NEW ideas on controlling the pharmacokinetics, pharmacodynamics, non-specific toxicity, immunogenicity, biorecognition and efficiency of drugs have generated new strategies, often called as the drug delivery system. Evolution of an existing drug molecule from a conventional form to a novel delivery system can significantly improve its performance in terms of patient compliance, safety, and efficacy. Over the past several years, great advances have been made on development of novel drug delivery systems (NDDS) from synthetic and natural bioactives such as polymeric nanoparticles, nanocapsules, liposomes, phytosomes, nanoemulsions, microsphere, transferosomes, and ethosomes have been reported. The variety of dressings based on types of wounds and novel polymers used for the delivery of drugs to acute and chronic wound has resulted in a wide range of new products frequently introduced to target different aspects of the wound healing process. These include hydrocolloids, alginates, hydrogels, polyurethane, collagen, chitosan, pectin, and hyaluronic acid. Nevertheless, nanofibers with their physical and chemical properties and nanotopography display improvements in the fields of tissue engineering, wound therapy and drug delivery systems. At present, there is so many existing drug delivery technologies that a total compilation is not within the scope of this article. Yet an attempt is being made to compile some of the most successfully marketed drug delivery technologies. This review extends the information and hopes to give insight into past, present and future strategies and approaches for wound healing managements.

**Keywords:** Drug delivery systems, Novel drug delivery, Wound, Wound healing management.

**INTRODUCTION**

Novel drug delivery system is largely based on promoting the therapeutic effects of a drug and minimizing its toxic effects by increasing the amount and persistence of a drug in the vicinity of the target cell and reducing the drug exposure of non-target cells [1]. Novel formulations are reported to have remarkable advantages over conventional which include enhancement of solubility, bioavailability, protection from toxicity, enhancement of pharmacological activity, enhancement of stability, improved tissue macrophages distribution, sustained delivery, and protection from physical and chemical degradation. Development of novel drug delivery systems (NDDS) from synthetic and natural bioactives such as polymeric nanoparticles, nanocapsules, liposomes, phytosomes, nanoemulsions, microsphere, transferosomes, and ethosomes has been reported. Nanoparticles and nanof ormulations have already been applied as drug delivery systems with great success; and nanoparticulate drug delivery systems have still greater potential for many applications [2].

The skin is a complex organ with three distinct histological layers: the epidermis, the dermis, and the hypodermis. Wound healing of healthy skin is an immediate restorative response to injury [3], and the process is dependent on uninfective and multifunctional stem cells that reside in the basal layer of the epidermis, the hair follicle bulge, the sebaceous glands at the base of the hair follicle, the dermal papillae, and the dermis [4-6]. According to the Wound Healing Society, a wound is the result of ‘disruption of normal anatomic structure and function’ [7]. Wound healing progresses through a series of interdependent and overlapping stages in which a variety of cellular and matrix components act together to reestablish the integrity of damaged tissue and replacement of lost tissue [8, 9]. The wound healing process has been reviewed and described by Schultz [10] as comprising five overlapping stages that involve complex biochemical and cellular processes. These are described as haemostasis, inflammation, migration, proliferation and maturation phases. In fact, Cooper [11] has argued for expanding the understanding of wounds beyond the cellular level to a molecular context as well. He emphasized the need to approach wound healing at multiple levels (cellular and molecular) to help improve wound treatment and management. In the developed countries, many sophisticated dressings are available to the wound care practitioners which are made from a wide range of materials including polyurethane, salts of alginic acid and other gel able polysaccharides such as starch and carboxymethylcelulose. These materials are combined to form products as diverse as films, foams, fibrous products, beads, hydrogels and hydrocolloid dressings [12] (table 1). The situation is totally different in the developing countries like ours where what is still commonly available to wound care provider are traditional agents such as sodium hypochlorite, hydrogen peroxide, cetrimide solution, chlorhexidine and others. These agents have been proven to be of limited efficacy and may also have an adverse effect upon the healing process [13] and therefore get out of favour [14]. Wound management methods depend on the healing process, the status and living environment of the patient, and the physical/chemical properties of the wound. Therefore, there is much attention given to the study of the physical characteristics and clinical role of available dressings with respect to each wound treatment phase and wound type [15, 16]. Wound related factors takes priority when considering choice of dressing for a particular wound. Therefore, we should always ask ourselves what type of wound are we dealing with? Is it a superficial, full thickness or cavity wound? Is the wound necrotic, sloughy, and granulating or epithelising? What about its characteristics, is it dry, moist, heavily exuding, malodorous, excessively painful or liable to bleed? What about the bacterial profile, is it sterile, colonized or infected? For example, a superficial, granulating or epithelising wound with minimal exudate should not be dressed with agents like hypochlorite solution or hydrogen peroxide. Rather, such wound may be dressed with sofra-tulle soaked with saline soaked gauze or even dry gauze. In clinical practice, when considering dressings for an acute wound, the emphasis should be on prevention of infection and promotion of healing [17] whereas in chronic wound-healing, the control of wound infection is more important [18]. The aim of this study is to re-appraise the problem of limitation of wound dressing selection in the developing countries. We are still hoping to acquire newer agents for wound dressing in the developing countries, we have
made an effort to discuss some characteristics needed to make us choose wisely from the limited variety of dressing materials to meet the needs of our wounds for efficient wound care. This is with the aim of sensitizing the wound care practitioner on the use of the commonly little available products based on the needs of a different wound or even the same wound throughout its healing course.

**Wound healing managements**

Effective wound management depends on understanding a number of different factors such as the type of wound being treated, the healing process, patient conditions in terms of health (e.g. diabetes), environment and social setting, and the physical chemical properties of the available dressings [19]. It is important therefore, that different dressings be evaluated and tested in terms of their physical properties and clinical performance for a given type of wound and the stage of wound healing, before being considered for routine use.

Several factors apart from the choice of wound dressings need to be considered to ensure successful wound healing. In the case of chronic wounds, underlying factors such as disease, drug therapy and patient circumstance must all be reviewed and addressed before a particular wound dressing is applied. Table 1 [20] describes factors to be considered in the choice of wound dressings based on their performance characteristics (functions) [21-23]. In the past, traditional dressings (table 2) such as natural or synthetic bandages, cotton wool, lint and gauzes all with varying degrees of absorbency were used for the management of wounds. Their primary function was to keep the wound dry by allowing evaporation of wound exudates and preventing entry of harmful bacteria into the wound. Modern dressings are based on the concept of creating an optimum environment to allow epithelial cells to move unimpeded, for the treatment of wounds. Such optimum conditions include a moist environment around the wound, effective oxygen circulation to aid regenerating cells and tissues, and a low bacterial load. Other factors which have contributed to the wide range of wound dressings include the different type of wound (e.g. acute, chronic, exuding and dry wounds, etc.) and the fact that no single dressing is suitable for the management of all wounds. In addition, the wound healing process has several different phases that cannot be targeted by any particular dressing.

The use of topical pharmaceutical agents in the form of solutions, creams, ointments and incorporated drugs i.e. active compounds and the dressings (novel polymer systems) play an active role in the wound healing process either directly or indirectly as cleansing or debridging agents for removing necrotic tissue, antimicrobials which prevent or treat infection or growth agents (factors) to aid tissue regeneration and also possess antiseptic and antibacterial actions. Some dressings such as gauze and saline are useful for the initial stages of wound healing for absorbing blood and exudates, cleansing and debridement. Other dressings provide a moist environment during the latter stages of wound healing, whilst some medicated dressings and biomaterials can take active part in all the stages of wound healing. In most cases, a combination of dressings is needed in order to achieve complete wound healing in a reasonable time. Wound healing formulations (dressings) and novel technologies developed to date focus on one or more of these aspects of the natural healing process [24] that are summarized briefly in table 3.

Most modern dressings are made from polymers which can serve as vehicles for the release and delivery of drugs to wound sites. The polymeric dressings employed for controlled drug delivery to wounds include hydrogels such as poly (lactide-co-glycolide) [25] poly (vinyl pyrrolidone) [26], poly (vinyl alcohol) [23] and poly (hydroxyalkylmethacrylates) [27-39] polyurethane-foam [40-44], hydrocolloid [45] and alginate dressings [46-49]. Other polymeric dressings reported for drug delivery to wounds comprise novel formulations prepared from polymeric biomaterials such as hyaluronic acid [50, 51], collagen [52, 53] and chitosan [54-57]. Synthetic polymers employed as swellable dressings for controlled drug delivery include silicone gel sheets [58], lactic acid [59]. Some of these novel polymeric dressings for drug delivery exist as patents [60-65]. Composite dressings comprising both synthetic and naturally occurring polymers have also been reported for controlled drug delivery to wound sites [66, 67]. Sustained release tissue engineered polymeric scaffolds for controlled delivery of growth factors and genetic material to wound sites has also been reported [68, 69]. The modern dressings for drug delivery to wounds may be applied in the form of gels, films and foams whilst the novel polymeric dressings produced in the form of films and porous spun webs or as tissue engineered polymeric scaffolds [70, 78] (table 4) (fig. 1).

Bioengineered skin substitutes, both biosynthetic skin substitutes and cultured autologous engineered skin, are available to provide temporary or permanent coverage, with the advantages of availability in large quantities and negligible risk of infection or immunologic issues. With advances in burn resuscitation and critical care management, more patients with significant body surface area burns are surviving, leading to the issue of coverage of large wounds. Autograft is currently the preferred option, but in many instances there is an insufficient amount of tissue available for grafting; or the patient’s condition precludes the use of autograft. Allografts and xenografts can provide a temporary coverage option, but they come with issues regarding rejection, and possible disease transfer, availability, as well as cultural and ethical considerations. Biobrane is a temporary dressing composed of knitted nylon mesh bonded to a thin silicone membrane and coated with porcine polypeptides [79]. It is used in clean superficial and mild/middermal depth burns or as coverage for donor sites in split-thickness skin grafts. Trans Cyte is a biosynthetic dressing of a semi-permeable silicone membrane on a nylon mesh coated with porcine collagen and newborn human fibroblast cells [79]. It is used as a dressing in superficial burns that do not require skin grafting, or as a temporary covering for excised burns prior to grafting. Dermagraft contains neonatal fibroblasts on a bioabsorbable poly lactin mesh. The fibroblasts produce dermal collagen, glycosaminoglycans, growth factors, and fibronectin to support wound healing [80]. It is a temporary or permanent cover used for excised burn wounds as well as venous ulcers and pressure ulcers [79]. Results show it to be comparable to allograft for wound infection, healing time, exudates, and graft take, with higher patient satisfaction [81, 82]. Apligraf is composed of an epidermal layer of allogeneic neonatal keratinocytes and fibroblasts from neonatal foreskin on bilayered type I bovine collagen [79, 83] that is used as an adjunct covering to autograft, providing accelerated healing times [80]. It is also used alone in chronic wound ulcers, showing increased healing times when compared to controls [84]. Integra is a semiskin bilayered dressing composed of a matrix of type I bovine collagen, chondroitin-6-sulfate, a glycosaminoglycan from shark cartilage, under a temporary silicone epidermal sheet [79, 85]. The pore size (70–200 μm) is designed to allow migration of the patient’s own endothelial cells and fibroblasts. As the temporary sheet is removed and a thin autograft is grafted onto the neoepidermis to complete the wound coverage.

Recently, the method of delivering growth factors from outside the body using a drug delivery system is being researched for the treatment of chronic wounds [86]. Growth factors stimulate mainly fibroblasts and keratinocytes via transmembrane glycoproteins [87]. The development of modern wound dressings, which mimic exactly the missing matrix, is the most comprehensive approach for the treatment of non-healing wounds. For the aforementioned reasons, nanofibers can be used as efficient natural extracellular matrix (ECM) analogues. After the application onto the wound, cells will take the latter as if synthesized by themselves and consequently oriented chemotaxis, adhesion, differentiation and cell growth will be stimulated as well as the formation and deposition of a provisional matrix and re-epithelialization [88-90].

**Future strategies and approaches**

The goal of wound healing management need not always be a more rapid healing, but rather can also encompass a reduction in pain or improved wound quality for life. With the development of these strategies, including the complete healing, little pain when attaching and detaching the wound dressing, etc. there will no doubt be significant crossover in wound dressing that leads to better, safer, and more integrated original tissue. The primary wound treatment method has been changing from the dry method in the 1900s and the wet
As technology and engineering processes become increasingly sophisticated, it seems ideal to have composite dressings which combine the different characteristics of current technologies. This will aid in targeting the many aspects of the complex wound healing process, to ensure effective, complete wound healing and shorter treatment, and their indications are continually expanding to encompass aspects of wound management. By supporting the wound with growth factors and biologic substances, we can help augment or modulate the wound healing process itself. There may be many unexplored polymeric dressings to ensure optimal healing conditions for all wounds and, perhaps as the full effects of neovascularization are realized. Negative pressure wound devices are relatively new in wound care treatment, and their indications are continually expanding to encompass aspects of wound management. By supporting the wound with growth factors and biologic substances, we can help augment or modulate the wound healing process itself. There may be many unexplored polymeric dressings to ensure optimal healing conditions for all wounds and, perhaps as the full effects of neovascularization are realized.

More recently the hyperbaric oxygen therapy in diabetics with chronic foot ulcers (HODFU) study was completed [92, 93]. This suggests that in addition to immediate assistance in healing, hyperbaric oxygen also has a role in long-term wound improvement, perhaps as the full effects of neovascularization are realized.

Table 1: Desirable characteristics and clinical significance for wound healing

<table>
<thead>
<tr>
<th>Desirable characteristics</th>
<th>Clinical significance for wound healing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debridement (wound cleansing)</td>
<td>Ensures removal of necrotic tissue, foreign bodies and particles to prevent infection</td>
</tr>
<tr>
<td>Provide or maintain a moist wound environment</td>
<td>Provides a moist environment for reepithelialization of the wound, promoting healing</td>
</tr>
<tr>
<td>Absorption, Removal of blood and excess exudate</td>
<td>Prevents desiccation and cell death, enhances epidermal migration, promotes angiogenesis and connective tissue synthesis, and supports autolysis by rehydration of desiccated tissue</td>
</tr>
<tr>
<td>Gaseous exchange (water vapour and air)</td>
<td>Permeability to water vapour controls the management of exudate. Low tissue oxygen levels stimulate angiogenesis.</td>
</tr>
<tr>
<td>Prevent infection: Protect the wound from bacterial invasion</td>
<td>Infection prolongs the inflammatory phase and delays collagen synthesis, inhibits epidermal migration and induces additional tissue damage. Infected wounds can give an unpleasant odour.</td>
</tr>
<tr>
<td>Provision of thermal insulation</td>
<td>Normal tissue temperature improves the blood flow to the wound bed and enhances epidermal migration</td>
</tr>
<tr>
<td>Low adherence. Protects the wound from trauma</td>
<td>Adherent dressings may be painful and difficult to remove and cause further tissue damage</td>
</tr>
<tr>
<td>Cost effective low frequency of dressing change</td>
<td>Dressing comparisons based on treatment costs rather than unit or pack costs should be made (cost-benefit-ratio). Although many dressings are more expensive than traditional materials, the more rapid response to treatment may save considerably on total cost</td>
</tr>
</tbody>
</table>

Table 2: Traditional wound dressings in the world market

<table>
<thead>
<tr>
<th>Dressing material</th>
<th>Brand name</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paraffin gauze dressing containing 0.5% chlorhexidine</td>
<td>Bactigras</td>
<td>Smith &amp; Nephew</td>
</tr>
<tr>
<td>Paraffin gauze dressing</td>
<td>Jelonet</td>
<td>Smith &amp; Nephew</td>
</tr>
<tr>
<td>Petroleum gauze</td>
<td>Xeroform</td>
<td>Chesebrough-Pond's Inc.</td>
</tr>
<tr>
<td>Petroleum gauze containing 3% bismuth tribromophenate</td>
<td>Xeroform</td>
<td>Chesebrough-Pond's Inc.</td>
</tr>
<tr>
<td>Scarlet Red dressing</td>
<td>Scarlet Red</td>
<td>Chesebrough-Pond's Inc.</td>
</tr>
<tr>
<td>Sterile hydrogel dressing</td>
<td>2nd Skin®</td>
<td>Spenco</td>
</tr>
<tr>
<td>Highly absorbent cotton wool pad</td>
<td>Exi Dry Dressing</td>
<td>Smith &amp; Nephew</td>
</tr>
<tr>
<td>Highly absorbent rayon/cellulose blend sandwiched with a layer of antishear high density polyethylene</td>
<td>Telfa &quot;Ouchless&quot;</td>
<td>Kendall (Covidien)</td>
</tr>
<tr>
<td>Absorbent cotton pad</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Advances in wound healing managements

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Dressings</th>
<th>Managements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Protective dressings</td>
<td>Inexpensive; Traumatic removal, lateral bacterial migration.</td>
</tr>
<tr>
<td></td>
<td>Gauze</td>
<td>Readily available; Cheap; accessible; Efficacy to retain and absorb exudates varies; need to be changed regularly to prevent maceration.</td>
</tr>
<tr>
<td></td>
<td>Bandage</td>
<td>Nonadherent; Preserves moisture; May not prevent maceration.</td>
</tr>
<tr>
<td></td>
<td>Impregnated gauze</td>
<td>Nonadherent; Preserves moisture; May not prevent maceration.</td>
</tr>
</tbody>
</table>
Honey dressing  Antimicrobial, antifungal, deodorizing, anti-inflammatory, maintains moist environment; As a topical treatment, it rapidly dilutes and requires frequent dressings to maintain efficacy.

**Antimicrobial dressings**

Antibacterial ointments, Iodine based Absorbent; Antiseptic, only small amounts of free iodine released into wound site; not for use with thyroid; through cytotoxic action against fibroblasts, keratinocytes and leucocytes; only suitable for short-term use.

Silver based Antimicrobial action well established; broad spectrum; Possible systemic toxicity currently being investigated; Effectiveness varies between products.

**Autolytic debridement**

Films Oclusive; allows exchange of gases

Hydrocolloids Provides a moist, hypoxic wound environment; Not for exudative or infected wounds

Hydrogels Can provide moisture to dry wounds as well as absorb excess exudates depending; Atraumatic when used correctly; Facilitates autolysis of necrotic tissue, and does not support bacterial growth.

**Chemical debridement**

Papain/urea Availability issues in US

Collagenase Selective debridement

**Absorbent dressings**

Foams Can be cut to any shape, thermally insulating, provides moist interface, absorbs excess exudate, impregnable; Absorbs moderate exudates; Not suitable for dry wounds.

Hydrogels Rehydrates to soften dry wounds; Only suitable for low exuding wounds or dry wounds. Can cause maceration in heavily exuding wounds, can shift from dry to wet gangrene in exuding ischaemic ulcers; Absorbs minimal exudate

Hydrofibers Absorbs heavy exudate

Alginates Absorbs heavy exudates; They are unsuitable for dry wounds or dry hardened necrotic tissue.

**Soft Silicone**

Prevents maceration of the surrounding tissue, atraumatic removal with nonadherence to the wound site, suitable for wide range of wound types, can be used for difficult wound sites, can be left for up to 10 days, can be impregnated with silver. Used in conjunction with secondary absorbent dressing, requires contact with the wound site.

**Scaffolds**

Scaffold-natural material (AlloDerm)

Biocompatible, degradable, and is low in antigenicity; Collagen may enable the transmission of infectious agents and thus requires vigorous disinfection protocols

Scaffold-Synthetic material (Integra)

Variety of methods of construction, electrospun scaffolds stimulate cellular adhesion. Polylactides degrade to lactic acid ensuring limited host immune response. Localised production of lactic acid may affect the efficacy of some proteins in the local environment.


### Table 4: Novel drug delivery approaches for wound healing management

<table>
<thead>
<tr>
<th>No.</th>
<th>Company/Products</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Activa Healthcare</td>
<td>Absorbent Dressings</td>
</tr>
<tr>
<td></td>
<td>Molnlycke</td>
<td>These dressings are indicated for highly exuding wounds and/or as a secondary dressing. *QIPP TIP-Where possible use dressing pads before using super absorbent dressings.</td>
</tr>
<tr>
<td></td>
<td>Convatec Carboflex®</td>
<td>Activated Charcoal Dressings</td>
</tr>
<tr>
<td></td>
<td>Kaltostat® Rope</td>
<td>Indications for use include malodorous exuding wounds such as fungating and/or malignant wounds and also infected wounds. *QIPP TIP-Charcoal becomes rapidly deactivated once it becomes wet.</td>
</tr>
<tr>
<td>2</td>
<td>Smith and Nephew Iodoflex®</td>
<td>Alginate Dressings</td>
</tr>
<tr>
<td></td>
<td>Advancis Activen Tulle®</td>
<td>Anti-Microbial-Iodine Dressings</td>
</tr>
<tr>
<td></td>
<td>Algiron®</td>
<td>Cadexomer iodine is recommended for infected wounds. It should not be used in children, pregnant or lactating women or people with renal impairment or thyroid disorders or those receiving lithium treatment. Maximum single 50g and 150g weekly application. *QIPP TIP-If wound not improving to treatment after 4 weeks treatment refer to tissue viability service</td>
</tr>
<tr>
<td></td>
<td>Actilite®</td>
<td>Anti-Microbial-Tube</td>
</tr>
<tr>
<td></td>
<td>Activen® Tube</td>
<td>Beneficial in the management of chronic wounds, including the reduction of odour, anti-inflammatory activity and the stimulation of healing. Should not be used on patients with allergy to bee stings or bee products or in patients with extreme sensitivity to honey. *QIPP TIP-Monitor blood glucose for patients who have diabetes.</td>
</tr>
<tr>
<td>3</td>
<td>Activa Healthcare Suprasorb® X+PHMB</td>
<td>Anti-Microbial-PHMB Dressings</td>
</tr>
<tr>
<td></td>
<td>Rope</td>
<td>This dressing is an antimicrobial hydrobalance dressing wound. It is suitable for use in a wide variety of wounds such as leg ulcers, pressure ulcer etc. *QIPP TIP-It is used to reduce the wound bioburden. If no improvement after 4 weeks use refer to tissue viability service</td>
</tr>
<tr>
<td>4</td>
<td>Smith and Nephew Acticoat®</td>
<td>Anti-Microbial-Dressings—Silver Dressings</td>
</tr>
</tbody>
</table>

*QIPP TIP: Should be reviewed regularly, weekly and long term use should be avoided. Where there are...
QIPP TIP - Trading enzymes matrix metalloproteases (MMPs) interfere with protein synthesis and denature growth factors. These dressings are suitable for shallow wounds and can be used as a secondary dressing. They protect newly epithelialising wounds from trauma. Additionally they can be used to protect skin from exposure to friction. Care needs to be taken while removing dressings and many have a specific method to break the adhesive bond to ensure a non-traumatic removal.

**Hydrocolloids**

Comfeel is often used to debride necrotic tissue. Duoderm is used to protect fragile skin or as secondary dressing. Can be used on a variety of wounds including pressure ulcers, leg ulcers, surgical wounds and minor burns. They can be used in granulating wounds and they can aid in the rehydration and debridement of dry, sloughy and necrotic wounds. *QIPP TIP - Avoid bordered hydrocolloids as these do not always adhere and may require more frequent changing due to increase exudate levels.**

**Hydrofiber® Technology**

Suitable for use in a wide variety of wound types including leg ulcers and pressure ulcers with moderate to high levels of exudate. The dressing absorbs and locks away large amounts of exudate and reduces the likelihood of peri-lesion maceration or excoriation. *QIPP TIP - Please ensure that you request Aquacel and not Aquacel AG as this contains silver and is not on formulary.

**Hydrogel**

These can be used on dry and sloughy wounds and are good at hydrating dry wounds by providing a moist wound environment. They have been shown to reduce pain.*QIPP TIP - Hydrogels possess a high water content and should not be used in highly exuding wounds.**

**Wound Contact Layer**

Primary dressings used for low exuding, granulating wounds. Suitable for use under compression bandaging systems. Adaptic Touch can be used on superficial burns to prevent trauma to the wound bed and make dressing changes less painful.

**Leg Ulcer Hosiery Kits**

Hosiery kits allow for cost effective treatment of small venous leg ulcers. This allows patients to self-manage where possible. Kits are less bulky than bandages, which may improve comfort and mobility.

**Aderma Dermal Pads**

Polymer gel-shaped pad that redistributes pressure while protecting and padding bony prominences used for pressure ulcer prevention. *QIPP TIP - These pads are washable and reusable.**

**Active Debridement Pad**

A soft pad of monofilament polyester fibres intended as a rapid, highly effective and safe debridement method for the removal of loose soft slough in superficial wounds and the surrounding skin. *QIPP TIP - Consider using in shallow pressure ulcers with light covering.**

**Negative Pressure Wound Therapy (NPWT)**

This is used for the management of large wounds such as cavity wounds with high exudate. Equipment should be requested from the Integrated Community Equipment Store. Please contact the Tissue Viability Service for support and advice.

**Protease Modulators**

Chronic wound healing is characterised by a protracted inflammatory phase as a result of altered biochemistry where elevated levels of proteases are found. The consequences of this distorted biochemical profile is that tissue degrading enzymes matrix metalloproteases (MMPs) interfere with protein synthesis and denature growth factors. These dressings are
Promogram® Prisma designed to interact with the wound and modulate protease activity.

Larvae Therapy
A Biosurgical treatment for the debridement of wounds. The larvae are sealed within a dressing which is a finely woven net pouch containing a small piece, or pieces of foam, which aid the growth of the larvae. The larvae remain sealed within the dressing throughout the treatment.

Biomond BioBag®
Larvae Therapy
A Biosurgical treatment for the debridement of wounds. The larvae are sealed within a dressing which is a finely woven net pouch containing a small piece, or pieces of foam, which aid the growth of the larvae. The larvae remain sealed within the dressing throughout the treatment.

Smith & Nephew PICO®
PICO
Indicated for a range of wound types including chronic wounds, incision sites, acute wounds, traumatic wounds, subacute and dehisced wounds, partial-thickness burns, ulcers (such as diabetic or pressure), flaps and grafts, dermal substitutes.* QIPP TIP—Due to the large cost of these dressings. This treatment is only to be prescribed following assessment by The Tissue Viability Service.


Fig. 1(a): A typical hydrocolloid dressing, (Tegasorb™). It combines moisture vapour permeability with absorbency, conformability and its transparency allows for wound observation
Source: Boateng JS. et al. 2007

Fig. 1(b): Polymeric hydrogel sheet for wound dressing. It does not need a secondary dressing and due to their flexible nature, can be cut to fit around the wound
Source: Boateng JS. et al. 2007

Fig. 1(c): Lyofoam® Max is designed for the management of moderately to highly exuding wounds. Its high absorbency and fluid handling capacity combined with the reduced risk of maceration
Source: http://www.klinemedicalsupply.com/Wound-Care

Fig. 1(d): Application of Kalypto forefoot wound dressing.
Source: http://www.diamondrx.com

Fig. 1(e): Pictured here are biosynthetic wound dressing gloves.

Fig. 1(f): Management of superficial partial thickness burns with Biobrane (15/3 denier nylon fibers)
Source: Greenwood JE. et al. 2009

Fig. 1(g): A transdermal adhesive is suitable for use in drug-delivery and combination devices. Offered as part of a company’s drug-delivery silicone family, DDR-1370 is a traditional pressure-sensitive adhesive (PSA), while DDR-4355 is a strong-tack silicone gel. Can be used in wound-care applications for dispensing pharmaceutical ingredients such as antibiotics, anti-inflammatory drugs, or antimicrobials. Source: www.nusil.com

Fig.1: Medicated dressings for drug delivery in wound healing managements

CONCLUSION
This article has considered many classes of wound dressings including topical pharmaceutical agents, traditional wound dressings and modern dressings such as hydrocolloids, alginites, hydrogels, polyurethane film and foam and novel biomaterials such as collagen, chitosan and hyaluronic acid used directly or as tissue engineered matrices for skin replacement. Polymeric dressings
designed as vehicles to deliver therapeutic agents directly to the surface of wounds have also been discussed. These include alginites, chitosan, pectin and hyaluronic acid as polymers of natural origin; collagen sponges and other hydrogel materials; artificial skin grafts and tissue engineered products. The mechanism(s) for the controlled delivery of drugs from polymeric dressings were also considered and the requirement for the development of novel dressings with improved residence on the wound site (prolonged delivery) was also solicited.

Effective dressings should have properties and delivery characteristics that are optimised for specific wound types with minimum or no inconvenience to the patient and at reasonable cost. To achieve these objectives, manipulation of the physical characteristics of the identified systems is necessary. Newer products are currently being used to replace or augment various substrates in the wound healing cascade. Faced with the prospect of increased prevalence of antibiotic-resistant pathogens, and the diminished effectiveness of current therapies, careful consideration of treatment options is now important. With the abundance of available products, the goal is to find the most appropriate modality or combination of modalities to optimize healing. This article extends the information and hopes to give insight into past, present and future treatment strategies and approaches for wound healing management.

ACKNOWLEDGEMENT

I gratefully acknowledge the encouragement and guidance given to me by Dr R. S. Pawar, Associate Professor, VNS group of institutions, Bhopal MP and grateful to Indian Council of Medical Research for providing financial support as ICMR-SRF.

CONFICT OF INTERESTS

Declared None

REFERENCES


