WORLD UNION OF WOUND HEALING SOCIETIES

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CONSENSUS DOCUMENT

WOUND EXUDATE

EFFECTIVE ASSESSMENT AND MANAGEMENT

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CONSENSUS DOCUMENT

FOREWORD

Exudate plays a key role in wound healing. However, exudate can delay healing when in the wrong amount, in the wrong place, or of the wrong composition. Effective assessment and management of exudate is therefore key to ensuring timely wound healing without complications.

Since the World Union of Wound Healing Societies (WUWHS) last issued guidance on exudate management in 2007, understanding of exudate and healing has moved on. In addition, some new treatments have become available and the roles of others have developed.

Recognition for the need for more up-to-date guidance resulted in this consensus document. The process of developing the document started with a meeting of an international group of experts in June 2018 and was followed by extensive review by the Core Expert Working Group and a Review Panel.

This new consensus document provides clear, practical guidance that will help clinicians to effectively assess and manage exudate to prevent exudate-related complications and to improve outcomes for patients.

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ROLE AND COMPOSITION OF WOUND EXUDATE

Wound exudate is produced as a natural and essential part of the healing process (Lloyd Jones, 2014). However, overproduction of wound exudate, in the wrong place or of the wrong composition, can adversely affect wound healing (Moore & Strapp, 2015).

Definition of wound exudate

Informal terms for wound exudate include 'wound fluid' or 'wound drainage' (WUWHS, 2007). In reference to this consensus document, exudate is best defined as: "Exuded matter; especially the material composed of serum, fibrin, and white blood cells that escapes into a superficial lesion or area of inflammation" (Merriam-Webster Dictionary, 2018).

Importance of wound exudate

In wounds that are healing naturally through the standard stages of wound healing, exudate supports the healing process by:

- Providing a moist wound environment
- Enabling the diffusion of immune mediators and growth factors across the wound bed
- Acting as a medium for the migration of tissue-repairing cells across the wound bed
- Supplying essential nutrients for cell metabolism
- Promoting the separation of dead or damaged tissue (autolysis) (Cutting, 2003; WUWHS, 2007).

Wounds with a moist environment heal more quickly than those that dry out and form scab (Winter, 1962). In fact, moist wounds heal 2–3 times faster than dry wounds (Swezey, 2014).

Exudate is a normal part of healing; however, it can cause problems in the wrong amount, in the wrong place or when of the wrong composition. Clinicians need to be able to clearly identify when exudate is having adverse effects

Composition of wound exudate

Wound exudate is derived from blood and so contains a wide variety of components (Table 1) (Trengove et al, 1996; White & Cutting 2006). It also contains metabolic waste products, micro-organisms, and can contain wound slough and devitalised tissue debris (White & Cutting, 2006).

If the wound is connected to the urinary or gastrointestinal tract – i.e. includes a urinary or enteric fistula – the drainage from the wound might include urine or gastrointestinal tract contents, such as gastric fluid or faecal matter and the microorganisms associated with each.

Table 1 | Examples of exudate components (White & Cutting, 2006; Gibson et al, 2009; McCarty & Percival, 2013; Bernardi et al, 2014)

Exudate component	Comments
Water	Medium for other components; prevents tissues drying out
Fibrin	Blood clotting
Glucose	Cellular energy source
Immune cells, e.g. lymphocytes and macrophages	Immune defence, growth factor production
Platelets	Blood clotting
Proteins, e.g. albumin, fibrinogen, globulins	Transport of other molecules, anti-inflammatory effects, blood clotting, immune functions
Growth factors	Stimulate cellular growth
Proteases (protein-degrading enzymes)	Degradation of proteins, assisting in autolysis and cell migration, scar remodelling
Metabolic waste products	By-products of cellular metabolism
Micro-organisms	All wounds contain some micro-organisms
Wound debris/dead cells	Proteases in exudate aid autolysis of devitalised tissue

Exudate from healing and non-healing wounds

Comparisons of the composition of exudate from healing and non-healing wounds have revealed some interesting differences, which may help to explain the slow healing that characterises chronic wounds (Table 2). For example, non-healing wounds have higher levels of inflammatory molecules, which stimulate the production of enzymes that degrade proteins (proteases). The raised levels of proteases (human and microbial) interfere with the healing process by degrading growth factors, hindering cellular proliferation and migration and disrupting the newly formed extracellular matrix (Gibson et al, 2009).

Table 2: Examples of differences in wound exudate composition between non-healing and healing wounds (Yager et al, 1996; Trengove et al, 1999; Trengove et al, 2000; Barrientos et al, 2008; Schultz et al, 2011; Stacey, 2018)

Exudate component/ characteristic	Level in non-healing wounds (in comparison with healing/acute wounds)	Comments
Pro-inflammatory cytokines	Higher	Cell-signalling molecules (cytokines) that stimulate the inflammatory process can increase levels of MMPs in relation to the levels of the proteins that inhibit MMP activity; in effect this increases MMP activity
Matrix metalloproteases*: MMP-2 and MMP-9	10–25 x higher	High levels of MMPs may result in degradation of growth factors; if rates of extracellular matrix (ECM) degradation match or exceed rates of ECM production, healing can be slowed or halted
Growth factors	Lower	Growth factors stimulate the proliferation and migration of cells involved in new blood vessel formation, epithelialisation, wound contraction and the deposition of extracellular matrix. In non-healing wounds, levels of growth factors are lower than in healing wounds, probably mainly because of degradation by proteolytic enzymes
Mitogenic activity**	Lower	Proliferation of fibroblasts (mitosis), a key aspect of wound healing, is stimulated to a much lower extent by fluid from non-healing wounds than by fluid from healing wounds

**Matrix metalloproteases (MMPs) are released by macrophages, endothelial cells and epidermal cells and degrade proteins, including those in the extracellular matrix.*
***Ability of wound exudate to stimulate fibroblast proliferation.*

The differences in the biochemical composition of exudate from non-healing and healing wounds have pointed to possible causes of wound chronicity and also indicate potential targets for therapeutic interventions aimed at stimulating healing

FORMATION OF WOUND EXUDATE

Wound exudate is derived from interstitial fluid found in the spaces between cells in body tissues (the interstitium). Interstitial fluid is formed from the blood in capillaries and has similar components to blood plasma (Kiang et al, 2017). Interstitial fluid acts as a transport medium for cell nutrients, signalling molecules and metabolic waste (Kiang et al, 2017). When it leaks into a wound cavity, it forms the basis of wound exudate.

Understanding the processes underlying wound exudate production will enable clinicians to consider all likely causes and plan suitable interventions when exudate is interfering with wound healing

Interstitial fluid balance

To prevent fluid accumulation in the tissues and maintain homeostasis, a mechanism for the drainage and recirculation of interstitial fluid is required. Until relatively recently, it was thought that about 90% of interstitial fluid was reabsorbed into capillaries, as described by E.H. Starling's principle of reabsorption (Starling, 1896). The remaining 10% was thought to drain back into the blood via lymphatic vessels (Ganong, 2005).

However, recent research has revealed that the lymphatic system has a more prominent role in maintaining fluid circulation than previously thought. It is now understood that in most tissues, and in normal circumstances, there is no reabsorption into capillaries (Mortimer & Rockson, 2014). The interstitial fluid – about 8 litres per day – is taken up by the lymphatic system, where it becomes lymph and is returned eventually to the central circulatory system (Levick & Michel, 2010; Mortimer & Rockson, 2014).

Factors affecting interstitial fluid levels

The amount of interstitial fluid in a body tissue is controlled by a complex interaction of factors, including those that control fluid formation (Box 1) and those that control lymphatic drainage.

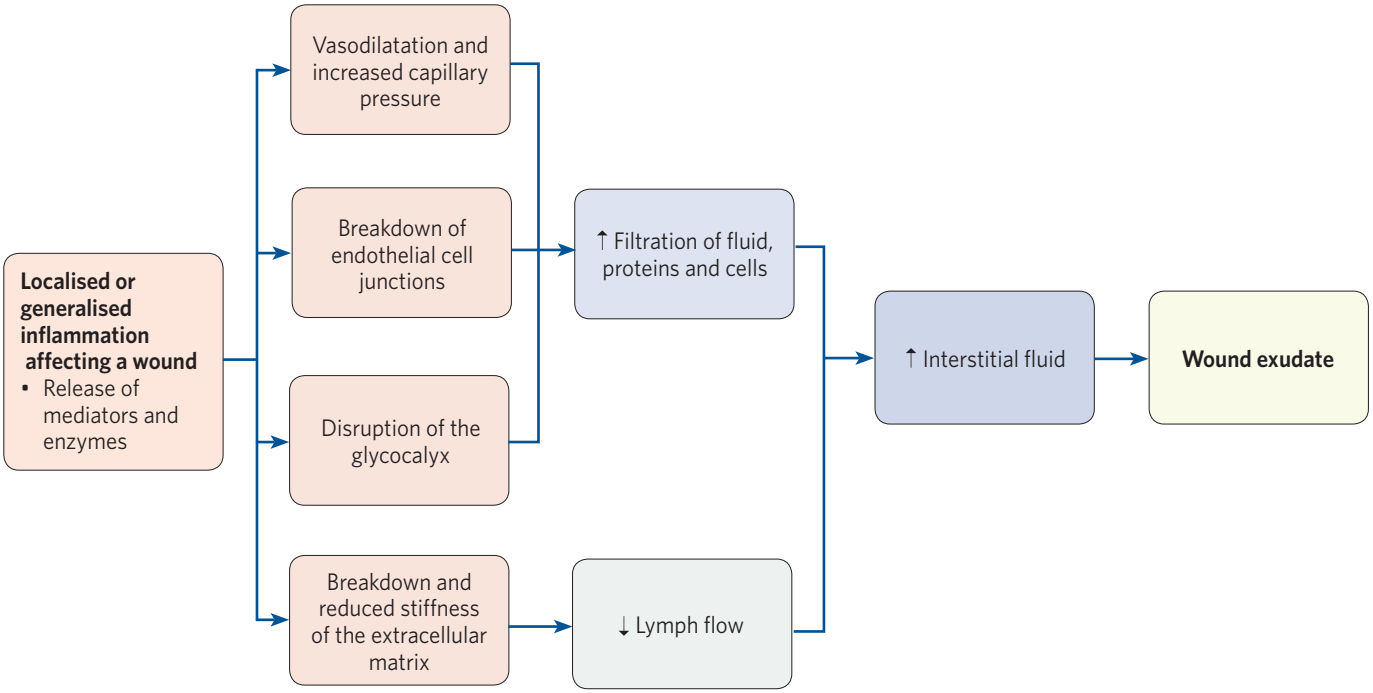
If the rate of interstitial fluid production exceeds the drainage capacity of the lymphatic system, e.g. because of high interstitial fluid formation and/or reduced lymphatic flow, tissue oedema results (Mortimer & Rockson, 2014). If a wound is present in the area affected, the amount of fluid draining from the wound will increase.

Any factor that increases the amount of interstitial fluid held in wound tissues will increase the amount of wound exudate from the wound surface

Box 1: Main factors influencing interstitial fluid production (Levick & Michel, 2010; Huxley &Scallan, 2011)

- **Hydrostatic pressure** – the pressure produced by fluid in the capillaries or tissues – e.g.:
  - Increased capillary hydrostatic pressure, e.g. due to hypertension or venous stasis, will increase filtration of fluid out of the capillary
- **Oncotic pressure** – the tendency of the molecules in the fluid to attract more fluid; in blood and interstitial fluid this is mainly due to the proteins present and may be called colloid oncotic pressure – e.g.:
  - If the oncotic pressure of blood is reduced because of lower protein levels, e.g. due to malnutrition or chronic renal disease, more fluid will leave the capillaries and enter the interstitial space
- **Permeability of the capillary wall** – the 'leakiness' of the capillary wall – e.g.:
  - Increased permeability of the capillary wall will allow fluid, large molecules such as proteins, and cells to move into the tissues

Figure 1: Role of inflammation in exudate production (Scallan et al, 2010)



Role of inflammation in exudate production

The process of wound healing is divided into four overlapping phases: haemostasis, inflammation, proliferation and remodelling (Velnar et al, 2009). In general, exudate production is highest during the inflammatory phase and decreases as healing progresses (Schultz et al, 2011).

The inflammatory process triggered by formation of a wound releases a range of substances (mediators and enzymes) that, among other effects, increase interstitial fluid production and so encourage the formation of wound exudate (Scallan et al, 2010) (Figure 1)

Inflammation-induced increase in capillary permeability

Of note is the increase in capillary permeability induced during inflammation. The tight junctions between the cells that form the capillary walls (the endothelial cells) and the porous carbohydrate-rich lining of capillaries have important roles in regulating fluid, protein and cell release into surrounding tissues. Inflammatory mediators break down the proteins that hold the endothelial cells tightly together and disrupt the lining, allowing fluid, proteins and cells to escape more readily (Lipowsky et al, 2011; Schött et al, 2016; Reglero-Real, 2016).

In wounds that are not healing, heightened and ongoing inflammation is a likely contributor to increased exudate production. This may be related to wound infection and/or the presence of biofilm (Schultz et al, 2011; Percival, 2017)

Other mechanisms of exudate formation

Although the liquid found in wounds is usually referred to as exudate because of its high protein and cell content, it may also contain transudate, a low protein filtrate of blood (Table 3). Tests to differentiate between exudate and transudate are undertaken in some conditions, e.g. pleural effusions and ascites, to help establish likely cause (Kopcinovic & Culej, 2014). Although such testing is not used in wound management, understanding that wound drainage can comprise exudate and transudate can help clinicians determine reasons for any increase in wound drainage and so identify and implement appropriate management.

In patients with comorbidities that increase capillary hydrostatic pressure (e.g. venous stasis) or decrease capillary oncotic pressure (e.g. malnutrition), increased levels of wound drainage might be explained by higher rates of transudation

Table 3: Overview of exudate and transudate (Damjanov, 2009; Firat, 2018)

Characteristic	Exudate	Transudate
Mechanism of formation	■ Increased capillary permeability usually due to inflammation, e.g. infection or other inflammatory process	■ Increased capillary hydrostatic pressure, e.g. due to venous stasis ■ Decreased capillary oncotic pressure, e.g. due to low serum protein from malnutrition
Composition	■ High protein ■ High cell count, e.g. high white blood cell count	■ Low protein ■ Low cell count

What is a normal rate of exudate production?

Research measuring exudate production has used different study methods and sometimes units of measurement (Table 4). For methods of measurement such as dressing weight, study results may be an underestimate because they do not allow for evaporation of fluid from the dressing surface.

Although it is clear too much or insufficient exudate delays healing, there is no internationally accepted standard method for measuring the rate of exudate production nor is there an accepted 'normal' rate

Table 4: Published exudate production rates

Wound type	Method of exudate production measurement	Rate of exudate production ($g/cm^2/24$ hours)
Leg ulcers	Dressing weight (Dealey et al, 2006)	0.17–0.21
	Dressing weight (Thomas et al, 1996)	0.43–0.63
Various	Negative pressure wound therapy canister collection (Dealey et al, 2006)	1.3*
Granulating wounds	Vapour pressure gradient (evaporative water loss) (Lamke et al, 1977)	0.51
Skin donor sites	Vapour pressure gradient (evaporative water loss) (Lamke et al, 1977)	0.42
Partial-thickness burns	Evaporimeter (Ferguson et al, 1991)	0.42–0.86
	Vapour pressure gradient (evaporative water loss) (Lamke et al, 1977)	0.43
Full-thickness burns	Vapour pressure gradient (evaporative water loss) (Lamke et al, 1977)	0.34

**Units: ml/cm²/24 hours*

EXUDATE-RELATED CLINICAL PROBLEMS

Box 2: Wound types that may produce high or low levels of exudate (Bates-Jensen & Ovington, 2007; Gardner, 2012; International Best Practice Guidelines, 2013; WUWHS, 2018)

- High levels of exudate
  - Chronic venous leg ulcers (VLUs)
  - Dehisced surgical wounds
  - Malignant fungating wounds
  - Burns
  - Inflammatory ulcers – e.g. rheumatoid ulcers, pyoderma gangrenosum
  - Skin donor sites
- Low levels of exudate
  - Ischaemic/arterial wounds
  - Neuropathic diabetic foot ulcers

Wound exudate can delay healing, severely affecting a patient's quality of life and producing significant socioeconomic burden when:

- The amount of the exudate is excessive or insufficient

and/or

- The composition of the exudate is abnormal

and/or

- The exudate is in the wrong place (Moore & Strapp, 2015).

Excessive or insufficient exudate production

The amount of exudate produced by a wound is dependent on:

- Wound aetiology – some wound types are more prone to high or low exudate levels (Box 2)
- Wound healing phase – the amount of exudate produced by a wound usually diminishes as healing progresses (Wounds UK, 2013)
- Wound size, depth and position – larger and deeper wounds may produce higher levels of exudate, as can wounds in dependent parts of the body, e.g. the lower leg (Dowsett, 2012)
- Comorbidities, complications and other factors – there are many other reasons for increased or decreased exudate production (Table 5).

Increased exudate production is often related to factors that cause inflammation (e.g. infection) or generalised/localised oedema (e.g. venous insufficiency, lymphatic disease)

Table 5: Factors that may influence exudate production (adapted from WUWHS, 2007; Iizaka et al, 2011; Wounds UK, 2013; Browning et al, 2016)

Factor type	Examples of factors that may alter exudate production	
	Increased exudate production	**Decreased exudate production**
Wound healing stage	■ Inflammatory stage of normal wound healing	■ Towards the end of the healing process
Local factors	■ Wound infection/biofilm, inflammation or trauma (e.g. surgical debridement) ■ Wound bed foreign body ■ Oedema near the wound – e.g. due to venous insufficiency, vena cava obstruction, lymphatic dysfunction/lymphoedema ■ Wound bed sinus ■ Wound bed fistula* – e.g. urinary, enteric, lymphatic or joint space ■ Tumour	■ Wounds with dry eschar ■ Ischaemia of the wound location
Systemic factors	■ Congestive cardiac, renal or hepatic failure ■ Infection/inflammation ■ Endocrine disease ■ Systemic medication – e.g. calcium channel blockers, non-steroidal anti-inflammatory drugs (NSAIDS), steroids, glitazones ■ Obesity ■ Fluid overload during intravenous therapy ■ Malnutrition ■ Increased age ■ Low serum albumin levels ■ Raised C-reactive protein (CRP)	■ Dehydration ■ Hypovolaemic shock ■ Microangiopathy
Practical factors	■ Wound position – e.g. wound is in a dependent position on the lower limbs or sacral area ■ Heat ■ Reduced willingness or ability of the patient to co-operate with pharmacological or non-pharmacological treatment ■ Inappropriate dressing/device/intervention**	■ Inappropriate dressing/device use or intervention**

**Drainage from a fistula within a wound bed is not wound exudate. However, for practical purposes exudate and fistula drainage are often managed together.*

***An apparent increase or decrease of exudate production in relation to inappropriate dressing/device/intervention may not be a true reflection of what is happening with the wound.*

Box 3: Problems associated with excessive exudate production (WUWHS, 2007; Dowsett et al, 2012; Wounds UK, 2013)

- Leakage and soiling
- Malodour
- Increased risk of infection
- Frequent dressing changes
- Discomfort/pain
- Protein loss and fluid/electrolyte imbalance
- Periwound skin damage, e.g. maceration and erosions
- Wound expansion
- Psychosocial effects

Effects of excessive exudate production

Excessive exudate production can be associated with a wide range of problems (Box 3). Leakage and soiling can be particularly distressing to patients and carers, and can be burdensome because of increased needs for washing of clothing and bed linen. Leakage or strikethrough may result in odour (which is sometimes, but not always, a sign of increased wound bioburden or infection). Leakage/strikethrough may also increase the risk of infection by providing a route by which micro-organisms can enter the wound.

Frequent dressing changes may be required to ensure containment of the exudate or to monitor the wound. Frequent dressing change may also be of benefit in preventing potential infection and biofilm formation (IWII, 2016). However, frequent dressing changes may be taxing and distressing to the patient, especially if associated with pain, and can cause wound bed or periwound skin damage (Wounds International, 2016). Consequently, further studies investigating the potential impact and benefits of increased dressing change frequency and positive clinical outcomes are required.

Other causes of discomfort and pain in patients with an excessively exuding wound include periwound skin damage and a 'drawing' pain sometimes produced by dressings with a high rate of absorbency (Dowsett, 2012), especially when used in wounds where levels of exudate is decreasing.

High levels of exudation may also result in significant protein loss and put the patient at risk of fluid/electrolyte imbalance. For example, it has been estimated that a patient with a Category/Stage IV pressure ulcer (i.e. a pressure injury with full thickness tissue loss with exposed bone, tendon or muscle), could lose 90–100g/day of protein in exudate (Benbow & Stevens, 2010). This is more than the recommended daily intake of protein for many adults (Wolfe et al, 2017).

Excessive exudate can have a serious psychosocial impact on patients and reduce quality of life (Benbow & Stevens, 2010). For example, patients' work, social and home lives may be disrupted by dressing changes or by fear and embarrassment related to leakage or odour, which can prevent patients from leaving their homes.

Effects of insufficient exudate production

Insufficient exudate production may delay autolytic debridement and so delay healing (WUWHS, 2007). Adherence of dressings to the wound bed in wounds with low exudate production may cause wound bed damage and pain during dressing removal. In such cases, wound dressings that donate moisture may help to balance the lack of sufficient moisture and prevent pain.

Effects of abnormal exudate composition

Exudate produced by slow-healing wounds is different to that of healing or acute wounds and often has higher levels of inflammatory mediators and proteolytic enzymes (Table 2). Inflammatory mediators stimulate human and microbial protease production, which then results in growth factor and extracellular matrix degradation in the wound bed (Gibson et al, 2009) (Figure 4). Clinically, these effects manifest as further delays to wound healing. Indeed, when protease activity in a wound is elevated, there is a 90% chance that the wound will not heal (Moore & Strapp, 2015). Furthermore, if the exudate comes into contact with periwound skin, it can damage the skin and even cause wound expansion (Wounds UK, 2013).

Figure 2: Periwound maceration (photograph courtesy of Dr Paul Chadwick)

Periwound skin damage

Periwound skin damage includes maceration and erosions of the skin surface (Figure 2). Over/hyper-hydration may begin to occur, which can be reversible, but may lead to maceration. Maceration is a softening of the skin due to prolonged exposure to moisture and proteolytic enzymes, which predisposes skin to breakdown (Voegeli, 2012). Macerated skin is usually pale in colour (Voegeli, 2013), but if inflamed may become red. Changes of colour in macerated skin are potentially important and should be monitored.

Skin erosions are due to partial loss of the skin surface. In the context of maceration, skin erosion is often called excoriation, although strictly speaking excoriation is skin erosion due to scratching, rubbing or picking (MSD Manual, 2018).

Once the skin is damaged, it is more susceptible to the effects of irritants and may become inflamed (Woo et al, 2017)

Health economic impact of exudate-related problems

The specific health economic impact of exudate-related problems is unclear. However, the management of wounds is known to place a huge burden on healthcare systems:

- In Canada in 2011, the cost of treating diabetic foot ulcers was estimated to be $509 million (Canadian) (Hopkins et al, 2015)
- In the UK between 2012 and 2013, it was estimated that 2.2 million patients were treated for an acute or chronic wound by the National Health Service (NHS) at a cost of £4.5–5.3 billion (Guest et al, 2015)
- In the US in 2014, Medicare expenditure for all wound types was estimated to be US$28.1–96.8 billion (Nussbaum et al, 2018).

Therefore, any factors that delay healing and extend treatment time, including exudate-related problems, will have a detrimental health economic and societal impact.

Despite common perceptions, the principal driver of wound care costs is the cost of providing the care, and not the cost of the dressings/devices used. Analyses of two large general practitioner databases in the UK found that wound dressings accounted for just 2.9% of total wound care costs in one database and wound care products accounted for 13.9% in the other (Guest et al, 2015; Phillips et al, 2016).

Further to dressing costs and the cost of providing care, additional costs include those related to:

- Prolonged healing time and potential complications
- Care of damaged periwound skin
- Soiled linen and clothing

Evaluation of the cost-effectiveness of wound management needs to consider all related costs, i.e. the cost of an 'episode of care'; a focus on using the cheapest individual dressings and devices is unlikely to reduce overall costs or improve cost-effectiveness

ASSESSMENT OF WOUND EXUDATE

Assessment of wound exudate should take place in the context of a structured holistic wound assessment. Elements this should include are: the overall health of the patient, current wound management, patient/carer concerns, the cause of the wound, the wound itself, the exudate, the periwound area and the risk for future wound development (Table 6).

Structured holistic wound assessment – including exudate assessment – should be documented according to local policy

Wound assessment frameworks

Several generic wound assessment frameworks have been developed. These can be applied to all wound types and aim to support clinicians in taking a systematic approach to wound assessment, e.g.:

- TIME(S) (Schultz et al, 2004; Wounds UK, 2016; Leaper et al, 2012) – tissue, infection/inflammation, moisture imbalance, edge of the wound, (surrounding skin)
- Triangle of wound assessment (Dowsett et al, 2015) – wound bed, wound edge, periwound skin
- Generic wound assessment minimum dataset (Coleman et al, 2017) – general health information, wound baseline information, wound assessment parameters, wound symptoms, specialist investigations and referrals.

Holistic wound assessment

Holistic assessment (Table 6) will help clinicians to determine suitable short- and long-term treatment goals. It will also aid in the selection and implementation of appropriate management measures required to achieve those goals, including interventions to treat the underlying cause of the wound and to manage exudate and exudate-related problems. Holistic assessment also provides a baseline from which to assess progress and the effectiveness of the management measures.

Assessment of the overall health of the patient may help to determine the cause of the wound and any factors that may contribute to non-healing. A clear understanding of the current wound management regimen is important in assessing effectiveness and the need for adjustment.

Clarifying patient/carer concerns can help to determine treatment priorities, the most appropriate management modes, and engages patients in their care, which in turn can improve quality of life. The use of open-ended questions can help patients/carers to voice their concerns (Wounds International, 2016), e.g.:

- What worries you about your wound?
- How is your wound affecting daily living and your personal relationships?
- What issue or problem do you want to sort out first?
- What do you want to sort out in the next couple of weeks/longer term?

Patient concerns may differ from the clinician's priorities for treatment, but should be treated with respect and appropriate action taken

Assessment of the periwound area and the wound itself can provide important information about the effects and causes of abnormal exudate levels and/or composition. For example, signs and symptoms may indicate wound infection (Box 4).

Routine sampling of non-healing wounds for microbiological analysis is not usually justified. If undertaken, it should be carried out according to local protocols and interpreted in the context of clinical signs and symptoms (IWII, 2016)

It is now recognised that most chronic wounds contain biofilm (Box 5), which can disrupt healing by inducing and prolonging an inflammatory state in the wound (Fromantin et al, 2013; Schultz et al,

Box 4: Signs and symptoms of wound infection in a non-healing wound (IWII, 2016)

- New, increased or altered wound-related pain
- Delayed healing
- Wound malodour or change in odour
- Increased or altered/purulent exudate
- Periwound oedema
- Bleeding or easily damaged (friable) granulation tissue
- Wound bed discolouration
- Induration, pocketing and bridging
- Systemic signs and symptoms: malaise, loss of appetite, pyrexia or hypothermia, tachycardia, tachypnoea, elevated C-reactive protein (CRP), elevated or suppressed white blood cell count, sepsis, septic shock

Box 5: Overview of biofilm (Bjarnsholt et al, 2016; Wounds UK, 2017; Schultz et al, 2017)

- Biofilm comprises micro-organisms embedded in a matrix of molecules including proteins and DNA
- Biofilm can exist on the surface of a wound and within deeper tissues, and may be present as patches or islands
- Although biofilm is not visible to the naked eye, slough in a wound may be mistaken for biofilm. Even though slough is not biofilm, it is likely to contain micro-organisms and may be a product of biofilm-induced inflammation

Table 6: Elements of holistic wound assessment (WUWHS, 2007; Lawton, 2009; Wounds International, 2016; Wounds UK, 2018)	
Assessment domain	**Assessment items**
Overall health of the patient	■ Comorbidities – especially those that increase risk of delayed healing or infection – e.g. diabetes, peripheral vascular disease, malignancy ■ Medication/allergies/skin sensitivities ■ History of previous wounds ■ Nutritional status ■ Psychosocial status, quality of life, activities of daily living, mobility and social support/carers ■ Concordance ■ Capacity for self-care – e.g. performing dressing changes ■ Insight and understanding
Current wound management	■ Types/sizes of dressings/devices currently in use ■ Dressing/device change frequency ■ Condition of the dressing/device before and after removal ■ Periwound skin care ■ Level of patient/carer involvement and self-care ■ Reassessment frequency
Patient/carer concerns	■ Patient issues/concerns – e.g. leakage, malodour, pain, itching, sleep disturbance, interference with daily living/work, upcoming social activities ■ Short-/long-term aims ■ Management preferences
Periwound region*	■ General condition of skin – e.g. dry/moist, cool/warm/hot, thinned/thickened, discoloured ■ Erythema/cellulitis/lymphangitis ■ Maceration/skin erosions/skin stripping ■ Callus/hyperkeratosis/atopic eczema ■ Swelling/oedema ■ For foot wounds – sensation
Wound*	■ Number, location and duration of wound(s) ■ Wound type/classification ■ Wound size – maximum length, maximum width, area, depth ■ Wound bed: ❑ Tissue type (necrotic tissue/eschar; slough; granulation tissue; epithelial tissue) and proportion (%) of wound bed occupied by each ❑ Presence of sinuses or fistulae ■ Wound edges – tunnelling/undermining/rolled ■ Signs and symptoms of wound infection (local and systemic) (Box 4) ■ Wound-related pain – presence; timing and triggers; frequency; severity ■ For lower limb wounds – ankle–brachial pressure index (ABPI)
Exudate assessment	■ Type, colour and consistency ■ Amount ■ Odour
Risk for further wound development	■ Factors that may increase risk for further wounds ■ Formal risk assessment as appropriate and indicated by local policy – e.g. for pressure ulcers

**Body outline and clock diagrams can assist in recording the location and extent of clinical findings.*

2017). Currently, there is no easy-to-use test for the detection of biofilm in wounds. In the absence of overt wound infection, clinical indicators that biofilm may be interfering with healing include: delayed healing despite optimal management, increased wound exudate levels, failure of response to antimicrobial therapy, cycles of recurrent infection, low-level erythema and low-level inflammation.

During wound assessment clinicians need to recognise that different areas of the wound may be progressing at different rates or be affected by different clinical issues

EXUDATE ASSESSMENT

Assessment of exudate should include evaluating the:

- Effectiveness of current exudate management dressing/device
- Type, colour and consistency
- Amount
- Odour.

Dressing/device evaluation

Examining the dressing or device before removal from a wound and then again after removal will provide valuable information about the nature of the exudate present and the performance of the dressing/device (Box 6) (WUWHS, 2007; Bates-Jensen & Sussman, 2012).

For example, if the dressing/device is leaking, but not saturated, a better seal or a dressing with better retention capabilities may be required. However, if the dressing is saturated, a more absorbent dressing or more frequent dressing changes may be considered. In order to protect the wound and assure optimal healing, dressing changes should be as infrequent as possible. Longer wear time with a single dressing requires the device to be both highly absorbent and retentive of exudate; this will avoid wound maceration and associated complications.

Box 6: Assessing the current dressing/device (adapted from WUWHS, 2007)

- Before dressing/device removal assess for:
  - Evidence of leakage/strikethrough onto the patient's clothes, compression bandaging, bedding, footwear, secondary/primary dressing
  - Modifications made by the patient – e.g. use of plastic bags or additional absorbent material
  - Presence of malodour
  - Dressing/device comfort and conformability
  - Dressing/device fixation – e.g. type, security and integrity of the seal of fixation, evidence of skin damage caused by fixation
- After dressing/device removal assess for:
  - Colour, consistency and odour of exudate on/in the dressing/device
  - Volume of exudate if a collection device has been used
  - Level of wetness/saturation of the dressing

There is growing interest in the role and development of 'smart' dressings that incorporate sensors to measure the levels of a range of physical and biochemical markers and micro-organisms (Gianino et al, 2018)

Exudate type

Exudate type, colour and consistency (viscosity) can provide useful indicators of the stage of healing and possible problems (Table 7).

The presence of white blood cells and bacteria in the wound will thicken exudate (Davies, 2012)

A change from clear, thin exudate to opaque, discoloured, thick exudate may indicate the development of wound infection. However, clinicians should be aware that some dressing types alter the characteristics of exudate. For example, some hydrocolloid and alginate dressings may result in wound drainage that mimics purulent exudate (Bates-Jensen & Ovington, 2007).

Table 7: Types of wound exudate (Cutting & White, 2002; Bates-Jensen et al, 2012; Wounds UK, 2013; Vowden et al, 2015)			
Type	**Colour/opacity**	**Consistency**	**Comments**
Serous	Clear, amber or straw-coloured	Thin, watery	■ Normal during inflammatory and proliferative phases of healing ■ An increase in serous exudate may be a sign of infection ■ In excessive amounts may be associated with congestive cardiac failure, venous disease, malnutrition or be due to fluid draining from a urinary or lymphatic fistula
Serosanguineous	Clear, pink to light red	Thin, slightly thicker than water	■ May be considered normal during inflammatory and proliferative phases of healing ■ Pinkish due to the presence of red blood cells ■ May also be found post-operatively or after traumatic dressing removal
Sanguineous	Red	Thin, watery	■ Reddish due to the presence of red blood cells ■ May indicate new blood vessel growth or disruption of blood vessels ■ May be associated with hypergranulation
Seropurulent	Cloudy, creamy, yellow or tan	Thin	■ Serous exudate containing pus ■ May also be due to liquefying necrotic tissue ■ May signal impending infection
Fibrinous	Cloudy	Thin, watery	■ Cloudy due to the presence of fibrin strands ■ May indicate inflammation, with or without infection
Purulent	Opaque, milky, yellow, tan or brown; sometimes green	Often thick	■ Mainly pus (neutrophils, inflammatory cells, bacteria) and may include slough/liquefied necrotic tissue ■ Indicates infection ■ Green colouration may be due to infection with Pseudomonas aeruginosa ■ May be associated with odour
Haemopurulent	Reddish, milky, opaque	Thick	■ Mixture of blood and pus ■ Often due to established infection
Haemorrhagic	Red, opaque	Thick	■ Mostly due to the presence of red blood cells and indicative of increased capillary friability or trauma to the wound ■ May indicate bacterial infection

Table 8: Clinical methods of assessment of wound exudate production

Method	Details			
Wound Exudate Score (Falanga, 2000)*	**Wound exudate score**	**Extent of control**	**Exudate amount**	**Dressing requirement**
	1	Full	None/minimal	No absorptive dressings required. If clinically, feasible dressing could stay on for up to a week
	2	Partial	Moderate amount	Dressing changes required every 2–3 days
	3	Uncontrolled	Very exudative wound	Absorptive dressing changes required at least daily
Exudate amount element of Bates-Jensen Wound Assessment Tool (Bates-Jensen, 2001)	**Exudate amount**	**Indicators**		
	None	Wound tissues dry		
	Scant	Wound tissues moist; no measurable exudate		
	Small	Wound tissues wet; moisture evenly distributed in wound; drainage involves M25% dressing		
	Moderate	Wound tissues saturated; drainage may or may not be evenly distributed in wound; drainage involves >25% to M75% dressing		
	Large	Wound tissues bathed in fluid; drainage freely expressed; may or may not be evenly distributed in wound; drainage involves >75% of dressing		
Dressing: exudate interaction (WUWHS, 2007)	**Status**	**Indicators**		
	Dry	Wound bed is dry; there is no visible moisture and the primary dressing is unmarked; dressing may be adherent to wound		
	Moist	Small amounts of fluid are visible when the dressing is removed; the primary dressing may be lightly marked; dressing change frequency is appropriate for dressing type		
	Wet	Small amounts of fluid are visible when the dressing is removed; the primary dressing is extensively marked, but strikethrough is not occurring; dressing change frequency is appropriate for dressing type		
	Saturated	Primary dressing is wet and strikethrough is occurring; dressing change is required more frequently than usual for the dressing type; periwound skin may be macerated		
	Leaking	Dressings are saturated and exudate is escaping from primary and secondary dressings onto clothes or beyond; dressing change is required much more frequently than usual for dressing type		
Others (Gray, 2005; Fletcher, 2010)	■ Low, medium, high ■ None, scant, moderate, high ■ None, low, moderate, high, very high ■ Dry/none; slight (weekly dressing change); moderate (2–3 times weekly dressing change; copious (daily or more frequent changes) ■ +; ++; +++			

** New technologies developed in the last 18 years allow much better exudate management, with increased absorption and retention capabilities. Dressing change frequency is now lower, even for moderate to high exuding wounds.*

Exudate amount

Too much or insufficient exudate can delay healing. Therefore, clinicians need to be able to assess whether the amount of exudate being produced by a wound is normal, too low or too high, and, importantly, whether it has changed since the previous assessment. However, determining and classifying exudate level in an objective and meaningful way is difficult unless a canister-based negative pressure wound therapy (NPWT) device or an ostomy/fistula appliance is used to collect wound drainage.

Several other approaches to the assessment of exudate level have been proposed over the years (Table 8). These are generally quite subjective and vary in complexity and ease of use: no one approach is ideal (Iizaka et al, 2011). Many use dressing change frequency as part of the assessment. However, an expanse of factors – from clinician preference to condition of the wound to dressing absorption – affect dressing change frequency.

Overall, the Expert Working Group favoured Falanga's Wound Exudate Score (Falanaga, 2000) because

Table 9: Example of TELER indicator for assessing wound odour (Grocott, 2001)	
Score	**Indicator**
0	Odour is obvious in the house/clinic/ward
1	Odour is obvious at arm's length from the patient
2	Odour is obvious at less than arm's length from the patient
3	Odour is detected at arm's length
4	Odour is detected by the patient only
5	No odour

For more information on the TELER System see: www.longhanddata.com

of the relative simplicity and clinically helpful nature of the three-level classification (Table 8). Very simple systems (such as +, ++ and +++) can be difficult to use in practice because the lack of defined criteria for each means application tends to vary between clinicians.

The development of a useful, widely accepted wound exudate level assessment tool is awaited. In the meantime, clinicians should endeavour to be consistent in the means of assessment used with a patient and across a wound care team so that changes in level are more easily detectable (Davies, 2012)

Exudate and wound odour

Most wounds have a slight odour (Nix, 2016) and some dressings, e.g. hydrocolloids, are associated with a distinctive odour (WUWHS, 2007). However, an unpleasant malodour can arise from factors including the presence of necrotic tissue, micro-organisms, high levels of exudate, poorly vascularised tissue and/or a sinus/enteric or urinary fistula (WUWHS, 2007; Gethin et al, 2014). Extremely odorous, purulent exudate can be suggestive of wound infection (Nix, 2016). Management of malodour can be particularly challenging in patients with malignant wounds (Alexander, 2009; Thuleau et al, 2018).

Patients and carers state that malodour is the most distressing and socially isolating wound-related symptom (Gethin et al, 2014)

As yet, there is no internationally agreed method of assessment of wound odour (Gethin et al, 2014). Assessment of odour is subjective because of variation in individuals' abilities to detect smell. Even so, odour should be assessed.

Ideally odour assessment should use the same method for successive assessments of a patient and should include the strength, nature and impact of the odour and any interventions currently in place (Table 9 and Table 10)

Table 10: Assessment of odour	
Odour characteristic	**Approaches to assessment**
Strength	■ When the odour is noticeable – e.g. on proximity to the patient, before dressing/device removal, after dressing/device removal and whether the odour remains once the dressing/device has been removed for a short while; an example of this approach has been formalised in the TELER system (Table 9) ■ Absent, faint, moderate or strong (Nix, 2016) ■ Visual analogue scale, e.g. 0 = no smell to 10 = worst smell imaginable (Gethin et al, 2014)
Nature	■ Malodourous, pungent, foul ■ A smell of ammonia may indicate infection with Proteus species of bacteria (Bates-Jensen et al, 2012)
Impact	■ Psychological and social impact on the patient and carers
Interventions	■ Measures currently in place to deal with odour – e.g. topical treatments to the wound and environmental approaches

Clinicians should actively look for changes in a wound and, when observed, establish the reason for the change and manage the cause and effects of the change as appropriate

EXUDATE MANAGEMENT IN THE CONTEXT OF HOLISTIC WOUND MANAGEMENT

Effective management of wound exudate will take place in the context of comprehensive and individualised wound management that (Figure 3):

- Optimises patient condition and quality of life, manages wound-related symptoms and takes into account patient preferences
- Provides patient/carer education
- Conducts further investigations and makes specialist referrals
- Manages the factors contributing to the development or perpetuation of the wound and to abnormal exudate quantity or composition
- Optimises the condition of the wound bed and periwound skin
- Optimises wound bed moisture level
- Prevents and treats any other exudate-related problems.

The complexity and wide range of issues that a patient with a wound often faces means a multidisciplinary team approach that has the patient at the centre is often necessary (Moore et al, 2014)

Aims of management

The overall aim of wound management for many patients is to achieve healing and closure of the wound. However, healing is not always the aim. For example, for a patient with a malignant wound whose evolution depends on chemotherapy, radiotherapy or surgery, symptom-control is likely to be important along with containment of exudate or the formation of a crust or scab and no exudate production (WUWHS, 2007). For a patient with an uninfected ischaemic non-viable toe, the aim may be to dry the tissues to produce mummification and to prevent wet gangrene.

Management plan

The management plan should be devised in consultation with the patient/carer(s) and, as appropriate, the multidisciplinary team. It should include short-term and long-term goals, planned interventions, the rationale for the interventions, any further investigations or specialist referrals needed, and a date when reassessment will take place (Figure 3).

The individualised management plan should be documented in line with local policy and communicated as appropriate within the multidisciplinary team

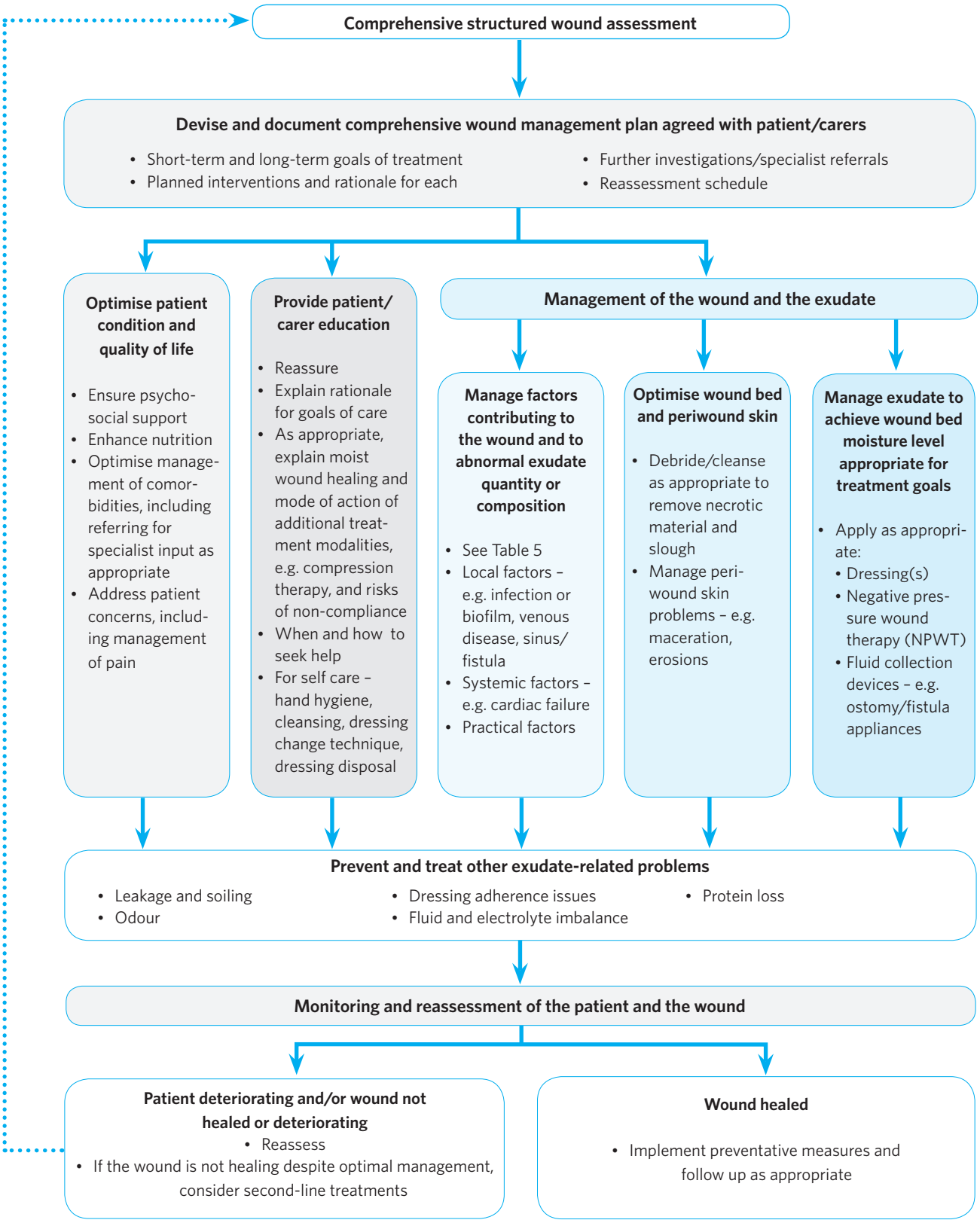
Stress, pain, poor nutrition, chronic disease and immunosuppression are risk factors for delayed healing (Guo & DiPietro, 2010; Thomas Hess, 2011; Megari, 2013): steps should be taken to correct or ameliorate these factors. Specialist referral for assessment and management of the comorbidities may be appropriate, particularly where comorbidity management is not optimal or involves the use of systemic medication (e.g. corticosteroids) known to impair healing.

Addressing patient concerns will contribute to improving quality of life

Education

Educating patients and carers about the cause of the wound and contributory factors, the rationale for treatment and when/how to seek help if problems arise are fundamental to shared decision-making and the promotion of concordance (Wounds International, 2016). Patients/carers undertaking dressing changes will need to be educated about hand hygiene, cleansing and dressing change techniques, as well as dressing disposal.

Figure 3: Exudate management in the context of comprehensive and individualised wound management



EXUDATE MANAGEMENT

The aims of exudate management are to:

- Optimise wound bed moisture level as appropriate for the patient
- Protect the surrounding skin
- Manage symptoms and improve patient quality of life.

Optimise wound bed moisture level

Any factor likely to contribute to the wound or to excessive or inadequate exudate production should be rectified or ameliorated where possible. Table 5 lists factors that can contribute to excessive or inadequate exudate production.

Reduce periwound oedema

Oedema in the tissues around the wound will increase exudate production and can be caused by a wide variety of issues, ranging from wound infection to venous hypertension to heart failure.

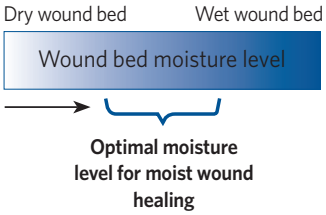
Compression therapy for venous leg ulcers is likely to be particularly effective in reducing exudate production. This is because compression therapy opposes leakage of fluid from capillaries into the tissues/wound bed and reduces oedema (Wounds International, 2015).

Manual lymphatic drainage (MLD) is a gentle massage technique used mainly in the management of lymphoedema and lipoedema. However, it may also have a role in reducing chronic oedema in the lower limb (Blanchfield, 2018).

Table 11: Methods of wound debridement and desloughing (Strohal et al, 2013; Atkin, 2014; Percival & Suleman, 2015; Wounds UK, 2017)

Type of debridement	Mode of action	Comments
Autolytic/ enzymatic	■ Devitalised tissues are softened and liquefied by enzymes occurring naturally in the wound	■ Aided by dressings that manage exudate or donate moisture to produce a moist wound environment ■ Can be used before or between other methods of debridement ■ Slow, but ease of use may lead to overuse and delay more appropriate method of debridement
Mechanical	■ A swab, cotton gauze, or monofilament pad is used on the wound surface to detach devitalised tissue	■ Easy to use ■ Patients can use for self-care under supervision
Sharp	■ Devitalised tissue is removed using a scalpel, scissors and/or forceps	■ Quick and selective; useful on hard eschar ■ Requires specialist training
Surgical	■ Non-viable tissue and wound margins are excised to achieve a bleeding wound bed	■ Useful for hard eschar and to debride large areas ■ Requires specialist training and usually requires anaesthesia and an operating theatre
Larval	■ Green bottle fly larvae are placed loose or bagged in the wound where they ingest devitalised tissue and microbes	■ Reduces pain, bacteria and odour ■ Unsuitable for dry, excessively moist or malignant wounds, or wounds that communicate with a body cavity/organ ■ Patients may decline
Ultrasonic	■ Ultrasound is used to break up devitalised tissue	■ Quick ■ Requires specialist training
Hydrosurgical	■ A high-pressure jet of saline is used as a cutting implement	■ Requires specialist training

Figure 4: Wound bed moisture level



Box 7: Factors affecting dressing/device choice

- Clinical need and indications for use
  - Wound type
  - Size/depth
  - Tissue type
  - Exudate level
  - Need for antimicrobial
  - Odour
  - Periwound skin condition
- Allergies/sensitivities
- Availability/inclusion in local formulary
- Reimbursement
- Ideal dressing/device change frequency
- Clinician preference/ familiarity
- Patient preference/ affordability

Management of infection/biofilm

A sudden increase in wound exudate and pain are indicative of wound infection. The infection should be treated in line with local policies on the use of topical antimicrobials (IWII, 2016). This may include the use of dressings containing topical antimicrobials such as silver, iodine or polyhexamethylene biguanide (PHMB). Spreading infection or local infection of a diabetic foot ulcer may necessitate treatment with systemic antibiotics.

In wounds that are not healing as expected despite optimal treatment, biofilm may be suspected. Management of wounds in which biofilm is thought to delay healing involves:

- Breaking up biofilm/slough (the house of the biofilm, which makes up over 90% of the total biofilm volume) and removing biofilm – through repeated debridement and maintenance desloughing (Percival & Suleman, 2015)
- Reducing biofilm reformation – through the application of topical antimicrobials and protection of the wound from contamination by other microbes (Schultz et al, 2017; Wounds UK, 2017; Percival, 2017).

Optimise the wound bed

Whether or not the wound is infected or biofilm is considered to be hindering 'timely' healing, devitalised tissue and slough are considered to support biofilm development and therefore should be removed from the wound bed using the most appropriate method of debridement and desloughing (Table 11).

The debridement and desloughing technique selected should be suitable for the wound type and within the competency of the clinician

Cleansing removes loose wound or dressing debris from the wound and surrounding skin (Randall & Fletcher, 2014). The selection of the cleansing agent should be guided by local policy. Potable (drinkable) tap water or sterile saline are widely used to cleanse wounds (Fernandez & Griffiths, 2012). Cleansing agents containing surfactants may be used, are considered to help with the wound cleansing process (Percival, 2017).

Managing wound bed moisture level

In patients with wounds that are expected to heal, the aim will generally be to achieve a moist wound healing environment that supports healing while protecting the wound from contamination (Figure 4).

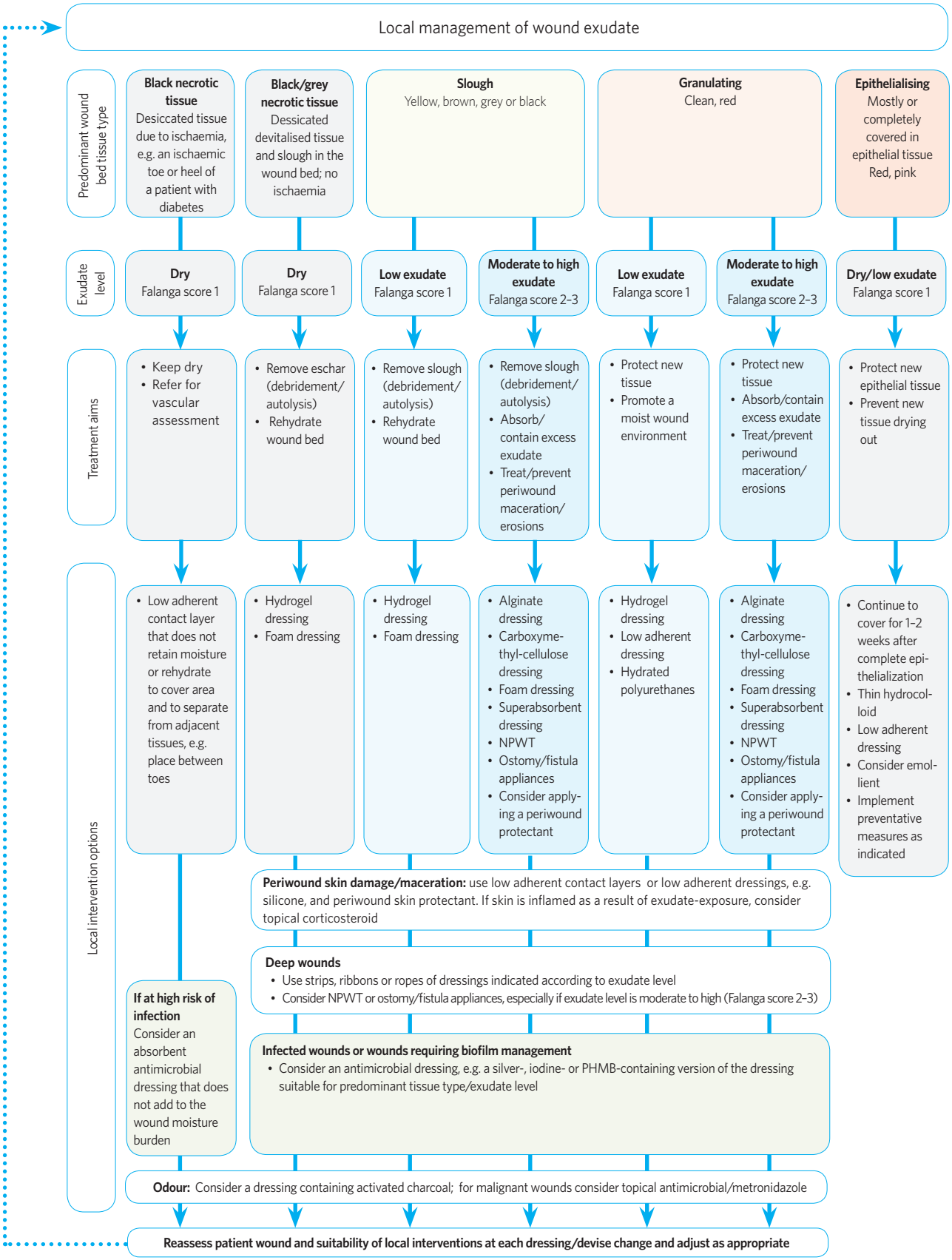
The main modalities of local management of wound exudate are:

- Dressings
- Negative pressure wound therapy (NPWT)
- Fluid collection devices, e.g. ostomy/fistula appliances

Many factors will affect selection of treatment modality (Box 7). Figure 5 summarises the options based on wound bed tissue type, exudate level, wound depth, infection/biofilm and odour. In practice, dressing/device availability, reimbursement issues, clinician familiarity and patient preference are also likely to play important roles.

There is no individual wound product that is suitable for use all the way through the course of management of a wound. Clinicians should expect to adjust management and to be prepared to 'step up' and 'step down' treatment as needed to ensure that the appropriate treatment is used at the appropriate time

Figure 5: Local management of wound exudate



DRESSINGS AND EXUDATE MANAGEMENT

Dressings are the mainstay of exudate management. In addition to handling fluid, dressings may also be used as a delivery vehicle for topical antimicrobials, to facilitate autolytic debridement or to modulate levels of proteases and inflammatory mediators (Eming et al, 2008; Sweeney et al, 2012).

Dressing selection should be individual to the patient, taking into account the management factors required – it may be beneficial to try different dressings to find the correct one for the individual needs of the patient and the clinical scenario.

In general, dressings manage fluid by absorbing it and/or allowing it to evaporate from the dressing surface (Wounds UK, 2013)

Absorption

Dressings made from cotton, viscose or polyester textiles and some simple foam dressings absorb fluid and hold it in the spaces within the dressing material. When placed under pressure, the fluid can be released from the spaces and leak out of the dressing.

Some dressing materials, e.g. hydrocolloids, alginates, carboxymethylcellulose (CMC) fibres, sulphonated CMC and some superabsorbent dressings, absorb fluid to form a gel. When placed under pressure, the gel can change shape but retains the fluid. Materials that form uniform cohesive gels are more likely to stay intact during use and may reduce lateral tracking of fluid and the risk of periwound maceration. This property may be particularly useful under compression therapy. Some gel-forming dressings also trap exudate components and micro-organisms (Sweeney et al, 2012; Browning et al, 2016).

Evaporation

Many dressings allow moisture to evaporate from their outer surface. This characteristic can be quantified as the 'moisture vapour transmission rate' (MVTR). Many dressings combine absorption and evaporation. Dressings with a very high MVTR may be useful in managing exudate where minimal bulk is preferable. However, it has to be considered that negative factors (e.g. MMP) may be concentrated under dressings with a very high MVTR (Wounds UK, 2013).

Laboratory tests

During the development and licensing processes, dressings are subject to a variety of tests of fluid-handling performance. Tests may include absorbent capacity, fluid retention under compression, strength of the dressing when wet or dry, lateral wicking (the extent of spread of fluid laterally within a dressing), waterproofness, MVTR and bacterial barrier properties (Wounds UK, 2013; Mennini et al, 2016). These tests often use a simulated wound fluid to obtain more realistic values. Individual manufacturers may use a simulated wound fluid for in-house testing that is unique to the company.

Consequently, comparisons of test results from different manufacturers are difficult. In general, many clinicians find the results of laboratory tests are of limited clinical relevance when selecting dressings. This means that considering the individual needs of the patient and their wound, and trying different dressings in a practical setting, are of particular importance.

Current laboratory testing of dressings is designed to fulfil current regulations. However, the tests do not necessarily produce information that is clinically relevant. Development and standardisation of clinically relevant laboratory tests and simulated wound fluid are needed

Using dressings to manage exudate

Some primary dressings (i.e. the dressings in direct contact with the wound) require a separate method of fixation. Some primary dressings do not absorb any or much fluid and need a secondary

dressing over the top to provide fluid handling. Some secondary dressings provide both the fixation and fluid-handling functions.

The dressing or dressing combination selected should have a fluid handling capacity that:

- Produces a moist wound environment without leakage, desiccation of the wound bed or periwound skin damage
- Allows for a suitable interval between dressing changes (WUWHS, 2007).

The dressing(s) should also be compatible with any periwound protectant products in use.

Box 8 lists the properties of the ideal dressing, and Table 12 summarises fluid-handling capacity according to exudate level of a range of dressing materials. Dressings can vary widely in the type(s) and quantities of materials from which they are constructed. The numerous dressings available and the variety of materials and formulations can make dressing selection challenging. Exudate handling capacity should be considered, along with the appropriate wear time, and whether care needs to be stepped up or down as the patient's wound progresses.

Clinicians should consult the manufacturer's information for each dressing being considered, and should have a clear understanding of the indications, contraindications, precautions and instructions for use of each dressing

Box 8: Properties of the ideal dressing (adapted from WUWHS, 2007; Dowsett, 2011; Vowden et al, 2011)

- Available in a range of shapes and sizes across care settings
- Easy to apply
- Does not require a secondary dressing
- Comfortable/reduces pain/does not cause pain on application
- Conformable
- Prevents leakage and strikethrough
- Absorbs odour
- Stays intact and remains in place during wear
- Suitable for extended wear*
- Suitable fluid-handling capacity as per level of exudate
- Retains fluid-handling capacity under compression therapy or when used with an offloading device
- Atraumatic and retains integrity on removal
- Unlikely to cause sensitisation or to provoke an allergic reaction
- Cosmetically acceptable and available in a range of colours to match the patient's request
- Does not impede physical activity
- Patient can shower with the dressing in situ
- Incorporates sensors/alerts to feedback on dressing performance, need for change and wound condition
- Inactivates factors that enhance inflammation (i.e. MMPs)
- Cost-effective – considering factors such as the unit cost of dressing versus time taken to change, the potential impact on healing by use of cheaper dressings, how to make the case to procurement

**N.B. Dressing change frequency should be determined by clinical need. For example, a patient with an infected diabetic foot ulcer is likely to need very frequent dressing changes to monitor the wound. However, if extended wear time is required, the clinician should select a dressing that can be left in place until the next dressing change. In suitable scenarios, it is worth considering the potential benefits of extended wear time for the patient, wound and healthcare system – e.g. undisturbed healing, patient concordance driven by familiarity, cost benefits.*

Table 12 provides a broad overview of the potential uses of different dressing materials for exudate management. The fluid-handling properties and licensed usages of individual dressing products – which often contain more than one dressing material and varying quantities of those materials – will vary and may differ from the broad generalisations made.

Table 12: Uses of different dressing materials according to exudate level (WUWHS, 2007; Wounds UK, 2013; Wiegand et al, 2015; Browning et al, 2016; Gupta et al, 2017; Tate et al, 2018)

Dressing material type	Exudate level				Comments
	None: dry wound	Low	Moderate	High	
As a primary dressing					
Cotton, polyester or viscose fibres or fabrics		✔	✔	✔	• Mainly used in secondary dressings • May be used in low adherent contact layers
Semi-permeable films	✔	✔			• No intrinsic absorbency • Adherence may damage new tissue or cause skin tears
Hydrogels*, SAP-containing hydrogels	✔	✔			• Can help to promote autolytic debridement • Can be designed to absorb or donate fluid or do both
Foams		✔	✔	✔	• Numerous types available • Provide some cushioning • Lack microbial retentions/ sequestration
Hydrocolloids	✔	✔			• Gel-forming
Alginates		✔	✔		• Gel-forming • Some are haemostatic
Carboxymethylcellulose fibres			✔	✔	• Gel-forming
Superabsorbent polymers			✔	✔	• Several types; some are gel-forming • Provide some cushioning
As a secondary dressing					
Cotton, polyester or viscose fibres or fabrics		✔	✔	✔	• Mainly used in secondary dressings
Foams		✔	✔	✔	• Numerous types available • Provide some cushioning
Superabsorbent polymers			✔	✔	• Several types; some are gel-forming • Provide some cushioning

**Hydrogels can donate moisture to a wound bed.*

Dressings often contain several layers of different materials or layers of combinations of materials. As a result, the fluid-handling properties of an individual dressing are dependent on the construction and constituent materials of the dressing

Dehydrated wounds

Dressing materials used on dry wounds that need to be rehydrated include:

- Semi-permeable films – can rehydrate the wound by preventing moisture arising from the deeper wound tissues from evaporating. Adherent properties may damage the wound bed or surrounding skin
- Hydrogels – have a high water content and can donate or absorb fluid, or can be developed to do both. If overlapped onto the wound edges can cause over/hyper-hydration and maceration. Hyper-hydration is a reversible process if the dressing is changed/removed in time. Fluid donation may also dilute the concentration of MMPs so that the corrosive effect of chronic exudate will tend to be reduced.

Exuding wounds

Dressing materials frequently used in the management of exuding wounds include:

- **Foams**, e.g. formed from synthetic polymers, polyurethane or silicone – a category with very wide-ranging fluid-handling properties that may also be formed of composites with other materials; may provide cushioning but may not perform well under compression therapy
- **Gel-forming materials**, e.g. hydrocolloids, alginates or carboxymethyl cellulose – may cause a 'drawing' sensation on application; some alginates have haemostatic properties; some dressings combine gel-forming materials to alter characteristics such as dressing integrity
- **Superabsorbent polymers**, e.g. polyacrylate polymers (SAP-containing dressings), are highly absorbent dressing materials with a growing use in exuding wounds. Previous studies showed that polyacrylate superabsorber particles reduce the MMP activity in chronic wounds by multiple mechanisms (direct binding, inhibition of MMPs activity through competition for divalent ions), thus, reducing wound inhibitors factors (Eming 2008); superabsorbent dressings maintain their fluid retention capacity under compression, provide high MVTR, provide cushioning, some available with silicone contact layer.

Using dressings to adjust wound bed moisture level

Table 13 summarises the strategies that can be used to adjust or maintain wound bed moisture level. Where a primary and secondary dressing is required, careful thought may be needed to maximise the effectiveness of the combination and to minimise bulk.

There may be times when an adjustment to the dressing regimen may be necessary, e.g. because the patient is going away on holiday or has a social event, such as a wedding. Such adjustments may include maximising dressing wear time, simplifying the regimen so the patient can undertake dressing changes, minimising bulk or endeavouring to make the dressing unobtrusive.

Table 13: Strategies to adjust wound bed moisture level when using dressings (WUWHS, 2007; Orsted et al, 2017)

Aim of adjustment	Strategies
Increase wound bed moisture level	• Choose dressing type that conserves or donates moisture • Use a thinner (less absorbent) version of the current dressing • Decrease dressing change frequency
Maintain wound bed moisture level	• Continue current dressing type and change frequency
Reduce wound bed moisture level	• Use a thicker (more absorbent) version of the current dressing • Change to a dressing type of greater fluid handling capability • Add or use a higher absorbency secondary dressing • Increase frequency of primary and/or secondary dressing change • Consider NPWT or a wound drainage collection or ostomy/fistula appliance

Clinicians need to combine an understanding of the fluid-handling characteristics of the dressings they use with clinical experience when selecting the most appropriate dressing for each patient

Deep wounds

Deep wounds can be packed with a dressing material appropriate for exudate level in rope, ribbon or strip form. The dressing material should be in contact with the wound bed and should eliminate dead space. However, overpacking should be avoided. The tensile strength of a packing material should be sufficient to prevent retained dressings due to breakage or disintegration in deep cavities or narrow sinuses.

NPWT may be helpful in the management of deep wounds, particularly if exudate levels are high. Once the wound base has filled in, management with wound dressings can be recommenced.

Odorous wounds

The underlying cause of the odour should be managed, e.g. debridement to remove necrotic tissue and antimicrobial treatment if the wound is infected. Dressings containing charcoal may help to absorb odour. Some superabsorbent dressings also show sequestration of odour, and NPWT devices use charcoal filters attached to the canister that help odour management (Wounds UK, 2013).

Management of malignant wounds with malodour may include topical or systemic metronidazole, or cadexomer iodine (Alexander, 2009); silver-impregnated dressings may be used, but may not affect bacterial load associated with malodour (Lund-Nielsen, 2011). Other environmental strategies include the use of odour absorbents (e.g. cat litter or charcoal), although these methods may not be acceptable in terms of patient quality of life; room deodorisers and odour masking (e.g. with aromatherapy oils) may also be used (EONS, 2015)

Periwound skin protection

The prevention and treatment of periwound maceration and skin erosions are important as the conditions may precede wound expansion and cause pain or discomfort. Contact between periwound skin and exudate should be avoided through appropriate dressing/device use.

The risk of skin trauma during dressing/device removal should be minimised. Use of low adherent or silicone dressings, avoidance of tape fixatives and application of periwound skin protectant creams or barrier films may help to protect the skin and reduce the risk of damaging the skin further (Bianchi, 2012) (Table 14). If the periwound skin is inflamed because of the irritant effects of exudate, a topical corticosteroid may be indicated (Woo et al, 2017).

Table 14: Periwound skin protectants (Beeckman et al, 2017; Woo et al, 2017)

Principal skin protectant ingredient	Advantages	Disadvantages
Petrolatum-based ointment	• Forms an occlusive layer that reduces transepidermal water loss • Transparent when thinly applied (allows skin inspection)	• May interfere with dressing adherence and absorption • May increase risk of folliculitis
Zinc oxide plus petrolatum ointment	• Forms an occlusive layer • Anti-inflammatory and antioxidant effects	• May interfere with dressing adherence and absorption • Often has a thick consistency that is difficult to apply and to remove • Opaque and may impede skin inspection
Silicone-based barrier preparations, e.g. dimethicone	• Dimethicone is permeable to water vapour and allows evaporation of perspiration • Easy to use; does not feel greasy	• Some preparations are not indicated for use on skin near open wounds • Thick preparations may interfere with dressing adherence and absorbency
Film-forming polymers in water or organic solvents	• Form an occlusive barrier • Easy to apply • Allows adherence of wound dressings and protects from skin stripping	• Some organic solvents may cause stinging and irritation • The film produced is generally thinner than that formed by cyanoacrylates
Cyanoacrylate formulations	• Forms a moisture-resistant film that is transparent and aids skin inspection • Relatively durable	• May be expensive • Patients may be allergic to cyanoacrylates

Delayed healing

In wounds that are expected to heal but that experience delayed healing despite optimal treatment for exudate and treatment/exclusion of infection and biofilm, a 'step up' in management and the use of second-line, or more effective novel therapies may be indicated. Such therapies include NPWT, dressings (e.g. those containing collagen/oxidised-regenerated cellulose/polyacrylate polymers, that modulate the levels of proteases in the exudate), acellular matrices, skin grafts or bioengineered skin equivalents (WUWHS, 2016a; Wu et al, 2017; Piaggesi et al, 2018).

Wear time considerations

Wear time is becoming an increasingly important factor in dressing selection. The number of dressing changes impacts on community nursing visits and associated costs for the patient, such as travel and time away from work (Dowsett, 2015). Leaving dressed wounds undisturbed for longer periods of time is proven to help healing (Rippon et al, 2012). Where possible, the choice of dressing should aim to reduce frequency of dressing changes to avoid disruption to the wound healing environment (McGuinness et al, 2004). This may lead to a reduced risk of infection and complications, and have a positive economic impact of the dressing in terms of reduced wastage and costs. Dressing preference is also a strong factor for patient concordance and may be impacted by dressings that do not securely stay in place as they cause discomfort, reduce confidence, and can impede patients' ability to carry out everyday activities.

NPWT AND EXUDATE MANAGEMENT

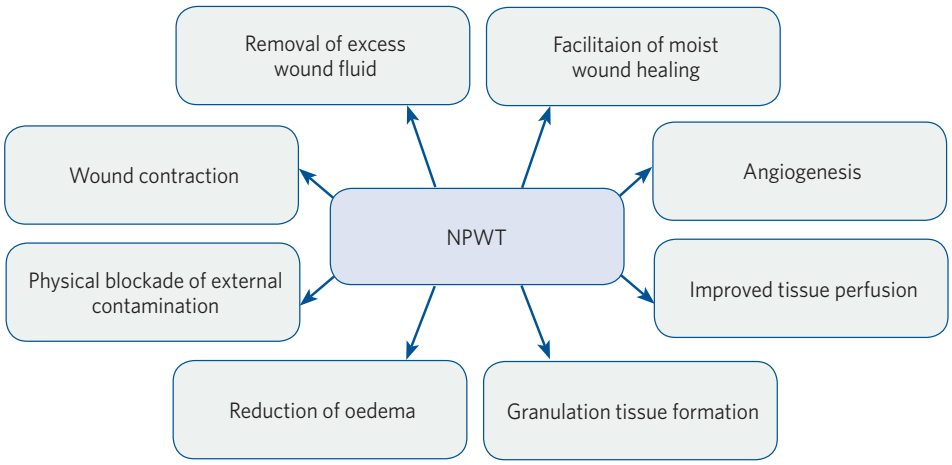
Negative pressure wound therapy (NPWT) devices apply controlled negative pressure (suction) over an open wound or closed surgical incision and the nearby tissues (WUWHS, 2016b; WUWHS, 2018). An adhesive film dressing is used to produce a seal over the wound that allows delivery of suction generated by an electrically- or mechanically-powered pump. NPWT pumps are powered by batteries or mains electricity. Deep wounds may need a wound filler, such as foam, and a liner.

Effects of NPWT

In addition to providing a physical barrier to external contamination, removing excess wound exudate and facilitating moist wound healing, NPWT has a number of other actions that aid healing in open wounds (Lalezari et al, 2017) (Figure 6).

Single-use NPWT is increasingly being used in the management of closed surgical incisions, where it also provides a barrier to external contamination and removes excess wound exudate. It may also aid healing by reducing lateral tension across the closed incision, improving lymphatic drainage and reducing the risk of wound infection and separation (dehiscence) (Karlakki et al, 2013).

Figure 6: Mode of action of NPWT in open wounds (WUWHS, 2018)



Exudate handling and NPWT devices

NPWT devices vary in size, portability and format. For example, some include a canister for the collection of fluid; the canisters vary in capacity. Some single-use devices are canister-free and handle fluid mainly through evaporation from the outer layer of the dressing (Malmsjö et al, 2014).

Some NPWT devices deliver topical solutions, such as saline or antimicrobial agents, to the wound bed. This is known as NPWT with instillation and may be used in the management of infection in acute and chronic wounds (Back et al, 2013).

Indications for the use of NPWT

NPWT has a number of roles in the management of wounds:

- Management of highly exuding wounds that would require very frequent dressing changes if managed conventionally
- Management of wounds that are failing to heal despite optimal treatment and the exclusion of infection/biofilm-related delayed healing
- Management of closed surgical incisions that are at high risk of surgical site complications (such as dehiscence or surgical site infection) (Netsch et al, 2016; WUWHS, 2016b; Lalezari et al, 2017; Strugala & Martin, 2017; WUWHS, 2018).

Selecting NPWT type

A variety of factors should be taken into account when selecting an NPWT device for a patient and wound (Box 9 and Box 10).

Box 9: Factors involved in selecting the type of NPWT for exudate management

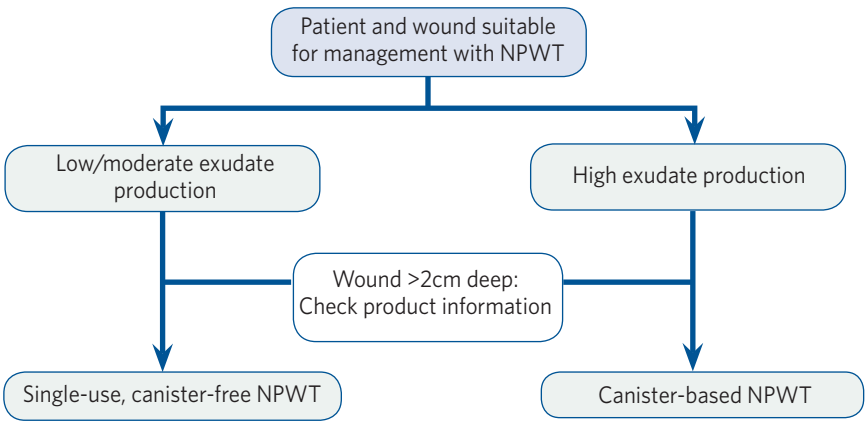
- **Contraindications and cautions** – to the use of the NPWT device under consideration (Box 10)
- **Volume of wound drainage** – the device selected should have the capacity to deal with the anticipated volume of drainage, e.g. if wound drainage is (for example) <300 ml/week canister-less single-use NPWT may be appropriate; if drainage is >300 ml/week a canister-based device of appropriate capacity may be more suitable
- **Depth of the wound** – deep wounds may require fillers and the NPWT device should be compatible with the use of fillers; some canister-less single-use NPWT devices cannot be used with fillers and should not be used on some deep wounds (check product information)
- **Size (area) of the wound** – the NPWT device selected must be suitable for the size (area) and shape of the wound
- **Location of the wound** – the NPWT dressing needs to conform to the three-dimensional shape of the anatomical region of the wound sufficiently well to avoid dead space and to form the seal needed for the device to work
- **Infection** – an antimicrobial interface may be required and should be compatible with the NPWT device being considered; if NPWT with instillation is considered necessary, the device needs to be instillation-capable
- **Care setting** – the NPWT device should be of a type that can be cared for appropriately and safely in the setting in which it will be used
- **Patient needs and preferences** – patients who are physically active or working are likely to prefer a portable device that is as small as possible

Box 10: General list of contraindications and cautions to the use of NPWT (Netsch et al, 2016; Apelqvist et al, 2017)

- Necrotic tissue with eschar
- Untreated osteomyelitis
- Enteric, non-enteric and unexplored fistulae
- Malignancy in the wound (unless treatment is palliative)
- Exposed blood vessels, nerves, organs or anastomotic sites in wound or near the vagus nerve
- Patients at high risk for bleeding
- Remove the NPWT unit for patients requiring:
  - Magnetic resonance imaging (MRI)
  - Treatment in a hyperbaric oxygen chamber (HBOT)
  - Defibrillation

Exudate volume is an important determinant of whether a canister-based or canister-free device is most appropriate (Figure 7)

Figure 7: Selecting NPWT modality according to exudate level and wound depth



Patients can be moved from one type of NPWT device to another as treatment progresses. For example, as a wound decreases in size and exudate levels reduce, a patient using a canister-based NPWT device may be able to use a canister with smaller capacity or a canister-free device.

Ostomy/fistula appliances and exudate management

Wound drainage collector, or ostomy/fistula appliances can be useful for managing exudate from highly exuding wounds or from wounds that contain fistulae (Adderley, 2010). The periwound skin of these wounds would need to be able to support the adhesive flange used to attach the bag (Romanelli et al, 2010). Collection devices suitable for a wide range of wound sizes are available and some incorporate activated charcoal to manage odour.

Wound reassessment

Monitoring of wounds and formal reassessment enables changes in the wound to be detected and management to be adjusted accordingly. Dressing/device changes provide an opportunity for ongoing monitoring of the wound. Formal holistic reassessment of the wound and the patient in line with Table 6 should be scheduled at regular intervals appropriate for the condition/type of wound. Formal reassessment should also occur if the patient and/or wound deteriorate (Orsted, 2017; Wounds UK, 2018).

FUTURE RESEARCH NEEDS

The socioeconomic impact of exudate-related problems can be considerable and has been proven as a key area of concern in recent years (Guest et al, 2015). Even with developments in dressing technology and NPWT devices, much research and clarification remains to be undertaken to enable clinicians to accurately assess exudate and implement the most appropriate, effective and cost-effective management regimen. This includes:

- Standardisation of simulated wound fluid and wound dressing fluid-handling tests
- Development of a standardised, validated and clinically-meaningful method of measuring the rate of exudate production that can be directly related to the fluid-handling capabilities and wear time of dressings/devices
- Development and validation of a tool based on clinical signs that indicates abnormally high MMP activity to prompt intervention to reduce activity
- High quality randomised-controlled trials of the clinical effects of dressings/devices
- Cost-effectiveness analyses of dressing/devices that consider episodes of care, rather than individual dressing/device costs

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NOTES

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