Wound management in children

Georgina Casey explains the physiological events in wound healing in children, the rationale for dressing selection and the importance of taking a holistic approach to wound management. This article was first published in Paediatric Nursing (1999) 11, 5, 39-44. Readers who successfully completed a written ‘Practice Profile’ assessment on that occasion may not do so again.


Aims and intended learning outcomes

The aim of this article is primarily to provide an explanation of the physiological events that occur during wound healing in children and relate these to both the clinical appearance of the wound and the selection of dressings and other topical treatments.

Wound healing is a complex process, although normally one that requires minimal nursing intervention. When intervention is required, such as for chronic wounds, the choice of treatment made by nurses can impact on the progress of healing. For children, while healing normally proceeds at a faster rate than for adults, the need for careful selection of appropriate dressings and ensuring the understanding and participation of both the child and his or her family is a prime consideration. But physiological and practical issues cannot be isolated from surrounding issues such as what caused the wound and what impact it has on the child and family: these are briefly addressed in the first part of the article.

After reading this article you should be able to:
- Describe how a holistic approach to wound management can contribute to effective healing;
- Relate the clinical appearance of a wound to the underlying physiological process;
- Discuss the key elements of the ideal wound environment and relate these to treatment goals;
- Critically review the selection of appropriate wound dressings with regard to type of wound, stage of healing and characteristics of the child.

Wounds in children

The most common wounds seen in children are those which result from injury. According to the Health Committee Report on Health Services for Children (House of Commons 1997), over 2.3 million children attend an Accident and Emergency department each year in the UK. Of these, over 60 per cent will attend as a result of injury: cuts, bites, puncture wounds and lacerations make up a large number of these injuries.

Around 500,000 children undergo in-patient or day-case surgery each year, many of whom will require wound management. More rarely seen, but usually more serious, are wounds associated with medical conditions such as meningococcal septicaemia or immune deficiency or with interventions (e.g. extravasation injuries, pressure sores).

All wounds are associated with pain: pain assessment (RCN 1998a) and pain management (RCPCH 1997) are essential elements of care throughout the course of healing. The goals of holistic wound management in children are to alleviate pain, minimise emotional distress and minimise scarring (Bale and Jones 1997). As in any paediatric context, an additional goal is for the child to be cared for at home as soon as his or her condition allows and provided that adequate support is available in the community.

The psychological and emotional impact on the child of even minor wounds cannot be underestimated. Research in adults suggests that stress and anxiety, sleep disturbance and emotional upset can affect the immune response and delay healing (Bale and Jones 1997). Although there are no similar studies in children, it seems safe to assume that rest and sleep, good nutrition and minimal distress will aid healing in all age groups. Depending on the child's age and understanding, his or her perception of the wound, its cause and its meaning for the future will vary widely and will change as time progresses. Skilled, ongoing assessment of these perceptions and the child's expectation of outcome ensures that appropriate psychological and emotional interventions are made, from simple explanations about healing through to expert counselling for children facing major changes to their body image.

Now do Time Out 1.

From your knowledge of parents' reactions to injury and hospitalisation, make a list of the feelings and concerns that parents may experience when their child has a serious wound.
They will worry about managing the child's own fears and concerns, about doing dressings and keeping these in place in an active child, about how to keep the child comfortable and occupied once at home. If there is likely to be lasting scarring, parents may experience deep sorrow and grieving for their child's loss and change in body image.

 Supportive care for the parents, along with information and education about wound management will enhance their coping strategies and enable them to manage the care of their child at home. They need to feel confident in taking responsibility for such things as:

- ensuring adequate nutrition to promote healing;
- restricting the child's activities if the nature and location of the wound require this and to prevent contamination;
- assessing the condition of the wound and seeking advice if they have concerns;
- providing pain relief and comfort measures;
- maintaining physiotherapy and other regimes to minimise long-term effects of scarring.

An understanding of the process of wound healing and the factors which promote or delay healing helps the nurse, in partnership with the child and his or her caregivers, to plan appropriate treatment for wounds. The advice and support of a wound care or tissue viability specialist nurse is invaluable: their detailed knowledge of wounds and wound care products helps ensure effective wound management, particularly of complex, chronic wounds.

Recall the last wound you dressed. Can you state what stage or stages of healing the wound was in? On what criteria did you base the selection of the wound dressing?

What clinical features indicate whether a wound is in the inflammatory stage of healing? A wound infection will also cause signs of inflammation. Can you list three features which distinguish an infected wound from one that is merely inflamed as a normal part of the healing process?

Wounds are often classified into two types: those healing by primary intention, meaning the edges of the wound are together, and those healing by secondary intention, where there is a cavity which must be filled by new tissue. In either case, the stages of healing that the wound goes through are the same. Most surgical wounds heal by primary intention as the edges are sutured together. However, with these wounds it is important to recall that the visible surface of the wound is not the only region of healing. All the tissue beneath the skin that has been injured and handled during surgery must also heal. Because it is not possible to visualise this healing process in these types of surgical wounds, the process of healing is often described in relation to cavity wounds, where the appearance of the wound visibly corresponds to the stage of healing. Cavity wounds in children can occur following complex surgical procedures where the wound is left open to drain. They also arise with pressure sores and excision of abscesses.

**Now do Time Out 2.**

Being able to provide a rationale for the choice of a particular treatment enables nurses to justify their decisions to healthcare colleagues and to parents or caregivers. For example, a decision on the frequency of dressing changes may be influenced by concerns about how much distress will be caused to the child or by the notion that you don't want to disrupt granulation. Providing an explanation to the child about the stage of healing will help him or her to understand why things are done at certain times and also to visualise what is happening to his or her body.

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**Fig. 1. Stages in wound healing**

<table>
<thead>
<tr>
<th>Early Inflammation</th>
<th>Late Inflammation</th>
<th>Maturation</th>
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Adapted from Clark et al, 1988

INFLAMMATION

The first stage, inflammation, occurs in the first 24 to 48 hours following injury. The early inflammatory stage is characterised by an influx of neutrophils into the wound bed. These white blood cells are responsible for phagocytosis of any dead tissue, foreign matter and bacteria within the wound. As the neutrophils phagocytose or digest this material they die and form pus or slough. These cells are replaced by macrophages, derived from monocytes in the blood. A predominance of macrophages in the wound bed signals the late inflammatory stage of healing. Macrophages continue to phagocytose debris in the wound, including the dead neutrophils. They have a more important role, however, in the healing process. Macrophages secrete a variety of chemicals called growth factors which control and direct the activity of the other cells involved in the healing process. The type of growth factor a macrophage secretes depends on the type of environment it finds itself in. This will be described further below.

**Now do Time Out 3.**

The main indication of inflammation in a wound is the presence of a yellow slough on the surface (referred to as the ‘yellow’ stage of healing – see table 1). Sometimes there is minimal redness and heat in the surrounding skin. However, an infected wound will display signs of surrounding tissue involvement as the bacteria invade beyond the surface of the wound. This will be apparent as redness, swelling and heat in the surrounding tissue, and an increase in wound exudate as immune cells in the area become more active. There may also be an increase in wound pain and the...
A wound may begin to break down. In addition, the child will probably display systemic signs of infection such as fever, restlessness and a generalised malaise (but bear in mind that the neonate may exhibit different signs such as hypothermia and shock). 

Prior to inflammation, a wound may appear necrotic (‘black’). A wound in this state is not able to heal until the necrotic tissue is removed and the underlying cause of the necrosis is addressed. Removal of necrotic tissue can be undertaken by mechanical, physiological, enzymatic or surgical means. Mechanical debridement occurs when wet gauze (using either saline, or another topical solution) is applied to the necrotic wound, left in place a sufficient time to dry and adhere to the surface, and then removed. As the gauze comes away from the surface, necrotic material is torn off also. This is a painful process and requires analgesia – it should be avoided if possible with children since the pain may become associated with any type of dressing change thereafter.

Dressing changes and other procedures which could cause acute pain need to be managed effectively from the very first instance, as even very young children quickly associate events, people and places with unpleasant or painful experiences, with lasting consequences. Entonox has been found to be effective in this situation for even young children who appreciate being in control of pain relief. Methods for managing procedural pain are given in RCPCH (1997), and an overview of the use of distraction technique in Kleiber and Harper (1999).

Physiological debridement, using the principles of moist wound healing and allowing the wound to perform its own debridement, is the most gentle form of debridement and is appropriate where there is relatively little necrotic tissue present in the wound. Enzymatic debridement, for example using Vascase, involves destruction of the fibres which make up necrotic eschar or slough. Enzymatic debriding agents must be used cautiously and reviewed frequently.

**GRANULATION OR PROLIFERATION**

The next stage in healing is that of granulation tissue formation. During this time, fibroblasts and endothelial cells in the tissue surrounding the wound begin to proliferate and migrate into the wound bed. Fibroblasts secrete a scaffold of proteins such as collagen for the guidance of other cells entering the wound. The endothelial cells bud off from nearby capillaries and migrate into the wound to form new blood vessels providing oxygen and nutrients to the wound bed. This stage of healing is easily identified by the appearance of the wound (table 1).

<table>
<thead>
<tr>
<th>Wound Colour</th>
<th>Stage of Healing</th>
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</thead>
<tbody>
<tr>
<td>Black</td>
<td>Necrosis - no healing begun</td>
</tr>
<tr>
<td>Yellow</td>
<td>Slough - inflammation</td>
</tr>
<tr>
<td>Red</td>
<td>Granulation tissue formation</td>
</tr>
<tr>
<td>Pink</td>
<td>Epithelialisation</td>
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| Table 1. Simplified colour guide allowing clinical appearance of wounds to be related to stages of healing |

The bed of the wound becomes reddened and, if disturbed, it bleeds readily. It used to be thought that making the wound bleed at this stage was ‘healthy’ but in fact bleeding indicates damage to the newly-formed and fragile capillary bed. As this second stage proceeds, epithelial cells from the surrounding skin begin to migrate across the top of the new granulation tissue in the process of epithelialisation. As new skin grows the wound takes on a shiny pink appearance (table 1). Again, this new tissue is very fragile and easily damaged. Failure to move on from this stage can lead to hypergranulation.

Unfortunately, it is at this stage that the wound can become itchy, with a high likelihood that the child will interfere, disturbing the granulating tissue and causing bleeding. Great ingenuity is called for to find dressings and fixings which are impervious to prying, scratching fingers.

**MATURATION**

The final stage of healing is maturation. This can continue for a year or more and while the wound itself may become fully re-epithelialised and look healed, activity within the wound bed is ongoing. During this stage the new blood vessels within the wound bed retract and the scar takes on a pale appearance. At the same time, the collagen and other connective tissue fibres in the scar are re-organised to strengthen the wound. Wound strength will only ever reach about 80 per cent of the strength of intact skin.

**TIME OUT 4**

The major factor of concern is growth and the inability of scar tissue to keep pace with normal tissue growth in children and adolescents. Wound healing in children seems to involve the same processes as in adults although children do have a greater capacity for repair. They also have fewer reserves to deal with infection, electrolyte imbalance and changes in body temperature, all of which can affect the healing process (Garin, 1990). Depending on the site and the extent of any scar, the child could develop contractions, have reduced movement and an increase in the unsightly appearance of the scar because of growth in surrounding tissues. Although healing of burns is not specifically addressed in this article, the principles for long-term management of scarring from wounds other than burns, follows the same principles.

Remnants (especially pre-term infants) are particularly vulnerable because of the immaturity of their skin structures. The top two layers of skin are loosely bound and thin even in the full-term infant, so the slightest friction can cause blistering (Young 1995). Healing can be delayed because of this fragility and specific products are recommended for wound management in this age group (Young 1995).

**TIME OUT 5**

Most important is the child’s experiences and feelings about the dressing change procedure, the wound and its progress. By discussing and documenting (or drawing for a younger child) his or her perceptions, the child can be encouraged to express concerns and fears. These can then be addressed with more infor-
Wound management in children

As stated previously, the macrophage is not only involved in phagocytosis, it directs the whole progress of healing through the secretion of a variety of growth factors. These growth factors act on the cells and removing waste products such as lactic acid, leads to marked differences between the edge of a wound and its centre. Macrophages at the centre of a wound are experiencing a low oxygen, high acid environment. They secrete growth factors which will encourage the division and migration of endothelial cells and, thus, the formation of new capillaries, so bringing oxygen and nutrients to the area. Macrophages that are already in a high oxygen, low acid environment will secrete different growth factors which encourage division and migration of fibroblasts and epithelial cells so that the scar tissue is laid down and epithelialisation begins. It is therefore vitally important that the wound environment be maintained so that this difference between the margin and centre occurs. Both are necessary for healing to proceed, and the role of nurses in wound care should be to create ideal conditions for the maintenance of this environment.

The role of macrophages

Fig. 2. Oxygen and acid profile in a cavity wound

Adapted from Clark et al 1988

Table 2. Assessing dressing performance

On removing the dressing you should note:

- Has the dressing leaked, or the edges lifted?
- Did the child or parents experience any problems with it? E.g., itching, lifting edges, unduly hot.
- The dressing lift off the wound and surrounding skin with out causing any damage?
- Is the debris left easy to clean away?
- Is there any maceration of surrounding skin, or dehydration of the wound bed? Indicating that the dressing is not appropriate for the amount of wound exudate.

in the wound bed and surrounding tissues to trigger cell division, migration and secretion. The type of growth factors a macrophage secretes depends on the type of environment it is experiencing. Figure two shows a cross-section of a cavity wound from the intact tissue at the edge to the centre of the wound. The presence of viable capillaries providing oxygen and nutrients, and removing waste products such as lactic acid, leads to marked differences between the edge of a wound and its centre. Macrophages at the centre of a wound are experiencing a low oxygen, high acid environment. They secrete growth factors which will encourage the division and migration of endothelial cells and, thus, the formation of new capillaries, so bringing oxygen and nutrients to the area. Macrophages that are already in a high oxygen, low acid environment will secrete different growth factors which encourage division and migration of fibroblasts and epithelial cells so that the scar tissue is laid down and epithelialisation begins. It is therefore vitally important that the wound environment be maintained so that this difference between the margin and centre occurs. Both are necessary for healing to proceed, and the role of nurses in wound care should be to create ideal conditions for the maintenance of this environment.

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growth factors and the extracellular material that makes up the scar tissue. The wound environment must therefore create ideal conditions for these activities as well as maintaining the correct conditions for macrophage activity. In order for healing to proceed at the optimum possible rate a wound must be:

- **Kept warm and moist** – cells function best at body temperature and in high humidity. The principle of moist wound healing has been acknowledged since the early 1960s (Winter 1962). Experiments at this time found that a wound dressed with a moisture-retentive film healed in half the time of a wound left exposed to the air. In addition, those wounds left exposed formed a scab which involved the sacrifice of several layers of healthy tissue from the bed of the wound, thus extending wound depth. It took nearly 20 years for this research to be adopted in clinical practice but very few practitioners would now dispute these findings (Hermans 1993).

- **Free from excess exudate**. While high humidity promotes healing, bathing the surface of the wound in large amounts of fluid does not. First, this can cause maceration of the granulation tissue and surrounding skin, possibly extending the wound margins. Second, wound exudate provides a good culture medium for bacteria. Although contamination or colonisation of a wound by bacteria will not necessarily delay healing (unless the child is immunosuppressed), these should be kept to a minimum to prevent the development of outright wound infections. Prevention of contamination of wounds in active young children who play in sand and mud, splash when they bath and seem to wear their food rather than eat it, can be challenging. Contamination by urine and faeces of wounds in the nappy area is particularly difficult, but occlusive, waterproof dressings held in place with the help of the nappy can be very effective.

**Now do Time Out 6.** A contaminated wound is one where bacteria are present but not multiplying, while colonisation implies that a population of bacteria is established. A wound is only infected if the bacteria begin to invade surrounding tissue and provoke an inflammatory response from the host. In most circumstances, only the last of these needs to be treated, through the use of systemic antibiotics. If there is invasion of surrounding tissue, the use of topical antibiotics or antibiotics is not helpful. Occasionally, a heavily contaminated wound can cause problems with excess exudate. In this case it may be worthwhile to treat the wound with antiseptics. This should, however, be an exception rather than the rule because topical antiseptics have a direct impact on the wound environment.

The optimum oxygen and acid profiles for macrophage function must be maintained. Look back at figure two and notice the capillaries at the wound margin. These are very vulnerable to the effects of any topical solution applied to the wound. Many, if not all, topical antiseptics will cause some disruption to the blood flow through the wound bed, thus disrupting the oxygen and nutrient supply (Brennan and Leaper 1985, Lineweaver et al 1985). Sometimes, as with Eusol (Edinburgh University Solution of Lime), this disruption is permanent – that is the capillaries are destroyed and new ones have to grow in from the nearest intact blood vessel. Because the healing wound is so vulnerable and delicate, it is a good rule of thumb never to use a solution on a wound that you wouldn’t use in your own eye!

**Now do Time Out 7.** If you are unsure about the impact of solutions on wound healing read the manufacturer’s literature enclosed with the product or contact a hospital pharmacist who may be able to give you information. If the use of topical antiseptics is routine in your work, now might be the time to rethink this practice (and there are cost advantages too!).

### The Ideal dressing

The use of dressings can promote the maintenance of an ideal wound environment. The ideal dressing does not yet exist, and while there are a number of factors that should be taken into account when selecting dressings, every wound and every child is different. There may never be an ideal, universal dressing but most modern dressings will meet many of the criteria for promotion of the ideal wound environment, particularly the maintenance of a moist environment. These criteria are shown in table three.

<table>
<thead>
<tr>
<th>Table 3. Criteria for the ideal wound dressing</th>
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<tbody>
<tr>
<td><strong>The ideal dressing:</strong></td>
</tr>
<tr>
<td>- removes excess exudate;</td>
</tr>
<tr>
<td>- maintains high humidity;</td>
</tr>
<tr>
<td>- provides thermal insulation;</td>
</tr>
<tr>
<td>- is impermeable to pathogens;</td>
</tr>
<tr>
<td>- allows trauma free removal (from both wound bed and surrounding skin);</td>
</tr>
<tr>
<td>- is contaminant free (leaves nothing embedded in the wound on removal);</td>
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<tr>
<td>- is cost effective (consider cost per dressing vs wear-time).</td>
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**TIME OUT 6**

What are the differences between contamination, colonisation and infection of a wound? In your practice, which of these would you attempt to treat and how?

**TIME OUT 7**

What type of topical solution(s) do you use in the treatment of wounds? Saline or plain water are the least disruptive to healing. If you have used any other solution, what was the rationale for this? Do you know what effect these solutions will have on wound healing?

**TIME OUT 8**

List the different types of dressing you use in practice (e.g. hydrocolloid, alginate, thin film). Prepare a table on a sheet of A3 paper with the type of dressing in the first column and the other columns headed with criteria such as those in table three or other criteria relevant to your area of practice (e.g. use in different stages of healing, comfort during dressing, flexibility for active children, waterproof for bathing/swimming etc.). Place a tick or cross against each dressing for each of your criteria. Use this table to evaluate the dressings, including their cost effectiveness.
References


All modern wound dressings come provided with detailed information about their composition and use in the packaging. It is a good idea to read this information and ensure that you are using the most appropriate dressing for the type of wound. When selecting a dressing you need to take into account the stage of healing the wound is in. Some dressings are more appropriate for red, granulating wounds than for black, necrotic wounds. Some dressings cannot be used on infected wounds. Others may be used across the whole spectrum from black to pink.

The next consideration is the amount of exudate from the wound. Using a dressing designed for low exudate on a low exuding wound, is the equivalent of leaving the wound exposed to the air – a scab will form and healing will be considerably delayed. Be aware that the type of dressing on a wound may need to be changed as the wound heals and its condition changes. Poor dressing selection can contribute to delays in healing. Further important factors need to be considered in selecting the most appropriate dressing for a child. It is far more cost effective to use a high-performance dressing and do fewer dressing changes, particularly in the primary care setting, than to rely on cheaper products that require greater input of nursing or parental resources.

Wound position and accessibility for the curious or inquisitive child may in fact be the major factor dictating dressing selection. The child’s age and level of cognitive development are also important factors, for example: a child at a ‘sensor motor’ level will be unaware of the dressing which is concealed by clothing, minimising the need for extensive strapping. Dressing materials which provide an occlusive or semi-occlusive environment (semi-permeable films and hydro-colloids (Forshaw 1993)) are particularly suitable and help relieve parents of some of their anxieties about returning the child to school or nursery before the wound is healed (Bale and Jones 1997).

Some children with chronic wounds can develop sensitivities to dressings or components of dressings. These should be well documented and this information shared with all carers (Alderman 1998). The rationale for the selection of dressings and methods used. In particular, note the effect of the following factors on the plan:

- changes in the wound;
- the child’s characteristics (age, ability to co-operate, activities etc.);
- the type of surgery or any underlying disease (such as diabetes, leukaemia etc.).

Review this article and evaluate this case study for your reflective exercise.

Case Study:

Reflect on a child with a wound that you have nursed. Write down the wound management you used, identifying the rationale for the dressings and methods used. In particular, note the effect of the following factors on the plan:

- changes in the wound;
- the child’s characteristics (age, ability to co-operate, activities etc.);
- the type of surgery or any underlying disease (such as diabetes, leukaemia etc.).

Review this article and evaluate this case study for your reflective exercise.

Most healthcare professionals involved in wound care have a favourite dressing product which they may continue to use without thought. Nurses need to question whether they are using the most appropriate dressing for the particular child and wound being treated. Although there is little research evidence available about wound management in children, a knowledge of the physiology of wound healing and the impact that various treatments can have on the wound environment, can ensure that nurses select the most appropriate treatment. They are also able to explain clearly to the child and parents the rationale behind dressing choice and any restrictions being placed on a child in relation to wound care.

Documenting the condition and progress of a wound with each dressing change allows other health professionals to follow the rationale for the selection of various treatments. This is a key requirement for continuity of care, case review and quality control. The use of the most appropriate dressing along with evaluation and treatment of underlying causes of a wound, means that the nurse can be assured that she or he is providing the best possible care to enable healing and minimise scarring. Wound management within a holistic framework that addresses the child’s physical, psychological and emotional needs (and the parents’ need for support), will also assist wound healing and reduce the stress of the experience for the child and family.