Wound dressings: principles and practice

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Abstract

Knowledge of clinically and cost-effective wound management is an obvious requirement for surgeons, yet wound care education rarely features within the medical curriculum. As a result surgical trainees are often poorly placed to join in multidisciplinary wound management and may feel threatened when asked to manage wound complications. A vast range of dressing products exists yet robust evidence of the function and effectiveness of individual products is often lacking. An understanding of wound pathophysiology, a defined treatment goal and regular wound assessment combined with knowledge of basic wound dressing categories will provide guidance on product selection for different clinical situations and wound types.

Keywords Cost effectiveness; wound assessment; wound dressings; wound healing; wound pathophysiology

Although wound management is an essential component of care, especially for surgical patients, it is a task that is frequently seen to be an area of nursing rather than medical practice and only when complications occur does the medical team become involved in direct treatment decisions. As a result many doctors are not specifically trained in wound care and have little or no knowledge of wound pathophysiology, dressing practice or the range and function of dressings available. This is somewhat surprising as the incidence of wound complications such as surgical site infection (SSI), pressure ulcer occurrence and amputation in diabetic foot ulceration are all seen as care quality indicators for surgical care provision.

Evidence underpinning dressing choice is often regarded as poor with few randomized clinical trials supporting treatment decisions. Care is therefore based largely on expert opinion[1] and subject to local variability with diverse product formularies. This only serves to increase the problem for surgical trainees rotating between hospitals as they may be faced with products with which they have little experience of working.

The basic requirements for all wounds to heal are a clean, adequately perfused wound environment free from infection, necrotic tissue and foreign material. Systemic factors such as nutritional and immunological status, stress, smoking and medical comorbidities such as renal failure and diabetes all impact on wound healing. For optimal wound healing these factors must be managed effectively.

Pathophysiological considerations informing dressing choice and development

Although wounds are either classified as acute or chronic and are then further subdivided into subcategories such as pressure ulcers, venous leg ulcers, diabetic foot ulcers, traumatic wounds and surgical wounds, the basic function of dressings used in their care remains the same, that is to provide a protective barrier to prevent bacterial contamination and absorb exudate. Work by Winter in the 1960s[2] established that a moist wound environment was conducive to improved wound healing with more rapid reepithelialization. Although the initial research was carried out on acute wounds the principle has been extended to include the management of all wounds. As a result dressings have evolved and are now designed to optimize wound bed moisture content by either donating fluid, absorbing excess exudate or controlling moisture loss.

Intact skin, by acting as a barrier to water vapour loss, performs an important function of controlling moisture balance. Once skin is damaged this and other skin functions such as physical protection, thermal regulation are in part lost. A range of dressing products have been developed to restore these functions in damaged skin while maintaining normal transepidermal moisture loss in surrounding intact skin thus avoiding maceration in the peri-wound area. Moisture vapour transmission rate (MVTR) is therefore an important consideration when evaluating dressings. The use of occlusive dressings, particularly on chronic wounds where bacterial overgrowth and therefore wound infection is a potential problem, initially raised concerns. Hutchinson et al. reviewed the use of these dressings, comparing infection rates between occlusive and non-occlusive dressings in over 100 published studies finding that rates were 2.6% versus 7.1% ($p < 0.001$) in favour of occlusive dressings.[3] In this situation preventing bacterial ingress into the wound would therefore appear to be more important than local bacterial overgrowth in causing wound infection.[4] Occlusive dressings also tend to produce an acidic wound environment which itself reduces bacterial overgrowth.

Other factors that need to be taken into consideration when selecting dressings is the interaction between dressing material and the wound bed. This includes the release characteristics of any agent, usually an antimicrobial such as silver contained within the dressing, the potential for shedding of dressing material into the wound, the adherence of the dressing to the wound, the ability of the dressing to bind bacteria, and the capacity of the dressing to hold exudate or donate fluid. When handling fluid the dressing needs not only to absorb fluid but also to take the exudate away from the wound bed without lateral spread so that the peri-wound skin is protected from maceration. A wound dressing may be a single product or may combine two or more layers of dressing material consisting of a primary wound contact layer and a secondary retention or absorptive layer which is not in direct contact with the wound.

Dressing fixation is also important. Adherence to intact skin needs to prevent leakage and allow skin mobility, but not cause skin stripping or pain on dressing removal. There has been

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significant investment in improving dressing adhesive performance and developing skin barrier products to prevent peri-wound skin damage while maintaining dressing wear time.

Although rapid wound healing is the primary aim of care for the majority of patients there are some in whom this is either not possible, such as those with a fungating tumour, or in whom healing will be slow and prolonged. In such patients symptom control, with minimal interference to lifestyle, are the basic treatment aims and care will focus on pain, exudate and odour control. Maintenance of dry eschar or the mummification of a necrotic digit is also an appropriate treatment strategy in some patients and requires a different approach to dressing selection with wound desiccation rather than hydration the main treatment aim.

What constitutes an ideal dressing?

It is important, not only that a dressing performs the function it claims, but that it does so in a cost and clinically effective way. Cost effectiveness is achieved by accurate clinical assessment and diagnosis and the appropriate choice of treatment.[5] This may not always be achieved by using the cheapest product and may be dependent as much on dressing wear time as product selection.[6] Factors such as healing time, nursing costs, frequency of dressing changes and requirements for other products such as secondary dressings, antibiotics and analgesics all need to be considered when selecting a wound dressing product. At times the use of multiple products may be necessary but in general this should be discouraged. Some dressings, such as antimicrobial dressings, potentially impact adversely on cellular function and so their use should be time restricted and reserved for specific indications.[7]

An ideal dressing or combination of dressings is considered to be one that ensures optimal healing by:

- maintaining high humidity
- removing excess wound exudate
- permitting thermal insulation
- allowing gaseous exchange
- conforming to the wound surface
- facilitating, when necessary, debridement
- minimizing scar formation

and

- is impermeable to extraneous bacteria
- is non-fibre shedding/non-toxic
- is non-adherent, comfortable and conforming.

Other than for a primary closed surgical wound rarely will one single dressing type cater for the changing wound bed status of a chronic or non-healing open acute wound. Careful assessment of the wound and the peri-wound tissues should inform dressing selection and dressing performance should be evaluated at each dressing change.

Wound assessment and choosing and appropriate dressing

Closed surgical wounds require a different approach to open acute and chronic wounds. NICE guidance on surgical site infection[8] emphasizes the importance of maintaining optimal physiological conditions during surgery and anaesthesia. The role of dressing selection is a secondary factor in wound outcome and a simple interactive dressing is recommended such as an occlusive film with pad, topical antimicrobial agents should not be used routinely. When applying a postoperative dressing the dressing should be fitted to allow for limb or joint movement to avoid dressing traction blistering. Surgical cavity wounds should be managed with a hydrofiber or alginate, with or without an antimicrobial component depending on predicted bioburden, covered with a secondary dressing such as a hydrocolloid or foam dressing. Topical negative pressure therapy may also be appropriate and its use is becoming routine after digital ray amputation in patients with diabetes, when tendon and bone is exposed in traumatic wounds, when large areas of tissue loss occur (e.g. after debridement in the management of pressure ulceration or necrotizing fasciitis), and in the management of a dehisced surgical wound or the open abdomen.[9]

Dressing use needs to be integrated into an overall management plan, which may include compression therapy for venous disease or offloading for pressure ulcers or diabetic foot ulceration. Dressing for a chronic or non-healing open acute wound should be chosen according to the wound bed status and the desired treatment aim and reviewed regularly as treatment progresses. Debridement is, for example, frequently an on-going process that may require repeating periodically throughout the healing process, often using a variety of debridement methods. The term 'maintenance debridement' has been used to describe this process.[10]

Wounds can be described and documented by the percentage tissue type or the colour of the wound bed. Four basic descriptors are commonly used indicating the state of the wound bed.

Tissue type	Colour
• Necrotic	• Black
• Sloughy	• Green/yellow
• Granulating	• Red
• Epithelializing	• Pink

Dressings have specific functions and dressing selection will be further modified by wound hydration, exudate levels, wound site, the state of the surrounding skin and any history of dressing contact sensitivity or allergy.

Wound dressings

Figure 1 describes a selection process for currently available and commonly used dressings based on wound depth, exudate levels and wound bed characteristics. Details on individual dressings can be found at www.dressings.org or from publications such as the *Wound Care Handbook 2014-2015*. Many NHS Trusts have their own wound care formulary from which to select a restricted range of products. When selecting dressings decisions should be made on the basis of the treatment goal, the timeline for care and how the progress and outcome will be measured. Modern dressings aim to provide enhanced functionality, such as greater ability to manage exudate, within a low profile product with extended wear time.

Low or non-adherent contact layer dressings

These dressings are applied directly to the wound bed and do not adhere to the wound surface or cause significant trauma during

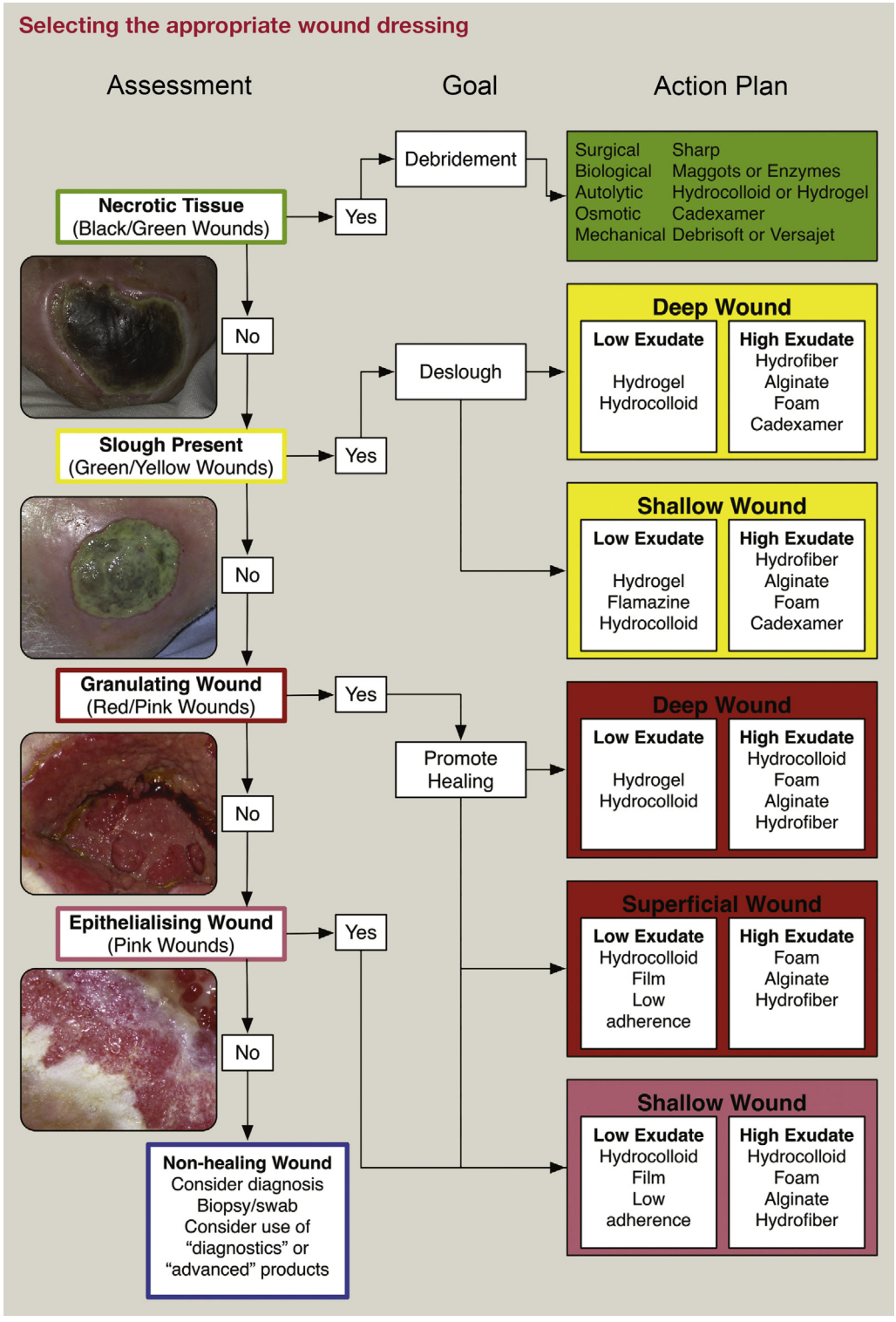

Figure 1

dressing removal. They require a secondary dressing usually an absorbent product. These dressings are largely silicone-based and are useful for finger tip injuries and following toe nail avulsion and are also of value for patients where dressings may adhered to the wound bed such as when using a topical negative pressure therapy (TNPT). Studies have shown the advantage of the use of silicone-based dressings in reducing wound pain at dressing change.

Semipermeable film dressings

Film dressings are flexible sheets of transparent polyurethane coated with an acrylic adhesive. They can be used as a primary

or secondary dressing. These dressings are semipermeable, vary in size and thickness, and have an adhesive that holds the dressing on the skin. They conform easily to the patient's body. As films are transparent, the wound can be easily monitored. Film dressings generally require a border of dry, intact skin for the adhesive edge of the dressing; film dressings will not adhere to moist skin or moist wound beds because the moisture inactivates the adhesive. Therefore, the condition of the peri-wound skin should be assessed before application to determine if a film dressing is appropriate.

As film dressings are semi-occlusive and trap moisture, they allow autolytic debridement of necrotic wounds and create a moist healing environment for granulating wounds. Example products include Tegaderm and Opsite, which have similar MVTR characteristics. Some film dressings have a higher MVTR and are frequently used on IV or epidural sites. These dressings when combined with an absorptive pad are suitable for use on minor injuries and as a post-surgery wound dressing.

Barrier films (spray on or foam applicators) functions to protect peri-wound skin from moisture damage and may help with dressing adhesion.

Hydrogel dressings

Hydrogel dressings are water- or glycerin-based products. Because they are usually clear or transparent, the wound can be monitored without removing the dressing. Use hydrogels to maintain a moist wound environment on a clean, healthy, granulating wound and to facilitate autolytic debridement in wounds with necrotic tissue such as slough or eschar. Hydrogels can be used on pressure ulcers, skin tears, surgical wounds, and burns, including radiation oncology burns and are safe on neonatal skin. These dressings are suitable for wounds with minimal to moderate exudate. Hydrogel dressings are commonly available in three forms: amorphous gel, impregnated-gauze, and sheet hydrogel and can be useful when managing painful wounds.

Hydrogel dressings that act as a release platform have also been developed containing hyaluronic acid, antimicrobials and antibiotics. Oxyzyme for example is a two component hydrogel dressing which releases both oxygen and iodine into the wound and is suitable for non-infected moderately exudating wounds.

Hydrocolloid dressings

Hydrocolloid dressings consist of absorptive ingredients (typically carboxymethylcellulose, pectin or gelatine). Like hydrogels, hydrocolloids can absorb minimal to moderate amounts of drainage and are suitable for partial- or full-thickness acute and chronic wounds. As they are occlusive, hydrocolloid dressings do not allow water, oxygen, or bacteria into the wound. This may help facilitate angiogenesis and granulation. Hydrocolloids also cause the pH of the wound surface to drop; the acidic environment can inhibit bacteria growth.

Like hydrogels, hydrocolloids can help a wound to granulate or epithelialize and encourage autolytic debridement in wounds with necrotic or sloughy tissue present. However, because of their occlusive nature, hydrocolloids should not be used if the wound or surrounding skin is infected and are not recommended for use in diabetic foot ulceration. Hydrocolloid dressings are conformable to the patient's body and adhere well to high-friction areas, such as the sacrum and heels. In some cases hydrocolloid dressings may produce a distinctive odour, this is usually due to product breakdown and not infection.

Hydrofiber dressings

This is a variant on hydrocolloid with extra absorbent properties, absorbing up to 25 times its own weight in fluid before loosing its integrity. The dressings contain sodium carboxymethyl cellulose. The dressing structure aids vertical wicking, which in turn helps reduce the risk of skin maceration. This type of dressing has to be used with a secondary dressing, e.g. a hydrocolloid.

Alginate dressings

Alginate dressings are available in non-woven sheets and ropes and are a fibrous products derived from brown seaweed. The alginate forms a gel when it comes in contact with wound fluid. These dressings are capable of absorbing up to 20 times their weight in fluid, and can be used in infected and non-infected wounds. As alginates are highly absorbent, they should not be used with dry wounds or wounds with minimal drainage. Alginates require a secondary dressing; foams or hydrocolloids will secure the alginate and keep it from drying out. If the wound is infected, the secondary dressing should be non-occlusive. The calcium component of the dressing acts as a haemostat and can be useful in managing wound bleeding.

Foam dressings

Foam dressings are semipermeable and either hydrophilic or hydrophobic with a bacterial barrier. They are either polyurethane or silicone-based and are capable of handling moderate to high volumes of wound exudate. They provide thermal insulation to the wound, create a moist wound environment, are non-adherent, and allow atraumatic dressing removal. Foam dressings may also be used as the secondary dressing with hydrogel or alginate dressings and may be used in conjunction with a topical antimicrobial for infected wounds.

Foam dressings may be manufactured with an adhesive border, which eliminates the need for a securing device or without an adhesive boarder. Shaped versions of these dressings are also available (Heel and Sacrum). Foam dressings are also available which release agents such as antimicrobials, moisturizers or anti-inflammatory analgesics into the wound.

Antimicrobial dressings

When using antimicrobials the objective must always be to provide optimum conditions to support rapid healing. The clinical evidence supporting the routine use of antimicrobial dressings is weak. In selecting antimicrobial agents to reduce or eradicate micro-organisms, choice must be influenced by the specificity and efficacy of the agent, its cytotoxicity to human cells, its potential to select resistant strains and its allergenicity. The range of topical antimicrobial agents currently used includes products containing iodine (cadexomer iodine and povidone iodine), products containing silver (silver sulfadiazine and ionic silver-impregnated dressings) and products containing antiseptic agents such as polyhexamine. Honey is also antimicrobial, acting as a debriding agent and can help with odour control.

Antimicrobial products should only be used where it is considered that the bioburden is a barrier to healing. Use should

be limited to short periods (recommendations suggest no more than 2 weeks) and if there is no improvement the wound should be reassessed and alternative treatments considered.

Larval therapy

Biosurgery with the larvae of *Lucilia sericata* (green bottle fly) are a proven method of wound debridement, which also reduce microbial load and stimulating healing. They may also encourage wound bed revascularization. To be most effective hard eschar should first be softened or excised by sharp debridement. Larvae are intolerant of excessive exudate. Larval therapy usually continues for 4–5 days and larvae can be applied as either 'free-range' or contained within a BioBag (LarvE). Larval therapy can cause discomfort and is contraindicated in patients with a bleeding disorder and should be used with caution when applied in areas communicating with a body cavity.

Deodorizing dressings

Wound odour can be a significant problem for patients, particularly those with non-healing or malignant wounds. Charcoal-based products can be effective in reducing wound odour. Clinisorb uses activated charcoal to absorb odour and is designed to be used as a secondary dressing or within a bandage system. A range of other composite dressings containing activated charcoal exists, some containing silver, which can be used as an absorbent wound contact layer managing both odour and exudate. As odour is usually due to bacterial, particularly anaerobic, activity Metronidazole Gel can also be effective as a topical odour reducing agent.

Topical negative pressure therapy

The introduction of TNPT has redefined modern wound treatment and improved the management of complex wounds. TNPT has been found to improve wound healing; to stabilize the wound and assist wound contracture, to stimulate angiogenesis and to remove wound exudate and decrease peri-wound oedema. In its simplest form localized negative pressure is applied to a closed foam or gauze-based wound dressing fitted to a cavity wound sealed under a film dressing. A number of commercial systems are available. Depending on the system chosen and the type of wound filler, a negative pressure of between 80 mmHg and 150 mmHg is maintained by a portable pump, exudate being collected from the wound in a sealed reservoir. Recent developments include the inclusion of a closed wound irrigation mechanism within the system, which allows the wound to be intermittently flushed with an antimicrobial solution. The V.A.C.Ulta™ Therapy System is currently the only integrated system that provides TNPT with an instillation option (V.A.C. VeraFlo™ Therapy). This provides standard TNPT coupled with automated, controlled delivery and removal of topical wound solutions, such as antimicrobial, to the wound bed.

A range of specialized dressings has been developed to assist in the management of complex wounds, including dressings for the open abdomen. A NICE report indicated that there is no increased risk of fistula formation when using TNPT with specialized abdominal dressings.

TNPT is not, however, suitable for all wounds. Wounds should be adequately debrided and not overtly infected and care should be taken when using TNPT close to exposed organs and blood vessels. Bleeding can be a problem in patients with clotting abnormalities and some patients experience pain, particularly at dressing change.

Detecting and modifying inflammation

One reason for delayed wound healing is a persistent destructive inflammatory response within the wound with elevated levels of proteases destroying attempts to establish a new extracellular matrix. A diagnostic kit has been introduced to monitor metalloprotease (MMP) activity in the wound and a range of protease modulating dressings are available, the majority derived from freeze dried, oxidized cellulose and bovine collagen, designed to reduce MMP activity and enhance growth factor availability. These products may contain an antimicrobial such as silver and when used on appropriate wounds have been found to aid healing.

Topical agents such as steroids may also be applied to the wound, especially those with an identified inflammatory cause such as pyoderma gangrenosum, and the peri-wound skin. When used steroid application should be time restricted but they may be of value in reducing exudate and can reduce wound pain. Similarly topical analgesics such as EMLA cream can be of value as a wound dressing when wound pain is an issue.

Dressings replacing or restoring the extracellular matrix

A range of dressing products have been developed that attempt to restore a functioning extracellular matrix. These range from the application of a degradable solution of amelogenin, a natural protein originally isolated from periodontal ligament, which assembles into a replacement membrane, to complex cellular or acellular constructs which are implanted into and gradually downgraded within the wound.

Conclusion

The majority of wounds heal without complication and in a timely manner. In some acute and chronic wounds, the healing process is, however, delayed and in these wounds careful assessment should identify potential causes of non-healing and allow targeted therapeutic intervention. Understanding the basic mechanisms involved in wound healing and knowledge of the type and function of available wound dressings will allow a systematic approach to dressing selection that is integrated into an individualized overall patient care plan. ◆

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