



THIS
MODULE FIVE
IS IDEAL TO
UNDERSTAND
WOUND
DRESSING
SELECTION.

MODULE 5 : DRESSING SELECTION

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LEARNING OUTCOMES

On completion of this module you should

- Identify the indications for each type of dressing and wound management product.
- Describe the composition of a product and how it affects its performance.
- Demonstrate how to select an appropriate dressing or treatment for a wound.
- Explain the concept of the ideal dressing.
- Analyse how different dressings can combine to create a healing environment.



DRESSING SELECTION

The number of woundcare dressings available on the market continues to grow. To ensure that the correct treatment is carried out, a number of factors must be considered.

Of prime importance is that product selection should be based upon a comprehensive and holistic assessment of the patient and their wound. Once the wound aetiology and the intended outcome of treatment (e.g. debridement) has been confirmed, an appropriate product can be selected (e.g. hydrogel).

'Advanced Woundcare' products can be divided into first, second and third line products. Most nurses would be expected to be familiar with the selection and use of first line products. Although a knowledge of second and third line products is beneficial, these should only be used under advisement from a woundcare specialist, such as a Tissue Viability Nurse.

Most hospital and Primary Care Trusts will have a wound management formulary (formulary) which lists the first choice dressings in each product category, and often the indication for use for each product.

CLASSIFICATION OF DRESSINGS

As a rule of thumb, dressing materials can be divided into two categories; 'Traditional Dressings', and 'Advanced Woundcare' products.

Whereas most nurses are familiar with traditional dressing products such as gauze, bandages and basic dressings, the very term 'Advanced Woundcare' can be a little off-putting in that it implies specialist new and advanced technology. The actual meaning of the term, however, is that it promotes a moist wound healing environment (See Module 2), and therefore the term can be used to describe products, such as hydrocolloids, that have been available in essentially the same form, for over 15 years. This is not to say that the field is not developing - far from it. The introduction in recent years of technologies such as antimicrobial silver and vacuum therapy products have achieved outcomes that would have been inconceivable before, and a tremendous amount of research and development is still going on.

Although there is good evidence to show that moist wound healing gives better outcomes than traditional dressings, there is a marked lack of evidence to clearly show where one type of dressing should be used rather than another, or to show whether the higher cost of newer technologies will give better outcomes, in any given clinical situations.

EVIDENCE IN WOUND CARE

It is very difficult to conduct randomised controlled trials (RCT) for wound care products. This is because each wound is unique, and therefore should be treated individually. This makes it very difficult to find a set of patients with the same characteristics in order to conduct an RCT. Ideally for an RCT the patients and their wounds would all be the same (no variables) and the only variable would be the type of wound care product applied. The upshot of this is that there is very little reliable evidence relating to wound care products. Such evidence, that does exist, tends to be either in the form of case studies or clinical evaluations with a small sample size. No wider conclusions can be drawn between studies on the efficacy of one wound dressing over another.



This lack of scientific evidence is well documented, for example, a report from the national prescribing centre included the following statement;

‘There is a lack of evidence from well controlled, randomised trials evaluating the clinical and cost effectiveness of wound care products. In addition, as the properties of dressings differ, there is no one product which is suitable for all wound types, or all the different stages of healing. Therefore, a flexible approach to the selection of wound care products is required, in order to optimise the healing process.’

National Prescribing Centre (1999)

Morgan also commented on the need for further research in an article in the pharmaceutical journal;

‘Finally, more research and evaluation is needed. At present, it is impossible to select the “best” hydrocolloid, alginate, hydrogel, etc., or to state that a particular dressing in one group is better than one in another for a particular wound type. Thus, there is a need for evidence-based information to aid selection of the most appropriate wound management product.’

Morgan (1999)

Nelson and Bradley’s 2003 review of the Cochrane database supports this assertion.

‘There is no evidence to allow any recommendation to be made on the choice of dressing type or topical agent.’

Nelson & Bradley (2003)

DRESSING SELECTION

In order to make an informed decision about which wound care product to use for an individual wound it is important to conduct a full patient and wound assessment. This is advocated by Morgan;

‘After a thorough assessment of the patient and wound type, the best existing advice is to select the cheapest product which has the most ideal characteristics’

Morgan (1999)

Morgan’s concept of an ‘ideal’ dressing is well documented and lists ideal dressing characteristics;

- Maintains moist environment at the wound dressing interface
- Provides thermal insulation
- Low or non-adherent
- Requires infrequent changing
- Provides mechanical protection
- Free from particulate contaminants
- Safe to use (non-toxic, non-sensitising, non-allergenic)
- Conformable and mouldable
- Good absorption characteristics (for exuding wounds)
- Impermeable to micro-organisms
- Acceptable to the patient
- Cost effective
- Sterile
- Available in a suitable range of forms/sizes

Morgan (1999)



The National Prescribing Centre (Prescribing Nurse Bulletin 1999) lists similar properties of an ideal dressing and suggests that it is also important to have a sound knowledge of the individual wound care products;

‘As there are several types of wound care products available, knowledge of their different properties and actions can ensure that product selection is made on a rational basis’

National Prescribing Centre (1999)

It goes on to suggest;

‘Generally, choice of dressing should be based on using the cheapest, effective dressing which is acceptable to both patient and prescriber.’

National Prescribing Centre (1999)

There are very few guidelines relating to which products should be used in particular circumstances. The National Institute for Health and Clinical Excellence (NICE) have, however, advised that the choice of debriding agent for difficult to heal surgical wounds should be based on:

- Comfort
- Odour control
- Other aspects relevant to patient acceptability
- The type and location of wound
- Total cost (NICE 2001)

It must be recognised that no one dressing provides the optimum environment for the healing of all wounds (Dealey 2005). In general the key to selecting the appropriate wound care product is a full wound and patient assessment. This will help you determine the wound size, depth, exudate level, tissue type, surrounding tissue condition and ultimately the aetiology of the wound. An appropriate course of action can be planned and dressing selection made. It will then be necessary to reassess the patient, wound and the appropriateness of the dressing selection, at regular intervals.



TRADITIONAL WOUNDCARE PRODUCTS

LOW ADHERENT DRESSINGS

Although low adherent dressings have little, or no absorbent capacity and do not provide a moist wound healing environment (Dealey 2005), their usage is widespread and so they have been included here for completeness.

Low adherent dressings are available with, or without, an adhesive border. Those without an adhesive border need to be secured with tape or covered with a secondary dressing.

Low adherent dressings should only be used for wounds with low exudate, as there is little absorbent capacity, they can however be used to 'carry' a dressing such as a hydrogel. This type of dressing does not provide a moist wound healing environment, they are mainly used as a primary dressing on wounds healing by primary intention (i.e. Surgical Wounds).

Low adherent dressings can be impregnated with iodine and are designed for use on shallow, open, clinically infected wounds (Benbow 2005).

These dressings provide effective treatment for infected, sloughy, chronic wounds and ulcers while preventing re-infection. They are suitable for moderate to low exuding infected wounds or for prophylaxis in minor traumatic wounds (Dealy 2005).

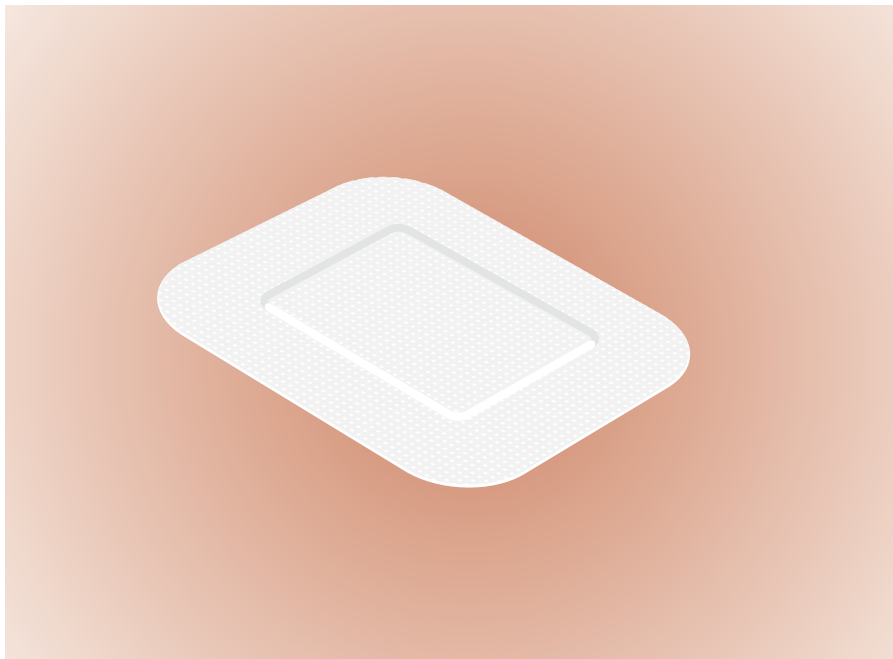


Figure 5.1 An example of a low adherent dressing.



LOW ADHERENT WOUND CONTACT LAYERS

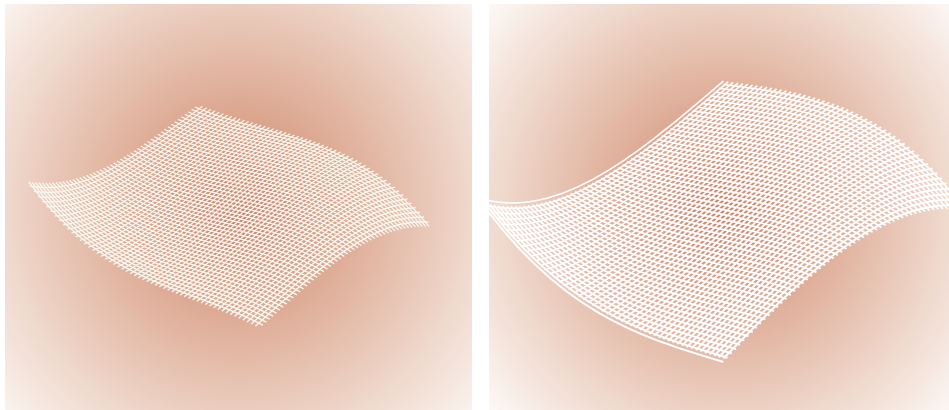


Figure 5.2 Examples of two different types of low adherent wound contact layer dressings.

Wound contact dressings are recommended as a primary dressing when adherence to the wound is a potential problem (Thomas 1998). Exudate if present passes through the dressing to the secondary pad. They are indicated for minor injuries, burns, superficial skin loss injuries, diabetic patients and leg ulcers.

Historically gauze dressings impregnated with substances such as paraffin, (known as tulle), were used as wound contact layers. However these dressings are no longer advocated because they do not provide the ideal wound healing environment and have no absorbent capacity.

These dressings readily become incorporated into the granulation tissue and have been reported to cause pain and trauma at dressing change (Hollinworth & Collier 2000). A secondary dressing is required with these dressings.

Other wound contact dressings impregnated with other substances such as chlorhexidine or antibiotics are also available.



CLASSIFICATION OF ADVANCED WOUND CARE DRESSINGS

The sheer variety of dressing types and therapies available within the classification of 'Advanced Woundcare' means that some further classification needs to be applied in order for the non specialist nurse to make appropriate dressing choices, and also to know when to seek advice from a clinical specialist.

Timmons (2006), has proposed a clear and practical system of dividing dressings into three classifications.

FIRST LINE

This category includes products such as alginates, foams, hydrocolloids, hydrogels and films. Such treatments are generally available on the Trust formulary, and as such are freely prescribable by non-specialist nurses, without involving a clinical specialist, on wounds which are viewed as 'healing normally.' (Timmons 2006).

SECOND LINE

These products would only be used under advice from a clinical specialist such as a Tissue Viability or Vascular Nurse, in situations where 'the wound requires more intense therapy.' (Timmons 2006). Antimicrobial products, such as silver, honey or iodine-containing products, larval therapy and vacuum assisted therapy fall into this category.

THIRD LINE

Third line therapies would be used on indolent wounds or other situations where the First and Second Line therapies have not proved to be effective. This is clearly the province of a clinical specialist.

For the purpose of this course, the aim is to provide sufficient information to allow the non-specialist nurse to become familiar with the selection and use of First-Line products for the day to day practice of woundcare.

Information on second line products and therapies is included in this course. The authors believe that it is necessary for the non-specialist to be aware of the more advanced options available, in order to know when to seek advice from a clinical specialist.

The use of third line therapies is outside the scope of this work.



SILICONE DRESSINGS

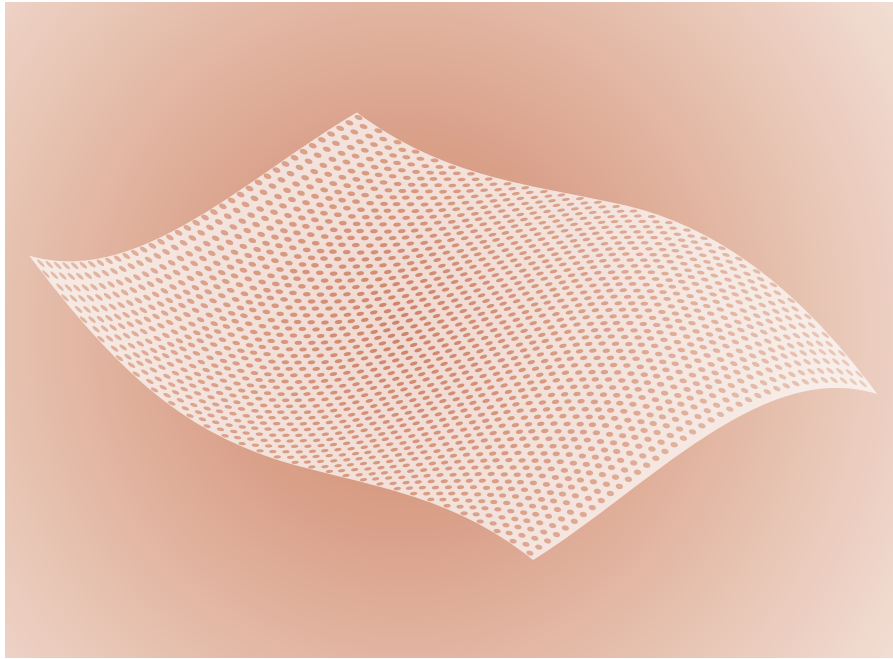


Figure 5.3 : An example of a silicone dressing.

Silicone dressings are indicated as primary dressings. These types of dressings are suitable for painful wounds as they are able to minimise trauma to the wound and to the patient during dressing changes. Silicone dressings may also be used on wounds with compromised skin (e.g. macerated or fragile skin).

These products are virtually non-adherent and are designed to be placed in contact with the wound and covered with a secondary dressing. Exudate passes through the silicone dressing onto the secondary dressing. The secondary dressing can then be changed as required whilst the silicone dressing remains in the wound. The length of time the silicone dressing can remain in the wound can be up to 10 days but varies between products.



FIRST LINE ADVANCED WOUNDCARE PRODUCTS



ALGINATE DRESSINGS

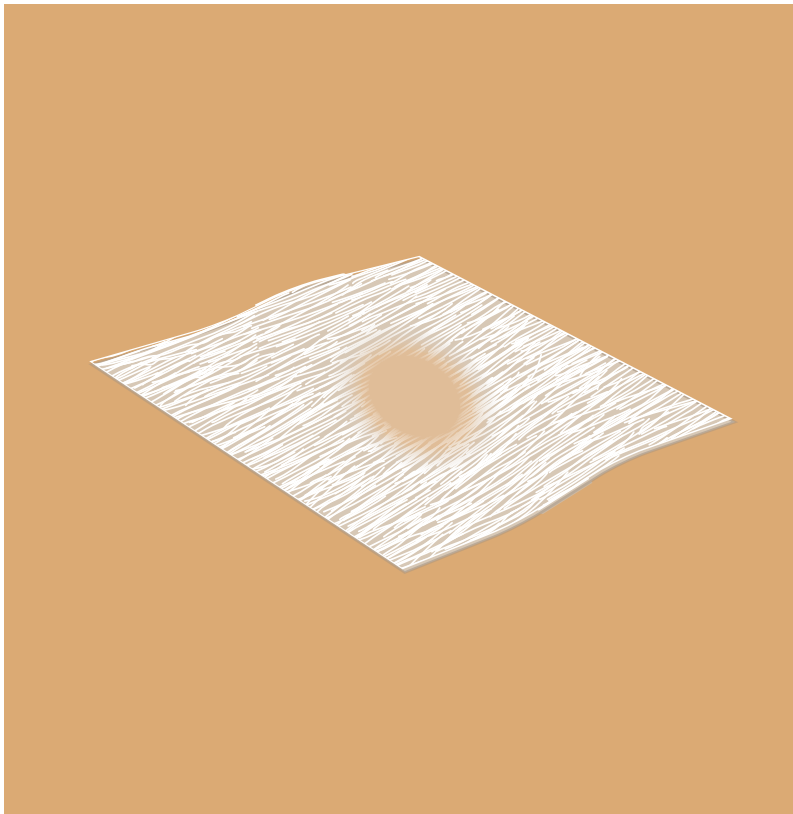


Figure 5.4 Illustration of an alginate dressing.

COMPOSITION & PROPERTIES

Alginate dressings contain either calcium or sodium alginate, which are derived from brown seaweed. Those that contain calcium have haemostatic properties, and means minor bleeding can be reduced by contact with an alginate for 10 minutes. The alginate should then be removed and replaced with another alginate dressing (Morgan 2004).

Alginic acid (found in seaweed) consists of a polymer containing mannuronic and guluronic acid residues.

Alginates rich in mannuronic acid form soft, flexible, dispersible gels which can be rinsed from the wound.

Alginates rich in guluronic acid form firmer gels that can be removed from the wound in one piece (integral).

Alginates that contain both mannuronic and guluronic acids form a soft gel that maintains its strength when wet.

As alginate dressings interact with the wound, their structure alters (Dealey 2005). On absorption of exudate, the dressing changes from a fibrous structure into a hydrophilic gel which conforms to the shape of the wound.

INDICATIONS FOR USE

Alginates are highly absorbent and are therefore indicated for medium to heavily exuding wounds.

They can be used on infected wounds.

They are also suitable for packing cavities and sinuses.



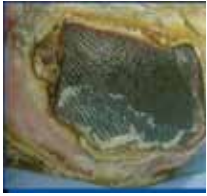





Wound Type		Nil to Low Exudate	Moderate to High Exudate
Necrotic			
Sloughy			✓
Granulating			✓
Epithelialising			
Infected			✓
Cavity		✓	✓

Figure 5.5: Dressing selection grid highlighting where alginate dressings are indicated for use.

Alginates are not suitable for use on dry wounds or where exudate level is low as the wound may become too dry.

If an alginate 'sticks' to a wound or it is difficult to remove from the wound, there is insufficient wound exudate. The alginate should be flushed from the wound using normal saline and replaced with a more appropriate dressing.

FOAM DRESSINGS

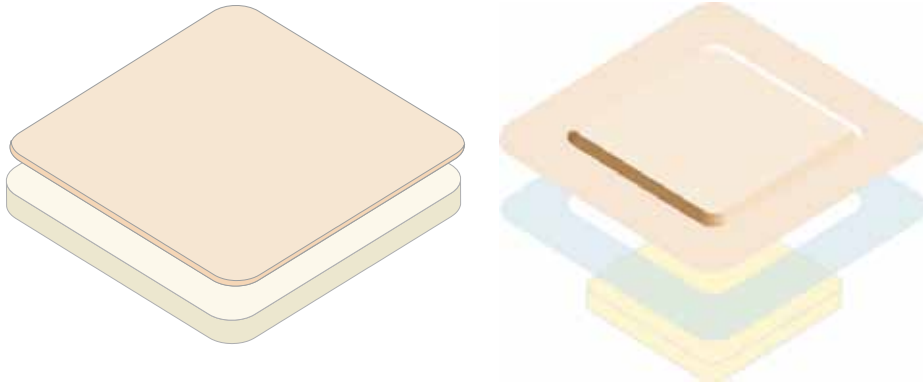


Figure 5.6 Example of foam island (adhesive) dressing and foam non-adhesive dressing.

COMPOSITION & PROPERTIES

Foams usually consist of absorbent polyurethane foam, which is sometimes combined with other components.

Foam dressings are usually available in flat sheets (with or without an adhesive border) or as a cavity dressing.

INDICATIONS FOR USE

Foam dressings are indicated for flat or cavity wounds with a varying amount of exudate, depending on the product.

It has been suggested that some foam dressings may be useful in the treatment of over granulation, although there is no evidence to support this (Young 1997).

Foams are not indicated for use on dry necrotic wounds except in conjunction with a suitable debriding agent (Morgan 2004).

Foam dressings vary considerably in construction and performance, therefore the manufacturer's instructions for use should be followed during dressing selection (National Prescribing Centre 1999).

Foams can be applied directly onto the wound, as a primary dressing, or in conjunction with other wound management products, as a secondary dressing.

Foam dressings should not be held in place with adhesive film dressings as this will reduce the Moisture Vapour Transfer Rate (MVTR) of the dressing and consequently reduce the ability of the dressing when handling the exudate. Foam dressings that are non adhesive should be fixed in place with a suitable tape to ensure the dressing remains centrally located.

Non-adhesive foams should be chosen for treatment on patients with a known adhesive sensitivity, fragile skin and for wounds that will require frequent re-dressing in order to protect the peri-wound area from adhesives.

Flat foam dressings are not suitable as packs for cavity wounds, but can be used as a secondary dressing (National Prescribing Centre 1999).

The time at which the dressing should be changed will depend on the volume of wound exudate being produced and the product that has been selected, therefore the manufacturer's instructions should be followed.





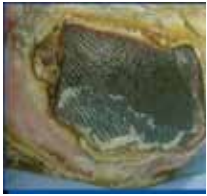














Wound Type		Nil to Low Exudate	Moderate to High Exudate
Necrotic		** 	** 
Sloughy			
Granulating			
Epithelialising			
Infected		* 	* 
Cavity			

Fig 5.7 Dressing selection grid highlighting where foam dressings are indicated for use.

*With the discretion of a health care professional.

**When used as a secondary dressing.

HYDROCOLLOID DRESSINGS

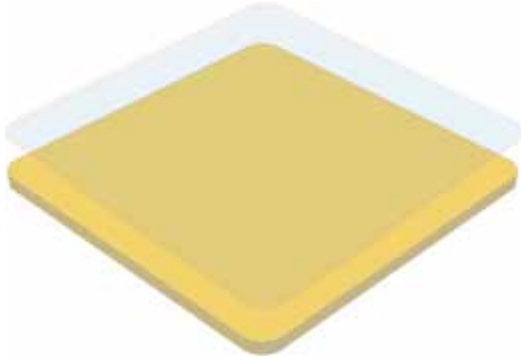


Figure 5.8 Example of a hydrocolloid dressing.

COMPOSITION & PROPERTIES

Hydrocolloids were developed from stoma products. Most hydrocolloids consist of a base made from pectin or gelatine, sodium carboxymethyl cellulose (CMC) and elastomers, this base is attached to a polyurethane film or foam backing. There are some hydrocolloids that do not contain gelatine.

Hydrocolloids are interactive dressings, in the presence of wound exudate, hydrocolloids absorb liquid and form a gel.

Some hydrocolloids are occlusive and others are semi occlusive. Those that are semi occlusive allow moisture vapour transfer, as the exudate is absorbed and gel forms the dressing becomes progressively more permeable, this means that the MVTR is controlled in proportion to the exudate.

Consequently these dressings can be used on a wider range of exudate levels ranging from low to moderate.



INDICATIONS FOR USE

Hydrocolloids are indicated for use on low to moderately exuding wounds. They also encourage autolytic debridement and therefore they may be useful to treat sloughy wounds or wounds with areas of necrotic tissue.

Hydrocolloids are often used as a primary dressing for minor burns and pressure sores.



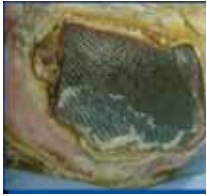





Wound Type		Nil to Low Exudate	Moderate to High Exudate
Necrotic		✓	✓
Sloughy		✓	✓
Granulating		✓	✓
Epithelialising		✓	
Infected			
Cavity			* ✓

Fig 5.9 Dressing selection grid highlighting where hydrocolloid dressings are indicated for use.

* As a secondary dressing.

FIBROUS HYDROCOLLOID DRESSINGS

COMPOSITION & PROPERTIES

These dressings are comprised entirely of sodium carboxymethyl-cellulose fibres.

The dressing functions by a hydrophilic action as it absorbs exudate by vertical wicking and has a rapid uptake of fluid directly into its fibres.

The dressing becomes a soft, conformable gel and allows an increased amount of exudate to be absorbed and retained within the fibres.



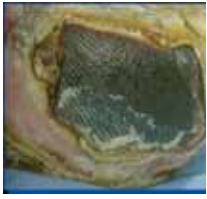





Wound Type		Nil to Low Exudate	Moderate to High Exudate
Necrotic		✓ Can be pre moistened	
Sloughy		✓	✓
Granulating		✓	✓
Epithelialising			
Infected			
Cavity		✓	✓

Fig 5.10: Dressing selection grid highlighting where fibrous hydrocolloid dressings are indicated for use.

INDICATIONS FOR USE

Fibrous hydrocolloids are indicated for the management of exuding wounds. They are best used in moderate to high exuding sloughy and necrotic wounds.

The dressing aids autolytic debridement of a wound and helps to provide an ideal environment for wound healing.



HYDROGEL DRESSINGS

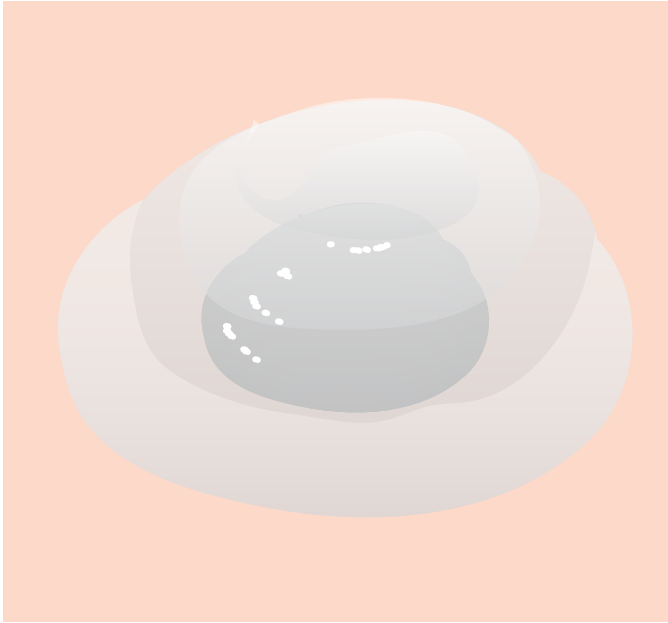


Figure 5.11 An example of hydrogel.

COMPOSITION & PROPERTIES

Hydrogels are available in an amorphous gel or sheet form. All hydrogels characteristically have a high water content of around 70%. The majority of hydrogels contain propylene glycol which acts as a stabilizer and a humectant. They also typically contain a gel-forming product such as carboxymethyl cellulose or a starch polymer. These ingredients mean that moisture is trapped within the product.

NB - propylene glycol increases the incidence of mortality in maggots, see 'maggot' section below for more information.

Hydrogels are used to debride wounds by rehydration and the promotion of autolysis.

INDICATIONS FOR USE

Hydrogels are indicated for use in dry wounds where rehydration is required to remove slough or necrotic tissue from the wound bed.

They are also suitable for wounds that are lightly exuding and shallow, granulating wounds.

Sheet hydrogels are often used in burns and scar tissue.

Hydrogels should not be used on heavily exuding wounds as this can encourage maceration of the surrounding skin.











Wound Type		Nil to Low Exudate	Moderate to High Exudate
Necrotic		✓	
Sloughy		✓	
Granulating			
Epithelialising		✓	
Infected			
Cavity		✓	

Fig 5.12 Dressing selection grid highlighting where hydrogels are indicated for use.

FILM DRESSINGS



Figure 5.12 Image showing a film being applied.

COMPOSITION & PROPERTIES

Modern film dressings usually consist of a sterile, thin, elastic polyurethane film coated with a layer of acrylic adhesive the wound contact side.

Most films have a Moisture Vapour Transfer Rate (MVTR), this means that they are permeable to moisture vapour and oxygen but impermeable to bacteria. The wound healing environment therefore remains clean, warm and moist.

The main differences between films are their MVTR and the way in which they are applied. Jones & Milton (2000).

INDICATIONS FOR USE

Films can be used as a primary or secondary dressing.

Films as a primary dressing

As a primary dressing films are generally suitable for low exudate, shallow, non-infected wounds.

Films are often used to cover wounds that are healing by primary intention.

A film can also be used to reduce the pain caused by the exposure of nerve endings, for example in minor burns.

When used as a primary dressing, films allow inspection of a wound without removing the dressing.

Films can also be used prophylactically to protect areas of the skin at risk of damage from friction forces. Collier (1995).

Films as a secondary dressing

Films are often used as a fixation device; however they should not be used to secure other dressings with a higher MVTR as this will reduce the overall MVTR, reducing the ability of the dressing to handle exudate.





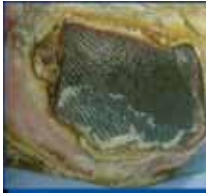





Wound Type		Nil to Low Exudate	Moderate to High Exudate
Necrotic		✓	* ✓
Sloughy		✓	* ✓
Granulating			
Epithelialising		✓	
Infected			
Cavity			* ✓

Fig 5.13 Dressing selection grid highlighting where film dressings are indicated for use.
*As a secondary dressing

SECOND LINE ADVANCED WOUNDCARE PRODUCTS

As stated previously, whilst it is important to understand the products in this category, they should be considered only on advice from a clinical specialist.

Before prescribing any of these products, we strongly advise contacting your Trust's Tissue Viability Service or other woundcare specialist.

LARVAL THERAPY



Fig 5.14 Wound showing healing by maggot therapy.

Maggot therapy, which is also referred to as bio surgery or larval therapy, has been used in wound healing for centuries. Baron Dominic Larrey, Napoleon's Surgeon in chief, reported that when maggots developed in battle injuries that they 'prevented the development of infection and accelerated healing' (Larrey 1832).

The use of maggots in wound healing was also documented during the American Civil War and the First World War. It became very popular during the 1930's and numerous papers were published. Livingston attempted to combine maggot therapy with a polyvalent vaccine in an attempt to increase the success rate. However this treatment caused systemic infections and the use of maggots declined. It was at this time that antibiotics were also being introduced; this also caused a decline in the use of maggot therapy.

In the mid 1980's the use of maggots was revived when Dr. Sherman used maggot therapy for treating pressure ulcers and other chronic wounds. (Sherman & Pechter 1988).



MODE OF ACTION

Maggots move over the surface of the wound secreting a mixture of proteolytic enzymes. These enzymes break down dead and devitalized tissue, turning it into liquid that the maggots ingest as a source of nutrient.

The sterile maggots now used in wound healing will not attack or burrow into healthy human tissue.

Various studies have shown that maggots can kill or prevent the growth of micro organisms in wounds, via two main mechanisms.

Firstly, in 1933 Robinson et al. found that, during feeding, maggots ingest bacteria which are subsequently killed in the gut (Robinson 1935).

Secondly, the secretions that maggots produce as they move over the surface of the wound increase the pH of the wound to 8-8.5 due to the presence of ammonia. This increase in pH has an inhibitory effect on the growth of some bacteria (Messer & McClellan 1935), (Pavillard & Wright 1957).

The removal of infected necrotic tissue from a wound has an important secondary benefit in that it results in a reduction of wound odour (Thomas 1998). Prete found that maggot therapy appeared to stimulate the formulation of granulation tissue and hence accelerated the healing process (Prete (1997).

INDICATIONS FOR USE

Maggot therapy is used to debride necrotic and sloughy tissue from a wound, including infected wounds (including those infected with MRSA).

Maggot therapy is not normally used as a first line treatment. It is normally considered for use by an experienced clinician, such as a Tissue Viability Nurse, once other methods of wound debridement have been tried.

Maggot therapy may be used in the following wounds (if there is devitalised tissue present that has not been debrided though other techniques);

- Osteomyelitis
- Burns
- Abscesses
- Sub acute mastoiditis
- Leg ulcers
- Pressure ulcers
- Infected surgical wounds
- Necrotic areas on feet of diabetics
- Necrotising fasciitis
- Malignant wounds

However, maggots should not be applied to fistulae or used on wounds that might connect with vital organs and should be used with caution if there are exposed blood vessels in the wound.

The use of maggot therapy should always be guided by an experienced clinician.



ADVERSE REACTIONS TO MAGGOT THERAPY

SKIN IRRITATION

As mentioned above, maggots secrete a mixture of proteolytic enzymes in order to breakdown devitalised tissue ready for ingestion. If these secretions come into contact with the skin that surrounds the wound this can cause skin irritation.

In order to prevent skin irritation a hydrocolloid dressing should be applied to the skin surrounding the wound prior to the application of maggots.

PAIN/DISCOMFORT

Sometimes patients, particularly when maggots are used in the treatment of ischaemic limbs, may experience pain which can range from a 'pricking' sensation to very severe pain. The pain may result from the increase in wound pH and is normally ceased immediately when the maggots are removed.

PYREXIA

Some patients will develop pyrexia whilst they undergo maggot therapy.

BLEEDING

Less than 1% of wounds being treated by maggots will bleed. Sometimes this bleeding can be heavy, possibly due to the erosion of a vessel wall.





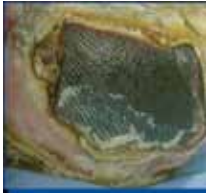





Wound Type		Nil to Low Exudate	Moderate to High Exudate
Necrotic		✓	
Sloughy		✓	
Granulating			
Epithelialising			
Infected			
Cavity			

Figure 5.15 Dressing selection grid highlighting where maggots are indicated for use. Please note: Maggots should only be considered for use by an experienced clinician

FACTORS INFLUENCING THE SURVIVAL OF MAGGOTS WITHIN A WOUND

There are factors that can affect or have been suggested might affect the survival rate of maggots within a wound;

ANTIBIOTICS

Studies have shown that if a patient is receiving normal therapeutic doses of antibiotics this should not affect the growth and development of maggots (Sherman & Pechter 1995).

HYDROGELS

Often wounds will have been treated with a hydrogel in an attempt to debride the wound prior to the decision to use maggot therapy. Some hydrogels contain propylene glycol which increases the incidence of mortality in maggots.

Therefore it is necessary to either; thoroughly remove all traces of hydrogels containing propylene glycol prior to the application of maggots or; to select a hydrogel that does not contain propylene glycol.

EXCESS EXUDATE

The survival and growth rate of maggots is reduced in the presence of excess liquid possibly because their digestive enzymes become diluted and are less effective.

This may explain why maggot therapy is sometimes not very effective in heavily exuding wounds.

X-RAYS

X-rays do not have an adverse effect on the growth and development of maggots and therefore they do not need to be removed from a wound prior to x-ray investigations.

ETHICS

No major ethical issues relating to the use of maggots and no special permission is required. It is important that the patient fully understands the treatment and is able to give consent.

To conclude maggot or larval therapy is a safe and highly effective method for debriding many different types of wounds but should only be undertaken following consultation with the Tissue Viability Service.



HONEY DRESSINGS

Honey has been used in wound care since ancient times and there has been a recent resurgence of interest. Honey has been shown to be effective against 60 species of bacteria, including aerobes, anaerobes, gram positive organisms, gram negative organisms and resistant strains of *Staphylococcus pyogenes* and *Staphylococcus aureus*.

MODE OF ACTION

The therapeutic effect of honey is produced by low concentrations of slow release hydrogen peroxide found naturally in the honey, and its high osmolarity, which inhibits bacterial action (Molan 2001).

The application of honey is known to facilitate wound bed preparation through the promotion of autolytic debridement.

The high sugar content of honey gives it a high osmolarity which draws out lymph fluid from beneath the wound tissue. This provides a good supply of protease enzymes at the wound interface and in the overlying slough and necrotic tissue (Molan 2005).

A review by Molan (1999) considered that Honey dressings had the following properties:

- Antibacterial action
- Deodorising action
- Promotes wound debridement
- Maintains moist wound environment
- Anti-inflammatory
- Stimulation of wound healing
- Pain relief

DISADVANTAGES

- May be a need for frequent dressing changes as a result of its dilution of exudate
- Possibility of honey allergy
- Can cause pain at the wound site (sometimes described as a “drawing sensation”)

ADVANTAGES

- Non irritant
- Soothing
- Pain free on application



INDICATIONS OF USE

There are a wide variety of wounds where honey may be beneficial, for example;

- Burns
- Pressure ulcers
- Venous and arterial leg ulcers
- Pilonidal sinuses
- Fungating wounds
- Surgical wounds
- Superficial wounds
- Donor sites
- Infected wounds that are unresponsive to conventional treatment



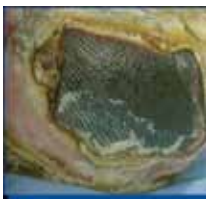





Wound Type		Nil to Low Exudate	Moderate to High Exudate
Necrotic		✓	✓
Sloughy		✓	✓
Granulating			
Epithelialising			
Infected		✓	✓
Cavity			

Figure 5.16 Dressing selection grid highlighting where honey dressings are indicated for use.

CONTRAINDICATIONS

Honey dressings should not be used in patients with Diabetes because glucose and fructose can be absorbed from an open wound. Also it should not be used in patients with a known sensitivity to honey.

Honey is commercially available in sheet or gel form which should be covered with an appropriate secondary dressing, depending on the exudate level. It is also available in impregnated foam dressings which can be applied directly to the wound and do not require a secondary dressing.

The current available literature would generally support the continued use and evaluation of honey in the wound care setting although more clinical trials are required to demonstrate significant clinical outcome differences compared to first line dressings.



SILVER DRESSINGS

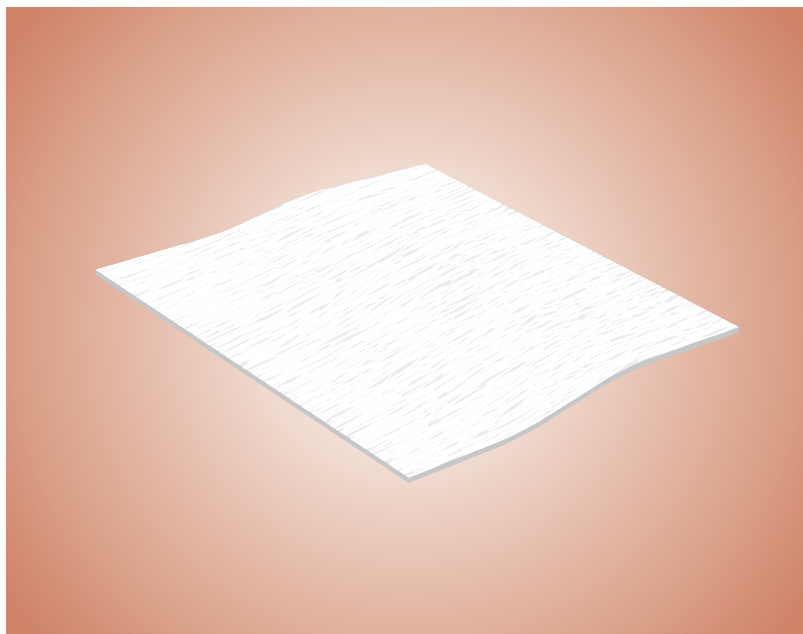


Figure 5.17 Example of a Silver Dressing

There has been a recent resurgence of interest in the use of silver for its anti-bacterial properties in wound care as a result of increasing problems associated with antibiotic resistance (White 2001). Silver sulphadiazine has been very successful in controlling burn wound infections (Fakhry *et al* 1995).

Wound infections present particular problems, including delayed healing. Almost all skin infections are sensitive to silver as an antibiotic and there is increasing evidence that shows that sustained silver release technology is well suited in treating difficult to heal wounds (Lansdown 2002).

MODE OF ACTION OF SILVER

Silver in its metallic form does not readily interact with tissues of the human body. However, in the presence of moisture, body fluids and wound exudates, silver ionises to release Ag^+ ions. This process is known as “hydro activation” and is the method by which antibiotic therapies and silver wound dressings release silver. The concentration of the Ag^+ ions released is proportional to the antiseptic efficacy of the product.

The current wound care products containing silver exhibit proven anti-bacterial action against bacteria commonly found in wounds and their efficacy against bacteria includes MRSA. The release of silver ions is triggered by wound fluids and continues for as long as exudate is absorbed.

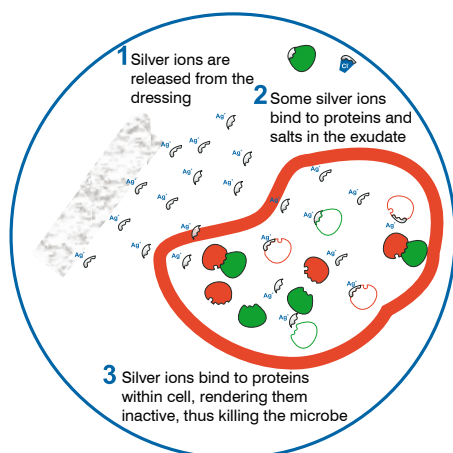


Figure 5.18 Diagram of dressing releasing silver and it's action on bacteria

SUSTAINED SILVER RELEASE DRESSINGS IN WOUND MANAGEMENT

The aim of silver containing dressings are, primarily, to release continuously small amounts of antimicrobial silver into the wound to inhibit the growth of bacteria.

White (2001) suggests the following as characteristics of the ideal silver dressing:

- Delivers silver in a sustained therapeutic way into the wound.
- Has a combined antimicrobial effect and capacity to absorb exudate.
- Has an odour control function.
- Easy to apply and comfortable for the patient.
- Cost effective.

There are many silver release dressings currently available that vary in their composition and clinical indications for use. However, they all exhibit the following 'main' features.

- Release "active" silver ions in a controlled way during the stages of wound healing (up to seven days)
- Exhibit broad spectrum anti bacterial activity in the wound bed
- Manage wound exudate, odour and pain
- Easy to apply, conformable and atraumatic removal
- Cost effective
- Benefit wound healing

INDICATIONS FOR USE

Silver dressings are indicated for use in infected wounds and as a prophylactic treatment in patients who are at a high risk of developing wound infections (e.g. immunocompromised patients).

CONTRAINDICATIONS

Silver dressings should not be used on patients with a known sensitivity to silver or who are undergoing MRI examination.

Silver containing dressings are also expensive and therefore they should not be used on wounds that are not infected or not at risk of becoming infected.





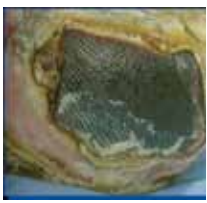





Wound Type		Nil to Low Exudate	Moderate to High Exudate
Necrotic		✓	✓
Sloughy		✓	✓
Granulating			
Epithelialising			
Infected		✓	✓
Cavity		✓	✓

Figure 5.19 Dressing selection grid highlighting where silver dressings are indicated for use.

These dressings should only be used if clinically infected or if the wound is at risk of becoming infected.

When using a silver containing dressing the clinician must read the indications for use leaflet to ensure that it is being used appropriately and that the product is being used within licence. Clinicians should also ensure that they are following the wound care formulary of the local trust.

To conclude, new dressings containing silver permit a controlled release of silver ions for up to seven days and they have become very popular as an effective means of managing infected and chronic wounds.

PHMB

PHMB also known as the antimicrobial/antiseptic polyhexamethylene biguanide, polyhexanide or PHMB is relatively new to the UK wound care market. PHMB is a heterodisperse mixtures of polymers and is a synthetic compound structurally similar to naturally occurring antimicrobial peptides (AMP's). AMPs are important in innate immune response and are produced by the majority of living organisms. They have a broad spectrum of activity against bacteria, viruses and fungi (Moore and Gray 2007). AMP's are produced by many cell within the wound, such as keratinocytes and inflammatory neutrophils, where they are thought to play a role in protection against infection (Sorensen *et al* 2003).

MODE OF ACTION

The structural similarities between AMP's and PHMB mean that PHMB can insert into bacterial cell membranes and kill bacteria in a similar way to AMPs (Moore and Gray 2007). PHMB is thought to adhere to and disrupt target cell membranes, causing them to leak potassium ions and other cytosolic components (Davies and Field 1969) (Broxton *et al* 1984) (Yasuda *et al* 2003).

PHMB may be used to reduce the wound bioburden. *In vitro* work indicates that, following PHMB contact with Escherichia coli, there is a rapid attraction of PHMB towards the negatively charged bacterial cell surface, resulting in cell death (McDonnall and Russell 1999).

Advantages of PHMB

- Excellent skin tolerance
- Non toxic, non irritant
- Hypoallergenic
- No known resistance

INDICATIONS FOR USE

Varying levels of exudate dependent on the wound dressing, of critically colonised and infected wounds.

CONTRA INDICATIONS.

Known sensitivity to PHMB.



REFERENCES

DAVIES A, BENTLEY M, FIELD B (1968) Comparison of the action of vantocil, cetrmide and chlorhexidine on Esherichia coli and its spheroplasts and the protoplasts of gram positive bacteria. J Appl Bacteriol 32 (2) 233-43

BROXTON P, WOODCOCK P, HEATLEY F, GILBERT P (1984) Interaction of some polyhexamethylene biguanides and membrane phospholipids in Escherichia coli. J Appl Bacetrial 57, (1): 115-24

McDONNELLI G and RUSSELL A (1999) Antiseptics and disinfectants: activity, action and resistance. Clinical Microbial Rev 12,1, pg147-179

MOORE K and GRAY D (2007) Using PHMB antimicrobial to prevent wound infection . Wounds UK 3 (2) 96-102

SORENSEN O, COWLAND J, THEILGAARD MONCH K, LIU L, GANZ T, BORREGAARD N (2003) Wound healing and expression of antimicrobial peptides/ polypeptides in human keratinocytes, a consequence of common growth. J Immunol 170 (11) 5583-9

YASUDA K, OHMIZO C, KATSU T (2003) Potassium and tetraphenylphosphonium ion-elective electrodes for monitoring changes in the permeability of bacterial outer and cytoplasmic membranes. J Microbial methods 54 (1) 111-15



PROTEASE MODULATORS

Chronic wounds are characterised by a prolonged inflammatory phase. Integral to chronicity are elevated levels of tissue degrading enzymes and matrix metalloprotease (MMPs).

MMP's are a specific group of zinc containing proteolytic enzymes. They play an important role in remodelling the extra cellular matrix during healing in both degradation and regeneration and in supporting epithelisation. In normal wound healing there is a balance between the clearing of damaged tissue and building of new tissue.

Protease activity not only prolongs the inflammatory process, but adversely effects cell migration, granulation tissue formation and wound contraction. TIMP. (Tissue inhibitors of MMP) are the natural inhibitors of MMPs. In normal wound healing the levels of TIMPs and MMPs are balanced, therefore in chronic wounds there is an imbalance TIMPs and MMPs which leads to an unstable extracellular matrix.

MODE OF ACTION

A range of dressings have been developed that are able to interact with the wound and modulate the protease activity. The intention of the dressings are to influence the wound environment and restore the balance of MMPs and TIMPs.

INDICATIONS FOR USE

Indicated for the use with chronic non infected wounds such as

- Diabetic foot ulcers
- Leg ulcers
- Pressure ulcers

In order to regulate the micro environment of the wound, regulate the MMP imbalance, facilitates re epithelialisation, promoting wound closure and supports faster healing of chronic wounds.

CONTRAINDICATIONS

For dry wounds



REFERENCES

GREENER B, HUGHES N, BANNISTER N, DOUGLASS J (2005) Proteases and pH in chronic wounds. *Journal of wound care*. Vol 14, No 2 59-61

FALANGA V (2003) wound bed preparation : future approaches. *Ostomy Wound Management*. 49 (5A suppl) 30-33



TOPICAL NEGATIVE PRESSURE THERAPY

Topical negative pressure therapy is a device, which applies a universal negative pressure to a wound, to encourage blood flow and faster granulation (Baxandall 1996). It also removes exudate, reduces bacteria colonisation and reduces odour with the convenience of exudate being removed from the wound.



Figure 5.20 Wound showing total negative pressure therapy *in situ*.

MODE OF ACTION

The vacuum assisted device assists in wound closure by applying localised negative pressure to the wound bed.

A porous foam dressing is positioned in the wound which is attached to the Topical Negative Pressure Therapy machine via a tubular plastic drain. The Topical Negative Pressure Therapy machine controls the degree of negative pressure applied to the wound and the dressing ensures that the negative pressure is distributed evenly across the wound.

An air-tight film dressing is used to secure the porous foam dressing within the wound.

The system creates a hypoxic environment in which aerobic bacteria cannot survive and pulls blood that is rich in growth factors and macrophages into a relatively uncontaminated area (Hampton 1999). Topical Negative Pressure Therapy has been shown to accelerate debridement, promote angiogenesis, and remove slough and loose necrotic tissue in many wound types.



INDICATIONS OF USE

Topical Negative Pressure Therapy has been used to manage;

- Acute wounds
- Chronic wounds
- Traumatic wounds
- Sub acute wounds
- Pressure ulcers
- Diabetic ulcers
- Dehisced surgical wounds
- Skin flaps and grafts
- Infected wounds

CONTRAINDICATIONS

Topical Negative Pressure Therapy is contraindicated in the following circumstances;

- Necrotic tissue with eschar
- Malignant wounds
- Untreated osteomyelitis
- Fistulas to organs or body cavities
- Over exposed arteries or veins

If haemostasis has been difficult or if a patient has active bleeding or is on anticoagulant therapy, Topical Negative Pressure Therapy should be used with extreme caution.

ADVANTAGES

- Excellent on heavy exuding wounds
- Assists in the reduction of infection
- Stimulates growth factors
- Accelerates debridement
- Promotes angiogenesis
- Reduces odour
- Accelerates healing and formation of granulation tissue

DISADVANTAGES

- Difficult to apply
- Patient being attached to a machine therefore difficult to move around
- Expensive in both hire of the therapy unit and purchase of the dressings
- Growth of granulation tissue into foam can occur if it is left in place for too long

To conclude, total negative pressure therapy can be very effective and convenient, and removes excess exudate and odour. It can also be cost effective as it can reduce the overall time taken for a wound to heal.

This method is also well accepted by patients and clinicians despite limited scientific proof of its usefulness. Therefore more scientific research is required.

This module has looked at the evidence surrounding wound care and at the commonly used dressings and wound management products. This is not an exhaustive list of wound management options available to practitioners and therefore you may wish to conduct further research into the products available, please see the recommended further reading section.



The information given here is a general guide only and must not replace clinical judgement. Individuals are advised to make their own further enquires to manufacturers regarding specific treatments or products.

Specialist advice can also be obtained from the Tissue Viability Service provided by individual hospital and primary care trusts or from other clinical specialists.

When you are ready, please complete the following “Test Your Knowledge” section . . .



TEST YOUR KNOWLEDGE

1. There are lots characteristics of an ideal dressing, choose the correct combination from the following list?

- a. Impermeable to micro organisms, requires frequent dressing changing and safe to use.
- b. Mouldable, provides thermal insulation & acceptable to the patient.
- c. Cost effective, good absorption characteristics and keeps the wound dry.

2. What should dressing selection be based on?

- a. That the dressing is cost effective.
- b. On a comprehensive and holistic assessment of the patient and their wound.
- c. On assessment of the patient.

3. Which of the following dressings are considered to be 'First Line Advanced Wound Care'?

- a. Maggot Therapy
- b. Silver dressings
- c. Foam dressings

4. What exudate level is an alginate suitable for?

- a. Low to Moderate exuding wounds
- b. Dry wounds
- c. Moderate to highly exuding wounds.

5. Choose two of the statements below that best describe Alginates.

- a. Alginates that contain both mannuronic and guluronic acids form a soft gel that maintains it's wet strength when wet.
- b. Alginates are rich in guluronic acid and form a gel which can be rinsed from the wound.
- c. Alginates that contain calcium have haemostatic properties.
- d. Alginates are not suitable for packing cavities.

6. What exudate level is a Hydrogel dressing suitable for?

- a. Moderate to highly exuding wounds.
- b. Dry to lightly exuding wounds.
- c. Highly exuding wounds.

7. Hydrogels can contain what substances which can effect the mortality of maggots?

- a. Starch
- b. Propylene glycol
- c. Water

8. Hydrogels should not be used on heavily exuding wounds as it can cause?

- a. Maceration to the surrounding skin
- b. Debridement of necrotic tissue
- c. Provide the ideal environment for wound healing.



9. Foam dressings should not be held in place with adhesive film as it will reduce(please complete the sentence by choosing one correct statement)

- a. Adhesiveness
- b. MVTR
- c. Skin Maceration

10. What are foam dressings not indicated for?

- a. Moderate to highly exuding wounds.
- b. Sloughy wounds
- c. Dry wounds

11. Hydrocolloids are used to encourage?

- a. Keeping the wound dry.
- b. Autolytic debridement.
- c. Infection.

12. Hydrogels are indicated for? (Choose one correct statement)

- a. To debride wounds by rehydration and the promotion of autolysis.
- b. To promote angiogenesis.
- c. To prevent maceration.

13. Hydrocolloids are indicated for wounds that are (Choose one of the following)

- a. Moderate exuding wound
- b. Moderate to heavy exuding wounds.
- c. Low to moderate exuding wounds.

14. What is the definition of moisture vapour transfer rate?

- a. The process whereby epidermal cells differentiate to form the stratum Corneum.
- b. Excessive production of granulation tissue.
- c. The rate at which moisture passes through a dressing and evaporates into the atmosphere.
- d. Promotion of angiogenesis.

15. When would maggot therapy be indicated?

- a. Maggot therapy is indicated for dry wounds.
- b. Maggot therapy is indicated for heavily exuding wounds.
- c. Maggot therapy is used to debride necrotic and sloughy tissue from a wound.

16. What wound types should maggots not be used on?

- a. Infected surgical wounds
- b. Pressure ulcers
- c. Fistulas
- d. Abscesses
- e. Wounds that may connect vital organs.
- f. On exposed blood vessels.

17. Maggots secrete a mixture of proteolytic enzymes to? (complete the statement)

- a. Break down dead and devitalised tissue.
- b. Promote granulation.
- c. To manage exudate.



18. Honey is indicated for use in infected wounds. How does the honey inhibit bacterial action?

- a. The high sugar content of honey which draws out lymph fluid and inhibits bacterial action.
- b. There are low concentration of slow release hydrogen peroxide found naturally in honey which inhibits bacterial action.
- c. There are a good supply of protease enzymes in honey that inhibits bacterial action.

19. The application of honey is known to facilitate (Complete the sentence)

- a. Wound bed preparation through the promotion of autolytic debridement.
- b. A moist wound environment.
- c. A good supply of protease enzymes.

20. How is silver released into a wound from a silver containing dressing?

- a. In it's metallic form silver readily interacts with body tissues.
- b. Silver dressing release silver in the presence of wound exudate as it ionises to release Ag +.
- c. Silver dressings contain low concentration of slow release hydrogen peroxide which helps them to release silver from the wound.

21. What is the primary aim of silver dressings?

- a. To manage exudate.
- b. To release continuously small amounts of antimicrobial silver into the wound to inhibit the growth of bacteria.
- c. To have an odour control function.
- d. Benefit wound healing.

22. Silver dressings are expensive therefore silver should not be used?

- a. If wounds are not infected or not at risk of becoming infected.
- b. If patients have a sensitivity to silver
- c. If the patient is taking antibiotics.

23. There are many advantages of topical negative pressure therapy. Choose one from the following.

- a. Soothing.
- b. Non irritant.
- c. Accelerates debridement.

24. Topical negative pressure is indicated for the following wounds. Choose one answer.

- a. Acute wounds, chronic wounds, pressure ulcers, malignant wounds, infected wounds.
- b. Pressure ulcers, Diabetic ulcers, Chronic wounds, infected wounds.
- c. Necrotic wounds, Malignant wounds, untreated osteomyelitis, Fistula, Exposed arteries or veins.



CASE STUDY

Majorie has recovered from her medical event and has been transferred back to the medical ward from the high dependency unit. Following assessment and review by the medical staff the decision was made to take Majorie to theatre for surgical debridement of the wound. On return from theatre the below wound was left.



Fig 5.21 Patient's wound after surgical debridement.

- a. What would your treatment of Majorie's be with this type of wound involve and discuss rationale for the dressing selection?
- b. Use an example from practice and analyse the current dressing choice in terms of effectiveness?
- c. In light of the knowledge gained from this module what are the alternate dressings that could be used?



DECLARATION OF COMPLETION

Learning outcomes

On completion of this module you should;

- Have an understanding of wound care evidence.
- Understand the concept of the ideal dressing.
- Understand the indications for use for each dressing and wound management product.
- Understand how the composition of a product affects its performance.
- Understand how to select an appropriate dressing or treatment for a wound

I hereby certify that I have fulfilled the learning outcomes outlined above.

Signed

Date



REFERENCES

- BENBOW M (2005)** Evidence-based wound management. Whurr Publishers Ltd: London
- BAXENDALL T (1996)** Healing cavity wounds with negative pressure. *Nursing Standard*. 11 (6) p79-84.
- COLLIER M (1995)** Pressure Sore Development and Prevention (revised). Educational leaflet 3 (1) Wound Care Society: Huntington
- DEALEY C (2005)** The Care of Wounds. A Guide for Nurses. Third Ed. Blackwell: Oxford p67
- FAKHRY S M, et al. (1995)** Regional and Institutional Variations in Burns. *Journal of Burn Care Rehabilitation* 16: 86-90.
- HAMPTON S (1999)** Choosing the right dressing. Cited in MILLER M & GLOVER D (eds) Wound management. Theory and Practice. London: NT Books p116-128
- HOLLINWORTH H & COLLIER M (2000)** Nurses views about pain and trauma at dressing changes: results of a national survey. *Journal of Wound Care*. 9
- JONES V & MILTON T (2000)** When and how to use adhesive film dressings. *NT Plus – Wound Care (supp)*. *Nursing Times*. 96 p3-4
- LANSDOWN A B G (2002)** Silver 1: It's Antibacterial properties and mechanism of action. *Journal of wound care*. 11(4) p125-30
- LANSDOWN A B G (2002)** Silver 2: Toxicity in mammals and how its products aid wound repair. *Journal of wound care*. 10(5) p173-7
- LARREY D J (1832)** Observations on wounds and their complications by erysipelas, gangrene and tetanus, *Clinique. Chirurgucale*. 51-51(Nov) 1829 translated from the French by E.F. Rivinus. *Des Vers ou larves de la mouche bleue*, Chez Gabon, Paris. Philadelphia: Key, Mielke and Biddle 1832
- MESSER F C & McCLELLAN R H (1935)** surgical maggots. A study of their functions in wound healing. *Journal of Laboratory and Clinical Medicine*. 20 p219.
- MOLAN P C (1999)** The role of honey in the management of wounds. *Journal of Wound Care*. 8 (8) p415-8
- MOLAN P C (2001)** Honey as a topical antibacterial agent for treatment of infected wounds. (www.worldwidewounds.com/2001/november/molan/honey-as-topical-agent.html)
- MOLAN P C (2005)** Mode of action cited in White R, COOPER R & MOLAN P eds: A modern wound management product. Wounds UK Publishing: Aberdeen. P1-23
- MORGAN D A (1999)** Special Feature The Pharmaceutical Journal 263 (7072) p820-5
- MORGAN D A (2004)** Formulary of Wound Management Products. A Guide for Healthcare Staff. Euromed Communications Ltd: Haslemere
- NATIONAL INSITUTE FOR CLINICAL EXCELLENCE (NICE) (2001)** Guidance on the use of debriding agents and specialist wound care clinics for difficult to heal surgical wounds. Technology Appraisal Guidance. 24. NICE: London



NATIONAL PRESCRIBING CENTRE (1999) Prescribing Nurse Bulletin. 1 (2)

NELSON E A & BRADLEY M D (2003) Cochrane Database Systematic Review – Dressings and topical agents for arterial leg ulcers. (1):CD001836

PAVILLARD E R & WRIGHT E A (1957) Nature. 180: 916-917.

PRETE P (1997) Growth factors of *Phaenicia sericata* larval extracts on fibroblasts: mechanism for wound healing by maggot therapy. Life Sciences 60 (8) p505-510.

RICH A (1998) Selection and appropriate use of wound dressings. Prescriber. 9 (7) P101-8 cited in NATIONAL PRESCRIBING CENTRE (1999) Prescribing Nurse Bulletin. 1 (2)

ROBINSON W (1935) Progress of maggot therapy in the United States and Canada in the treatment of suppurative diseases. American Journal of Surgery. 29 p67-71

SHERMAN R A, WYLE F A & THRUPP L (1995) Effects of seven antibiotics on the growth and development of *Phaenicia sericata* (Diptera: Calliphoridae) larvae. Journal of Medical Entomology. 32 (5) p646-9

THOMAS, S (1998) The use of Larval Therapy in wound management. Journal of wound care 7 , 521-524

TIMMONS J., “Third Line Therapies”, Wounds UK Woundcare E-Newsletter, July 2006

WHITE R (2001) An historical overview of the use of silver in wound Management. British Journal of Nursing. 10 (15) p3-8

YOUNG T (1997) Matching the dressing to the wound. Community Nurse 31-35 cited in NATIONAL PRESCRIBING CENTRE (1999) Prescribing Nurse Bulletin. 1 (2)



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Figures 5.12 & 5.13





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