APPLIED WOUND MANAGEMENT AND USING THE WOUND HEALING CONTINUUM IN PRACTICE

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Assessing a patient with a wound involves accurate assessment of both the wound and the patient's health status. The Applied Wound Management framework utilises three different continuums, each relating to a key wound parameter, the Wound Healing Continuum, the Wound Infection Continuum and the Wound Exudate Continuum.

The Applied Wound Management (AWM) framework utilises three different continuums, each relating to a key wound parameter:

- Wound Healing Continuum (WHC): is represented by the tissues in the wound and is a colour-based continuum.
- Wound Infection Continuum (WIC): is subdivided into named stages representing varying host responses to bioburden, each identified by clinical cues.
- Wound Exudate Continuum (WEC): is represented by volume and consistency parameters, and each can be graded according to a 'matrix' continuum.

This practical application to everyday wound care enables the practitioner to approach wound assessment logically and systematically. Increased workloads across the NHS require decision-making to be systematic, clear and coherent. The AWM system aids this type of decision-making, reducing the risk of poor practice and litigation.

Using the Wound Healing Continuum to assess tissue

Wound tissue types

If left to heal by secondary intention, the tissues in a wound (within the wound bed and margins) indicate the relevant pathologies present, reflect the state of healing and, consequently, the success of the management approach. Thus, a black wound (as opposed to black skin changes in melanoma, gangrene or frostbite) indicates the presence of eschar or necrosis (Bale, 1997). Wound eschar is full-thickness, dry, devitalised (dead) tissue that has arisen through prolonged local ischaemia. In relation to pressure ulcers, eschar might arise after a sudden large vessel occlusion caused by shearing injury (Witkowski and Parish, 1982). Unless removed, the eschar will delay healing, as healing cannot proceed effectively without a moist wound environment (Parnham, 2002).

Yellow and fibrous wound tissue that adheres to the wound bed and cannot be removed on irrigation is known as slough (Tong, 1999). This adherent, fibrous material is derived from the proteins, fibrin and fibrinogen (Tong, 1999). In combination with wound exudate, it serves as an ideal environment for bacterial growth and, consequently, infection (Davies, 2004). It also impairs healing by restricting re-epithelialisation (Kubo et al, 2001). The clinical objective of managing a sloughy wound is to debride (Tong, 1999; Hampton, 2005).

The red, moist tissue in a wound is a combination of new blood vessel growth (angiogenesis), and a matrix of fibroblasts (connective tissue or dermal cells), known as granulation tissue. This is usually indicative of a healing wound and

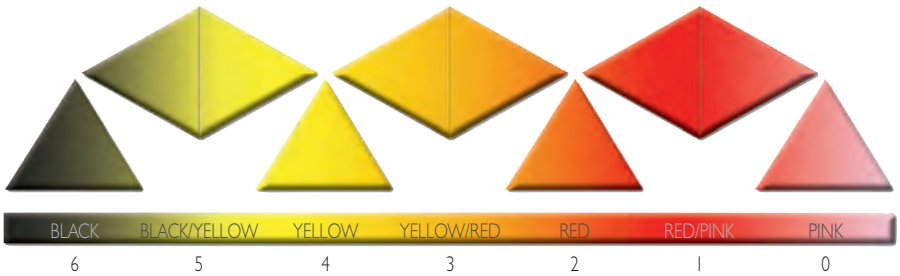

Figure 1. The Wound Healing Continuum.

is often accompanied by signs of re-epithelialisation (epidermal regrowth) (Gray et al, 2003). It is important to remember that not all red wounds are healthy; they may be critically colonised and non-healing/static, or show evidence of haemolytic bacteria (if a dull brick-red colour) (Dowsett et al, 2004).

The approach taken in the Wound Healing Continuum is to incorporate intermediate colour combinations between the four key colours (*Figure 1*). To use this system to the optimum clinical benefit, it is first important to identify the colour that is furthest to the left of the continuum. For example, if the wound contains yellow slough and red granulation tissue, it would be defined as a 'yellow/red wound'. A key objective of the consequent wound management plan would be to remove the yellow tissue and promote the growth of red granulation tissue (Gray et al, 2005).

Identifying and obtaining treatment objectives

Debridement

Where the wound exhibits dead tissue, eg. black, black/yellow, yellow, or yellow/red, a key treatment aim should be the debridement of the devitalised tissue, unless contraindicated by the patient's overall physical condition or disease process, such as PVD (European Tissue Repair Society [ETRS], 2003). The types of treatment available can be divided into three separate categories:

- Active
- Autolytic (moisture donation).
- Autolytic (moisture absorption).

Active debridement

- Surgical debridement: this involves removing the dead tissue from the wound bed. It is usually carried out under surgical conditions and results in a bleeding wound bed. It removes dead tissue and results in an inflammatory response from the wound, thus stimulating healing (Bale, 1997)
- Sharp debridement: this technique involves debulking the wound of slough and necrotic tissue. This process requires the use of surgical instruments, such as a specialist wound debridement pack
- Larval therapy: the larvae liquefy the dead tissue and, where the treatment is successful, can result in rapid debridement (Thomas et al, 1998).

Autolytic debridement

Autolytic debridement is the removal of devitalised tissue from the wound by means of the body's own enzymes operating in a moist environment. Where tissue can be kept moist it will naturally degrade and deslough from the underlying healthy structures. This process is facilitated by enzymes (matrix metalloproteinases) which disrupt the proteins that bind the dead tissue to the body (Schultz et al, 2003). The process can be enhanced by the application of wound management products which promote a moist environment. These products can be divided into two categories: those that donate moisture to the dead tissue, and those that absorb excess moisture produced by the body. Both are designed to facilitate the autolytic debridement process.

Clinical use of debridement techniques

Treatments from more than one group may be required to achieve full debridement of the wound. The heel pressure ulcer presented in *Figure 2* shows necrotic tissue which has been rehydrated using an autolytic (moisture-donating) treatment. This results in necrotic eschar lifting at the wound margins and separating from the slough below. The necrotic tissue is categorised as 'black' on the Wound Healing Continuum.

In *Figure 3*, the wound has been subjected to sharp debridement and the necrotic tissue removed to leave the slough below exposed. The wound is now categorised as a 'yellow' wound on the Wound Healing Continuum. No bleeding or pain has been caused. Following sharp debridement, the patient is treated with a moisture-donating product (eg. hydrogel) to continue the process of autolytic debridement.

The wound in *Figure 4* is producing high levels of moisture which need to be absorbed. The wound bed is covered with slough which requires debriding. The wound is categorised as a 'yellow/red'

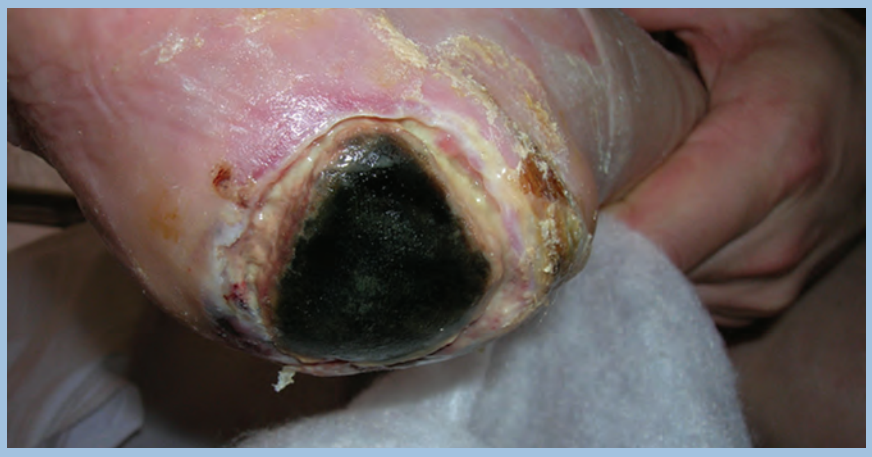

Figure 2. Black wound.

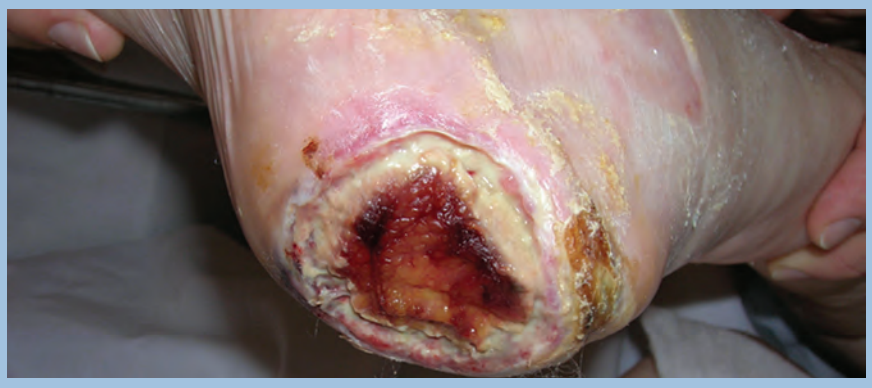

Figure 3. Black/yellow wound post sharp debridement.

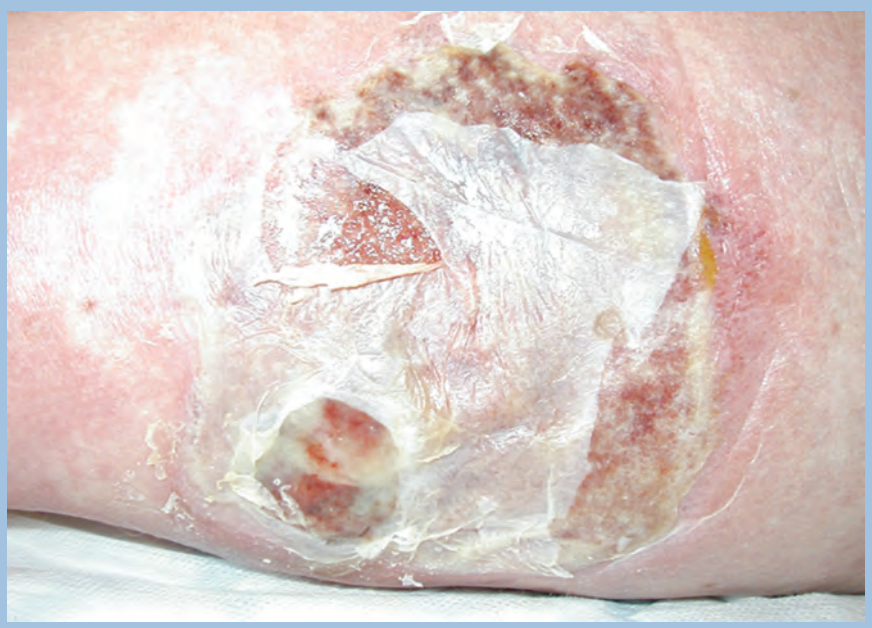

Figure 4. Yellow/red wound.

wound on the Wound Healing Continuum. By utilising an autolytic (moisture-absorption) treatment, the wound is successfully debrided and has moved on to the next stage of the Healing Continuum — 'red' (*Figure 5*).

Granulation and epithelialisation

Where a wound has been categorised as 'red' or 'red/pink', the main objective is the promotion of granulation tissue and then epithelialisation. Granulation (red) and epithelial (pink) tissue are the final two stages of the Wound Healing Continuum.

Active treatment

Topical negative pressure therapy (VAC® – vacuum assisted closure) is used in the management of large granulating wounds, particularly cavity wounds. A foam pad is placed into the wound, which is then sealed and negative pressure applied via a vacuum pump. This facilitates the promotion of granulation tissue as well as removing excess exudate (Moore, 2005).

Moisture donation

The fragile nature of granulation tissue means that it has to be kept moist to prevent desiccation and delayed tissue growth. Products such as hydrocolloids, hydrogels and honey, can all deliver moisture to the wound bed, thus supporting granulation. Hydrocolloids, sheet hydrogels and sheet honey dressings can also provide an element of moisture absorption (Cooper, et al, 2003), but this is not their main function which is that of moisture donation.

Moisture absorption

An excess of moisture on the wound bed can lead to maceration of the wound margins and delayed healing (Cameron and Powell, 1992). Alginates, cadexomer iodine, collagen products, foams and Hydrofiber®) absorb exudate, providing the ideal environment for the promotion of granulation tissue and epithelialisation of the wound.

Promotion of granulation and epithelial tissue in clinical practice

In *Figure 6*, the patient has presented with an abrasion to the knee. The wound is categorised as 'red' on the Wound Healing Continuum. Depending on the outcome of the assessment, the correct product selection will lead to a 'pink' wound as seen in *Figure 7*.

Using the Wound Infection Continuum to assess bioburden

While all chronic wounds left to heal by secondary intention will contain bacteria throughout, it is the delicate balance between the host (immune) response and the pathogen that must be managed if infection is to be avoided (Casadevall and Pirofski, 2000). The mere presence of colonising bacteria in a chronic wound is usually of no clinical significance, as this level of bioburden does not impair healing (Leaper, 1994).

From a clinical management perspective, it is the recognition of the state of the wound — with respect to the infection status — that is the challenge. The key to good wound management is to avoid infection. It is important to recognise the subtle signs and symptoms that precede infection, and to intervene accordingly. These factors are included in the evolving 'Wound Infection Continuum' and the related treatment guidelines.

The concept for building a bridge between microbiological theory and clinical practice is called the Wound Infection Continuum. This continuum seeks, in a highly simplified form, to align the states of colonisation, critical colonisation, local infection and spreading infection, with the

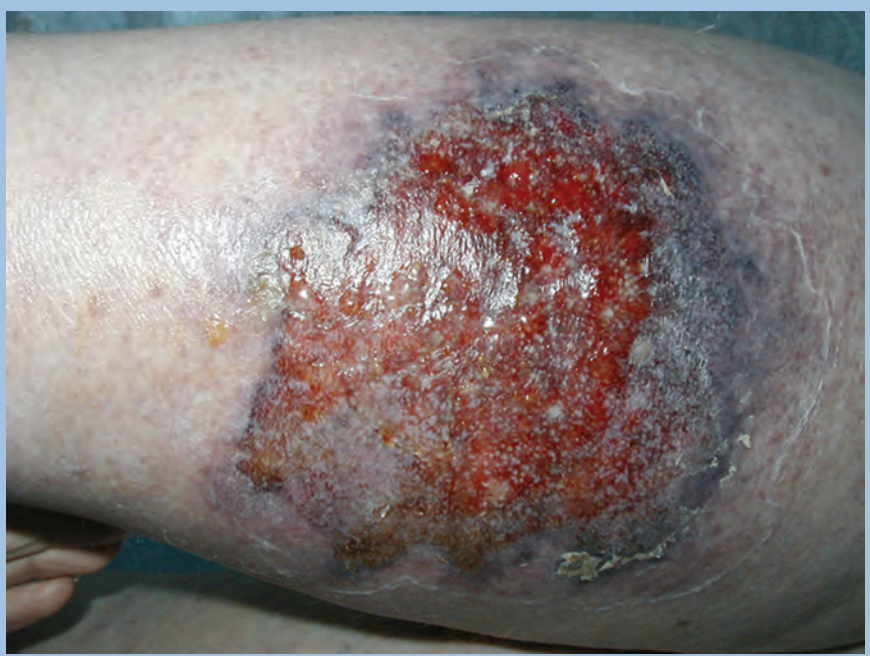

Figure 5. Red wound.

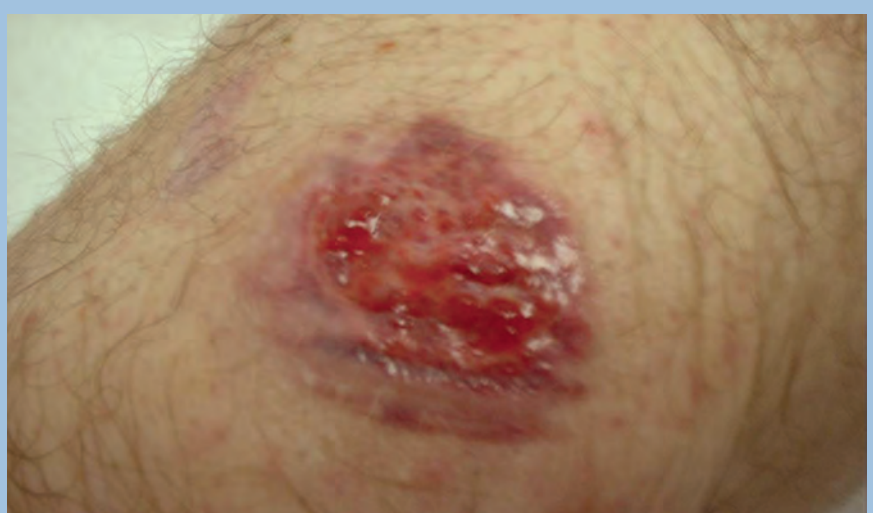

Figure 6. Red wound.

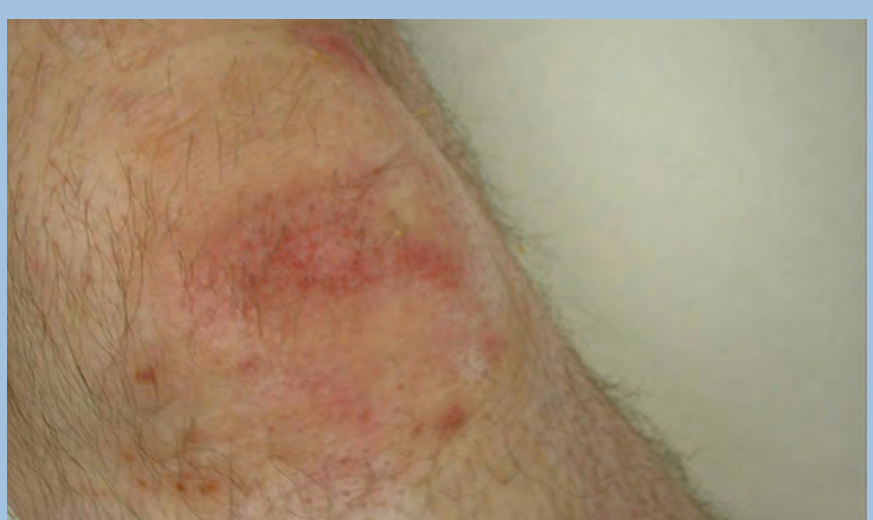

Figure 7. Pink wound.

probable bacterial bioburden and host response, thereby enabling the practitioner to interpret what is happening. In particular, it is possible using the Wound Infection Continuum to guide the appropriate use of the plethora of new antimicrobial therapies that are now available. This makes for good 'prescribing' in terms of both clinical- and cost-effectiveness.

Infection, critical colonisation and colonisation

The normal microbiological state of a healing wound is that of colonisation, which represents a stable state where growth and death of organisms is balanced or below the immune system's healing disruption threshold (Heinzelmann et al, 2002).

This classification has been used to provide guidance on the route of administration for systemic antibiotics. Schultz et al (2003) describe four levels of microbial interaction:

- Contamination
- Colonisation
- Critical colonisation
- Infection.

Edwards and Harding (2004) include two further levels:

- Spreading invasive infection
- Septicaemia.

Dow et al (1999) and Schultz et al (2003) utilise, with other factors, a ring of cellulitis of <2cm to suggest antibiotic treatment via oral route, with extensive cellulitis (by absence of further definition presumed to be >2cm) requiring intravenous therapy.

The stages in the Wound Infection Continuum identify different states of microbiological and immunological activity.

Each successive stage from left to right on the Continuum (*Figure 8*), involves an increase in the quantity of microbes, a new pathogen arrival, an increase in the quantity of virulent organisms, or an increase in the virulence (Wilson et al, 2002) of the collective species mixture through bacterial synergy (Bowler et al, 2001). The situation may shift in favour of the microorganisms if the host immune response is impaired or suddenly reduced (Heinzelmann et al, 2002). In addition, shift may result from the presence of potentiating factors, such as the introduction of foreign bodies that reduce the necessary inoculum needed to produce a worsening microbiological environment.

Identifying and obtaining treatment objectives

The Wound Infection Continuum is a useful adjunct to the identification of treatment objectives (Gray et al, 2005). At different stages of the Continuum, there is likely to be the need for a different treatment objective.

Spreading infection: remove blood stream infection and reduce wound and surrounding tissue bioburden

The presence of a spreading infection associated with an open wound is a systemic disease, which requires a systemic response. As such, the choice of dressing will have little impact on the spreading infection. A systemic response, in the form of antibiotics, is likely to be the treatment of choice.

Localised infection: remove infection from surrounding tissue and reduce wound bioburden

Some authors suggest that a localised infection can be treated using topical antimicrobials alone, without recourse to antibiotics (European Pressure Ulcer Advisory Panel [EPUAP], 1999). Others, however, recommend the use of topical antimicrobials with oral antibiotics (Kingsley, 2005). Where the practitioner is satisfied that the patient's overall condition does not suggest a high risk of the infection developing into a spreading infection, it would seem reasonable to adopt a topical antimicrobial-only approach. However, the practitioner should remain alert to the possibility of an exacerbation of the infection, and be prepared to alter the treatment as required. In addition, it would be valuable to set a period of time from the outset in which a reduction of signs and symptoms of infection

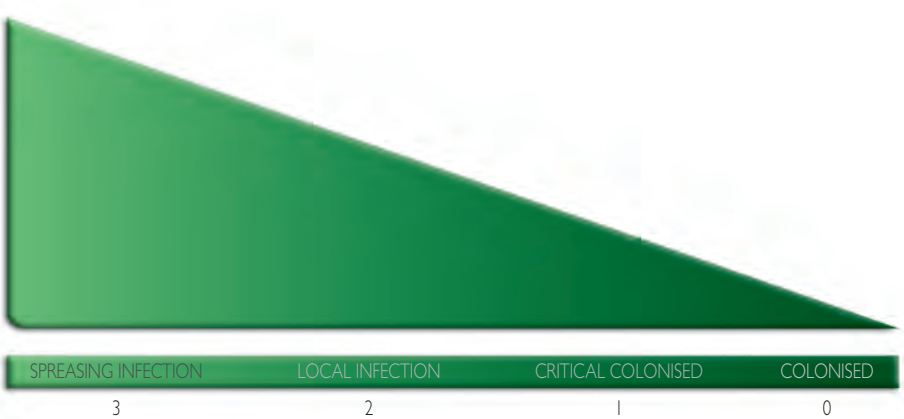

Figure 8. The Wound Infection Continuum.

would be expected to start (eg. <7 days or perhaps by the return of swab culture results), as it would be inappropriate to allow pain to continue unnecessarily or for the wound bed to deteriorate.

Critical colonisation: reduce wound bioburden

In critically colonised wounds, the level of bacteria must be reduced for healing to occur. The topical application of an antimicrobial is probably the most effective way in which to reduce the critically colonised wound bioburden to levels that allow the wound to heal (Cooper, 2004).

Colonised: maintain wound bioburden

Wounds that are identified as colonised do not require any form of topical antimicrobial as the wound bioburden is in a healthy state. Only where there are concerns regarding the patient's immune response, or overall medical condition, should topical antimicrobials be used prophylactically, for example, wounds with a history of recurrent infection, including some diabetic foot ulceration and wounds on lymphoedematous limbs. The indiscriminate prophylactic use of antimicrobials is to be discouraged.

Wound products used to attain treatment objectives

Topical antimicrobial dressings vary in their presentation and action in the wound. The wound treatments available are categorised into two distinct groups: active and passive. These terms describe the mode of the respective dressings, as some dressings donate antimicrobial properties into the wound (active), and others seek to act upon the bacteria as they pass into the dressing (passive).

Using the Wound Exudate Continuum to aid wound assessment

Wound healing occurs in four overlapping phases: haemostasis; inflammation; granulation/epithelialisation; and tissue remodelling (Davidson, 1992). Upon injury, vasoconstriction occurs with the aim of reducing blood loss. Haemostasis is achieved by the formation of a clot, which seals the wound. Following haemostasis the inflammatory process begins, during which wound exudate is produced by the tissues surrounding the wound. Normal serous exudate is essential to the healing of the wound (Field and Kerstein, 1994). However, wound exudate is not always 'normal' in terms of volume and/or consistency; it can present significant management challenges and be a sign of underlying problems relating to the wound bioburden (Cutting, 2004; Vowden and Vowden, 2003, 2004).

Where a wound is healing without complication, exudate can be considered a normal feature. It is produced when blood vessels dilate, post-haemostasis, as part of the inflammatory process. Endothelial cells swell and so open gaps in the vessel wall, permitting extravasation of serous fluid. The presence of this fluid in the tissues surrounding the wound contributes to localised pain, heat, and swelling; symptoms associated with inflammation.

Wound exudate has a key role to play in the moist wound healing process as it provides not only moisture, but also factors, which effect the removal of dead tissue and the formation of new tissue.

Assessing exudate

Traditionally, exudate has been described in terms of its perceived volume, eg. as light/low, moderate, or heavy (Watret, 1997). This form of assessment is subjective and difficult to quantify in the absence of significant investigation, such as the weighing of dressings pre- and post-use (Thomas, 1997). Vowden and Vowden (2003, 2004) suggest that exudate volume should not be viewed in isolation, but in conjunction with viscosity. The authors suggest that wound exudate volume and viscosity be assessed by:

- Considering the exudate that is retained within the dressing
- Noting the number of dressing changes required in forty-eight hours
- Visual inspection of the wound.

The Wound Exudate Continuum (*Figure 9*) is offered as an aid to quantifying the volume and viscosity of wound exudate. The gradings for both of these features are 'high', 'medium' and 'low', and allow wound exudate to be categorised by a numerical score. For example, a wound with exudate of low volume and of medium viscosity would be in the low/medium category and would score 4 (placing it in the low exudate [green] portion of the continuum). Any score in the green zone should be seen as advantageous to wound healing. If the wound exudate score is 6, then this places the wound in the amber zone. Wounds that are assessed as being in the amber zone require careful consideration, as this category could either indicate an improvement or deterioration in the wound's

condition. For example, if the previous recording had been in the green zone, the practitioner should seek to identify why the wound has moved (deteriorated) into the amber zone. A change in score to red from amber, ie. a deterioration, may be because of an alteration in the wound bioburden, indicating critical colonisation or the development of an infection. However, if the previous score had been in the red zone, an amber score would indicate an improvement in the condition of the wound. Any score in the red zone should be investigated urgently as this may indicate local or spreading infection, particularly if the previous score had not been in this zone.

Identifying and obtaining treatment objectives

Any wound assessed as having both high viscosity and high volume of wound exudate, would score a full 10 points and be regarded as causing serious concern. It is likely that such a wound may indicate a spreading infection, sinus or fistula formation, or some other cause for concern. Regardless of the zone, the assessment points to the treatment objectives will fall into one of three categories:

1. Absorb moisture.
2. Maintain current moisture balance.
3. Donate moisture.

When these objectives are added to the objectives identified using the Wound Healing and Wound Infection Continuums, a clear picture of the overall treatment objectives is achieved.

Once an assessment has been carried out and a colour zone identified using the Wound Exudate Continuum, it is possible to identify which product may be suitable.

Product functions

Device/dressings

In this category there are two different products. First, VAC® (topical negative pressure), which works by applying negative pressure to a wound bed and thus removing the exudate via a tube to a canister.

This product can function across the spectrum of exudate zones. A Wound Manager™ (ConvaTec) is a device similar in construction to a colostomy bag, which acts as a reservoir where there are large amounts of exudate. Generally, the Wound Manager™ has a short-term application in acute situations such as dehisced abdominal wounds.

Primary dressings

These dressings are applied directly to the wound bed and absorb exudate. Two classes of dressings have an antimicrobial function when combined with silver; namely, silver alginate and Hydrofiber® plus silver. The capillary dressing has no antimicrobial function, but has a large capacity to absorb fluid and wick it away from the wound bed. All of these primary dressings require a secondary dressing to cover them.

Primary/secondary dressings

The dressings in these categories can be applied as primary dressings (which do not require a secondary dressing), such as the hydrocolloids, hydrogel sheets or film dressings.

Foam dressings can act as a primary dressing, but are also frequently used as secondary dressings, absorbing exudate which has passed through the primary dressing.

Some products in these categories contain antimicrobial agents, and there are products which can also donate moisture to the wound bed as required. WE

	VISCOSITY		
VOLUME	HIGHT 5	MEDIUM 3	LOW 1
HIGH 5			
MEDIUM 3			
LOW 1			

Figure 9. The Wound Exudate Continuum.

A complete version of this article can be read in the book Essential Wound Management*, which is available atwww.woundsuk.com*

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