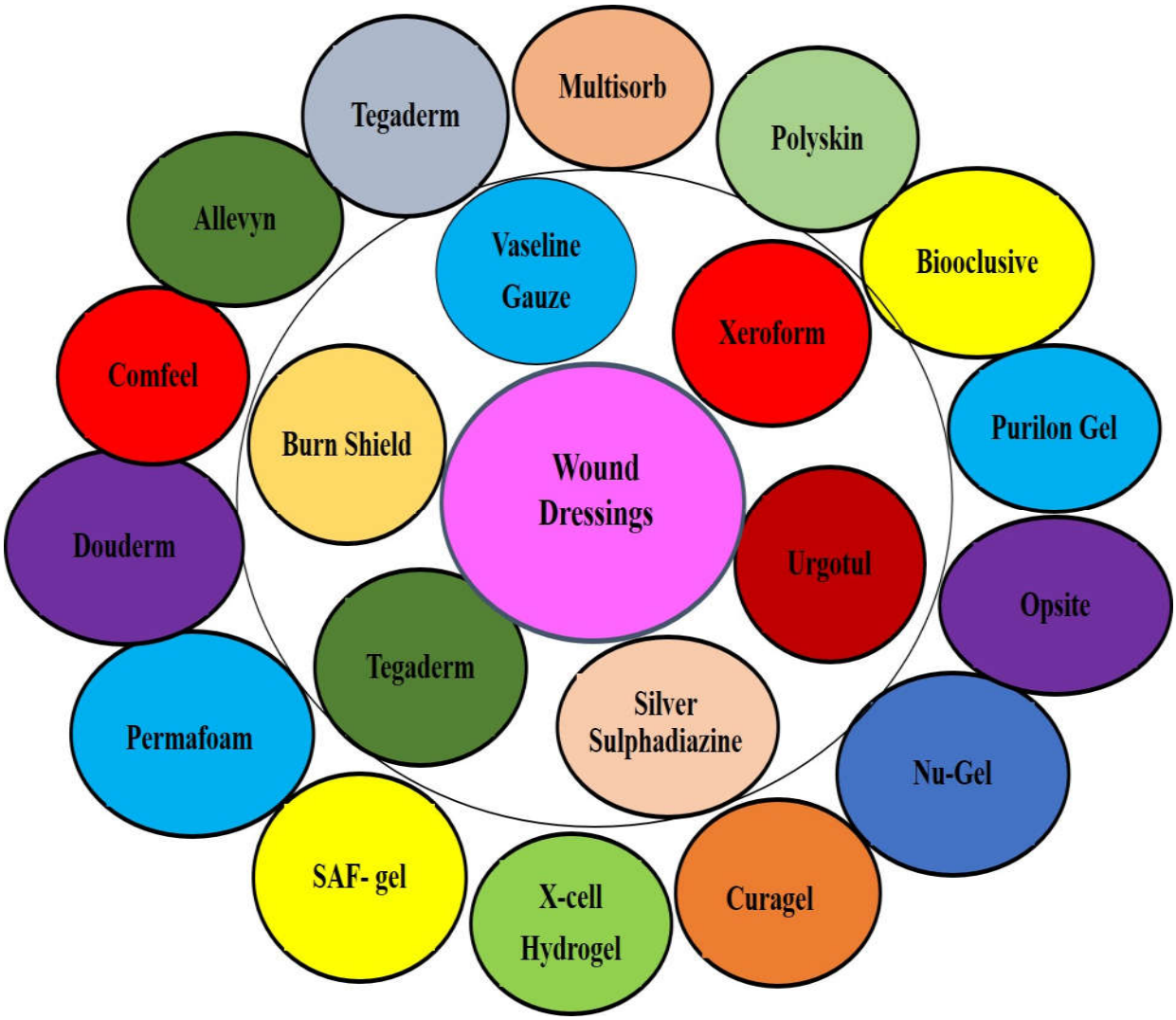
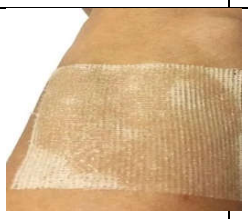
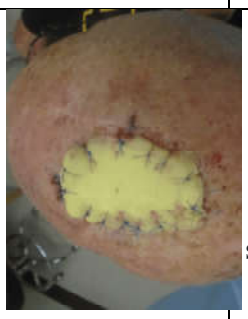
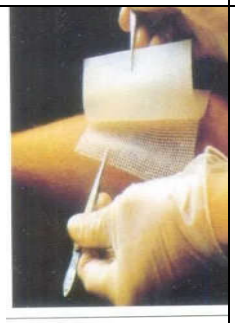
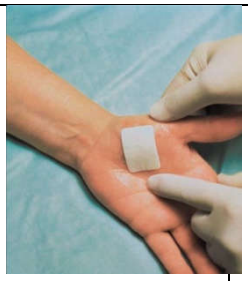
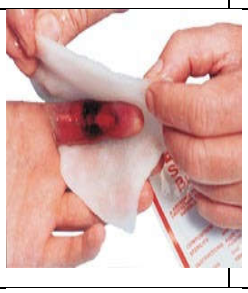
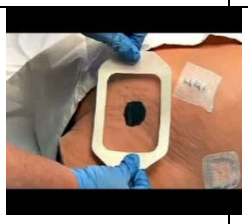
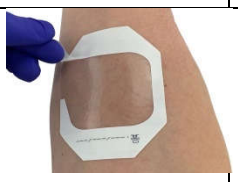
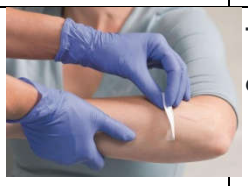
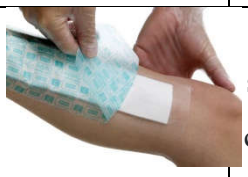
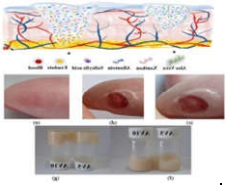
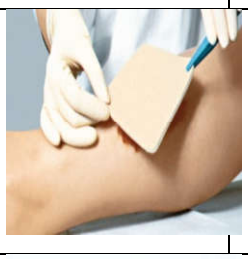
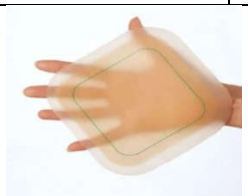


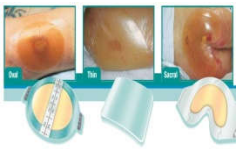
Table Legend

Table 1: Different types of dressings (marketed formulations) available commercially for wound management.

S. No.	Commercial Products	Images	Advantages	Disadvantages	Type of dressing	Ref.
i.	**Vaseline Gauze**		-Ease in application	-Easily dry and disrupt the wound	Passive	[227]
ii.	**Xeroform**		-Helps reduce the risk of wound infection and promotes a more sterile environment for healing	-Can damage granulation tissue on removal	Passive	[228]
iii.	**Urgotul**		-Faster healing time	-Poor water retention ability	Passive	[229]
iv.	**Silver Sulfadiazine**		-Inexpensive	-Lack of mechanical strength	Passive	[230]

v.	**Tegaderm**		-Prevent skin breakdown	-Mechanical trauma.	Interactive	231
vi.	**Burn Shield**		-Useful for highly exudate wounds	-Needs a secondary dressing due to its poor mechanical properties	Advanced Interactive	232
vii.	**Multisorb**		-Ease of application	-Not useful for highly exudate wounds	Passive	233
viii.	**Polyskin**		-Flexibility in nature	-Hard to remove and sometimes disturbs the epidermal layer	Interactive	234
ix.	**Biooclusive**		-Used as a secondary dressing cover for hydrogels and foams	-Excess exudate accumulation due to its non-absorbent property	Interactive	235
x.	**Purilon Gel**		-Recommended for dry wounds as they provide moist surroundings	-Not suitable for dry wounds	Advanced Interactive	236
xi.	**Opsite**		-Used as a secondary dressing cover for hydrogels and foams	-Hard to remove sometimes cause it disturbs the epidermal layer	Interactive	237

xii.	**Nu- Gel**		-Absorbs high-wound moisture	-Nonadherent in nature causes skin maceration and overhydration	Advanced Interactive	238
xiii.	**Curagel**		-Maintain high wound moisture	-poor adhesional properties	Advanced Interactive	239
xiv.	**X-cell hydrogel**		-Flexible, biocompatible, and chemically inert	-Not suitable for wet wounds	Advanced Interactive	240
xv.	**SAF- Gel**		-Helps to moisturize the skin and lightens	-Poor mechanical properties	Advanced Interactive	241
xvi.	**Perm foam**		-Highly absorbent	-Stick to wound when exudates dry	Interactive	242
xvii.	**Douderm**		-waterproof	- Highly thick	Advanced Interactive	243
xviii.	**Comfeel**		-Activate autolytic debridement	- Adhere to the wound	Advanced Interactive	244

xix.	**Allevyn**		-Highly absorbent	-Needs secondary dressings	Interactive	245
xx.	**Tegasorb**		-Activate autolytic debridement	-Adhere to the wound	Advanced Interactive	246