Wound care for preterm neonates

This article looks at the most common skin injuries and wounds which are found in the pre-term infant population. The causative factors, treatment and healing process are discussed with guidelines for prevention where appropriate. Parental involvement should be encouraged as treatment does not necessarily mean an extended hospital stay.

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Key points

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- Skin injuries can occur antenatally, as a result of the birthing process, due to direct care giving because of the immaturity of the preterm skin, or as a consequence of the intensive therapy required to sustain life.
- There is little published information on the treatment of such skin injuries and post surgical wound care for these infants.
- 3. Guidance for other population groups is not always relevant for neonates due to the specific needs of the preterm skin.
- Certain products and preparations are not appropriate for neonates and selection of these may result in a deterioration of the peri-wound area and delay the healing process.

The principles of moist wound healing were first published in 1962 by Winter¹ following his investigations on healing rates for surgical incisions made in the skins of pigs which were either left exposed or covered with polythene film. Results showed those covered with film epithelised twice as rapidly as those left exposed to air. The studies were replicated in humans² and in the 40 years since, there have been major advances in the research and development of wound contact materials.

The ideal dressing should maintain a moist environment, not cause maceration, maintain an optimum wound bed temperature and pH to allow healing to take place and require infrequent changes to prevent tissue damage³.

Wound dressings

The range of dressings generally available are⁴:

Hydrocolloids – wafer dressings with a microgranular suspension of pectin or gelatin polymers, which absorb exudate and have a hydrophobic adhesive matrix. The outer layer is waterproof but semi-permeable to gases, moisture and microorganisms.

Hydrogels – sheet or gel of insoluble polymers which hydrate the wound while absorbing exudate, so are useful for softening eschar and debridement. They do however require a secondary dressing.

Hydrofibres – non woven pad or ribbon of hydrocolloid fibres which are non adherent and highly absorbent, forming a gel which helps to maintain the moist wound environment.

Hydropolymers – A non adherent layer of perforated ethylene acrylate enveloping an absorbent material island to manage exudate with a polyurethane backing, for wounds with low levels of exudate.

Foams – low adherent but highly absorbent foams produced from poly-

urethane, most of which allow for the transfer of water vapour through the surface.

Films – thin polyurethane membrane with either an acrylic or a vinyl ether adhesive backing, which are hypoallergenic and vapour permeable. They are transparent but do not have any ability to absorb exudate, so are suitable only for shallow wounds or as a secondary dressing.

Alginates – flat sheets or ropes manufactured from seaweed which attract and absorb up to 20 times their weight of fluid and conform to the shape of the wound. They have haemostatic properties and can be used on infected wounds, but they are not recommended for use in neonates due to the potential for calcium to be absorbed.

Wound assessment

Failure to assess any wound properly may lead to inappropriate treatment.

The assessment should include:-

- The type of wound, either acute or chronic with any causative factors being documented.
- The site and the size of the wound, measuring across the widest dimension.
- The extent of the injury, detailing any damage to the epidermis, dermal or subcutaneous tissue.
- The colour of the wound bed black, yellow, red or pink.

Black – indicates necrotic tissue which is dehydrated and needs to be removed by debridement, either surgically or by autolysis.

Yellow – can suggest infection. Nearly all wounds are colonised by the same organisms that are found on the surface of the skin, but their presence does not indicate that the wound is infected. The clinical signs of infection include inflammation, heat, erythema, with the patient feeling pain around the area, swelling around the wound margin, evidence of pus and offensive odour. The presence of pathogenic bacteria must then be confirmed by culturing swabs taken from the wound in a rotating movement across the surface. However if the surface of the wound is dry the swabs must first be moistened with sterile water to ensure sufficient organisms are obtained for culture5. Wound infection delays healing as the production of collagen is affected by toxins produced by the bacteria which also compete with the new cells for oxygen and nutrients further delaying their production⁶. A yellow wound bed can also be due to the presence of slough which is composed of neutrophils which have infiltrated the wound to cleanse it of foreign particles before they themselves are phagocytosed by macrophages. **Red** – due to the presence of invading capillaries, which give the wound bed its granular appearance. Trauma to these will cause bleeding and will slow the healing process.

Pink – due to epithelisation tissue migrating from the wound margins into the centre of the wound. It only forms on top of moist granulation tissue which has reached the level of the surrounding skin.

Wound healing

The wound healing process has four phases which overlap in time.

Inflammation phase

This initial phase begins as soon as the injury occurs, with haemostasis and clot formation to protect the denuded wound tissue. The clot consists of platelets embedded in a mesh of fibrin fibres which acts as a store for cytokines and growth factors released due to the activated platelets. The cytokines influence leucocyte activity during the healing process and the production of growth factors attracts inflammatory cells to the area such as neutrophils and monocytes^{7,8}. Histamine is released increasing the permeability of the capillary bed, which allows the neutrophils and macrophages into the wound area.

Destructive phase

The neutrophils and macrophages play a large role in phagocytosis of devitalised tissue and destruction of any bacteria found in the wound bed. The presence of macrophages in the wound bed is the trigger for the formation of fibroblasts which produce collagen.

Proliferation/granulation phase

During the proliferation or grannulation phase the fibroblasts lay down the ground matrix and collagen fibres, which strengthen the wound bed, although these are laid down in a haphazard manner. Angiogenesis or development of new blood vessels into the area, occurs, which stops when the wound is filled with new granulation tissue. At this stage of wound healing, the wound bed looks red due to visibility of the capillary tips, which are easily damaged causing the wound to bleed.

Maturation phase

The final phase in the process is the maturation phase which starts with epithelisation from the wound edges into the middle of the wound. When the cells meet in the middle mitosis stops and further growth is inhibited. Contraction of the wound occurs at the same time, reducing the area which needs to be covered and the wound bed changes from red to pink. The collagen fibres remodel themselves to align to the stress lines of the wound, resulting in a different appearance of the avascular scar tissue. This may take up to a year to complete. The resulting wound tensile strength is only ever 70% as strong as normal skin⁹.

Wound cleaning

Lineaweaver et al¹⁰ documented the detrimental effects of the use of antiseptics on fibroblasts, which are responsible for the production of collagen. As a result the use of antiseptics in wound management became unpopular. However the clinical significance of any potential damage must be carefully considered since during the inflammatory stage of wound healing there is little or no fibroblast activity¹¹.

Howard¹² commented that although many are safe, the risks of using topical antimicrobials, which include local irritation, chemical burns, sensitisation and allergic contact dermatitis, cannot be disregarded. Also the effects of absorbing these chemicals through what may be an extensive wound bed is still largely unknown. If the wound is so heavily colonised with bacteria that it interferes with the healing process, then the use of antiseptics may be appropriate¹³, however others feel that topical antiseptics are only appropriate for use on intact skin, to reduce resident and transient flora by mechanical removal and /or chemical action¹⁴.

Fourteen randomised controlled trials using various solutions for wound cleaning were analysed by Ferandez et al¹⁵. The evidence suggested that there was no difference in infection or healing rates in acute or chronic wounds treated with either tap water or normal saline. For hospital patients, the use of normal saline is favoured as it is isotonic and unlikely to interfere with the healing process.

Thomlinson¹⁶ found that no matter which solution, technique or tool was used to try and remove bacteria from wound beds, the result was only a redistribution rather than removal. High pressure irrigation using a 35mL syringe with a 19gauge needle attached and pushed at full pressure, generates 7lb per square inch (psi). Although this has been shown to be effective at removing bacteria from wounds¹⁷ it has the potential to increase the risk of spreading bacteria in the resulting spray and damage the newly formed granulation tissue¹⁸.

With the modern interactive dressings it is not necessary or advisable to cleanse the wound bed and only the surrounding skin needs to be cleaned to ensure a good base for attachment of the dressing.

Neonatal wound care

As survival rates improve at the lower gestations the importance of skin and wound care in neonates is becoming more significant. Due to the relatively small numbers involved there is a limited market and it may not be commercially viable for companies to invest in specific products for this population group. Although there is a growing evidence base on which to develop guidelines for practice relating to general skin care issues, there is a much smaller resource base on the subject of wound care for the neonate or infant.

Congenital wounds

Although still a relatively rare occurrence infants can be born with congenital wounds due to:

Aplasia cutis congenitia – a condition affecting 1:3,000 live births, where there are absent areas of epidermis, dermis or subcutis¹⁹. Eighty per cent of such lesions are found on the scalp and the rest on the face, body or extremities. They are noninflammatory, hairless areas with defined margins and look like ulcers. Small lesions may only require epithelisation to

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take place and heal by secondary intention, but the larger defects may require plastic surgery. Full thickness defects have an increased risk of haemorrhage, thrombosis and infection and may need repairing using tissue expansion, bone or skin grafts.

- Abdominal wall defects by the third week of gestation the development of the abdominal cavity is complete. Any interruption to the fusion of the embryonic fold can result in such defects as gastroschisis, which occurs in 0.5-1.0: 10,000, or omphalocele which occurs in 1:4-7,000 live births²⁰. Both require surgical interventions as soon as the infant's condition has stablised sufficiently to be transferred to a surgical unit. In the interim the defects should be covered in cling film or a clear silastic bag to minimise insensible heat and fluid loss and to allow unrestricted visibility for monitoring the colour and perfusion of the contents. The use of saline impregnated gauze swabs is not recommended as this encourages heat loss through evaporation and tissues may become adhered if allowed to dry out, causing trauma on removal²¹.
- Unknown origin better antenatal care which allows the pregnancy to continue in less than optimum circumstances can lead to pressure from the uterine wall resulting in ulcers or skin damage which is noted immediately after birth²² (FIGURES 1 AND 2).

Mechanical injuries

Injuries can be caused by monitoring devices used during labour or by the method of delivery. Displacement of the fetal scalp electrode used to monitor the fetal heart can result in a small lesion which can be hidden by hair and often does not requires specific treatment.

Lacerations to the infant's face or body have occurred during emergency caesarian section when the main concern is the safe delivery of the infant or when there is reduced liquor to protect the infant from the scalpel blade. Depending on the site and severity, these injuries may require suturing or the use of paper sutures to ensure optimum healing by primary intention and minimum scarring.

Damage can also result on the cheeks of the face if the forceps used to assist the delivery slip, causing both bruising and epidermal damage due to shearing. The infant may have difficulty feeding due to



FIGURE 1 Congenital wound on arm.

the pain felt as a result and appropriate analgesia should be prescribed. The wounds, usually on both cheeks can be covered with the hydrocolloid product DuoDerm® (ConvaTec), as this will keep the wound bed moist, reduce pain by preventing the nerve endings from drying out and encourage rapid healing. This product also absorbs the exudate produced, can be cut to size and is conformable so moulds well to the shape of the cheek. The injuries should not mean that the infant has to stay in hospital longer than planned but will usually continue to require treatment after discharge. The parents can be involved in the changing of the dressings prior to discharge and can continue to do so if they so wish in the community setting. This means that there is no delay in re-dressing the wound in the absence of community nursing or midwifery staff, which would otherwise result in a cooling of the wound bed and a slowing down of the healing process.

Epidermal stripping

Post-delivery iatrogenic injuries can be as a direct result of care provision.

For the preterm neonate, epidermal stripping is a serious consequence of the use of adhesives or products, where the bond of the adhesive to the epidermis is stronger than the bond between the epidermis and the dermis²³. When the product is removed the epidermis which has adhered can be stripped off, leaving the dermal layer exposed. The need for any adhesive product should be assessed against the potential damage which could occur and if deemed to be necessary, the smallest amount possible should be used.

Servo-probes which are used to control the temperature of the incubator can be placed into a piece of hydrocolloid which has been cut into the shape of a keyhole before being adhered to the skin. The



FIGURE 2 Congenital wound on leg.

adhesive tape used to secure the probe is therefore attached to the hydrocolloid instead of the skin, and when the probe requires resiting the hydrocolloid remains in place to be used again, so reducing the possibility of damaging the skin²³.

The occurrence of epidermal stripping injuries has further been reduced with the application of a non-alcoholic barrier film under film dressings used to secure IV cannulae in place, even for the most preterm infant²⁴. Teaching staff the correct method for removal of such products, using the horizontal stretch method, is essential to raise awareness of the potential for skin damage and to prevent such injuries occurring.

However, if they do occur, a suitable dressing is the hydrocolloid Duo Derm® (ConvaTec) which can be cut to size and has a wear time of seven days. These wounds are considered to be clean and relatively superficial with minimal exudate production and epithelisation should be completed by the time the wound requires a second change of dressing (14 days).

Pressure/ischaemic injuries

Pressure/ischaemic injures are rarely caused by the factors found in other population groups, as the infant has a large surface area to weight ratio, four times that of an adult²⁵. One area which can be affected is the occiput of the head, if the baby is nursed supine for long periods eg during ventilation. The nasal septum can also be damaged if CPAP is being delivered by nasal prongs, even if they are removed frequently to reduce pressure from direct contact. Care must be taken to chose the correct size of prongs and if there are any signs of trauma the treatment should be reassessed. There are no guidelines available to advise staff on the frequency of repositioning nasal prongs as this must be done on an individual basis depending on gestation, size and general condition of the infant.

The tips and lobes of the ears can be traumatised by pressure from the infant lying too long in the one position or as a result of a hat, used to reduce heat loss from the head or to secure oral endotrachael tubes, becoming too tight if the infant becomes oedematous.

The hands or feet can suffer ischaemic injuries from the use of saturation probes causing pressure on the blood vessels in the dermal layers of the skin which supply the epidermis. Again, time factors for repositioning such probes must depend on the general condition of the infant and can be as short as 1-2 hourly.

Depending on the cause and the site of the injury, different treatments may be necessary. On the ear lobes observation only is appropriate, allowing natural separation of the necrotic area to take place, as the use of a dressing will only cause further pressure to the area. In other areas the use of an interactive wound contact material, e.g. hydrocolloid, may be indicated. Care must be taken if such a product is used around the nasal septum ensuring the piece of dressing used is big enough to prevent it being inhaled and that it is well adhered at all times.

Extravasation injuries

The extravasation of intravenous fluids creates a serious injury, as the leakage of vesicant fluids may have a toxic effect causing precipitation of proteins and cell death of surrounding tissue. In addition the pressure of the fluid causes collapse of small blood vessels which supply the area. Such injuries will ultimately leave a scar²⁶.

Many conflicting treatments have been recommended in the past, such as squeezing the fluid out through multiple puncture wounds made in the limb, cooling the affected area to prevent the spread of the irritating fluid and applying heat to cause vasodilation and encourage the spread and dilution of the fluid. Use of steroids was suggested and then disputed and for infants over three weeks of age glyceryl trinitrate has been advocated.

In animal studies the use of the enzyme hyaluronidase to break down the ground substance of the tissue and to allow dispersal of the fluid has been demonstrated, but in preterm infants the evidence is much less convincing with only the case histories of four infants^{27,28}.

This therapy has not gained wide spread support and the Royal Pharmaceutical Society recommends that it is only used with caution in infants²⁹.

Thomas et al³⁰ demonstrated the use of the hydrogel now known as Intrasite Gel® (Smith & Nephew) for the treatment of extravasation injuries claiming that the slow moist healing reduced the potential for scarring. This treatment requires the use of a sterile "mitt" or "boot" to contain the gel as the high ambient temperatures required to nurse preterm infants would dry it out quickly if used with only a secondary dressing. These are not commercially available and need to be adapted from another product and the resulting weight of the gel contained in the mitt or boot means the infant has difficulty in moving the limb which may need to be supported by a splint. The mitt or boot has to be secured around the already compromised limb by tape or a film dressing which can cause trauma on removal as previously described. This method of treatment also means that good tissue has to be treated as well and can lead to maceration of the area surrounding the wound.

DuoDerm Extra Thin® (ConvaTec) is a suitable hydrocolloid for use on neonatal wounds as it absorbs exudate and creates a moist wound environment to encourage healing³¹. It maintains the wound bed temperature to optimise macrophagic activity and acts as a barrier to atmospheric oxygen, liquids and bacteria. Initially the amount of exudate produced from an extravasation injury can overwhelm the dressing leading to frequent (<12 hourly) changes being required, but the wear time can be increased by combining it with the hydrofibre Aquacel® (ConvaTec) as this increases the absorptive properties. Once the wound is in the proliferative stage of healing the exudate production is reduced and the DuoDerm can stay in place for up to seven days if required.

Necrotising enterocolitis

This is mainly a disorder of preterm infants with up to 80% of cases found in this group. NEC increases in incidence with lowering gestations and is the third leading cause of death in neonates32. It is characterised by intermittent areas of bowel necrosis with the terminal ileum and right colon being the most commonly affected. The cause is multi-factorial, with perinatal asphyxia leading to intestinal ischaemia, infection, hyperosmolar enteral feeds, feeding additives or a rapid increase in the volume of feeds, all thought to contribute to its occurrence³². It usually presents in the first week of life with abdominal distension, ileus and increased gastric aspirates which can lead to shock, bleeding per rectum and bowel perforation. Infants are initially managed medically with oral feeds being withdrawn, and replaced with intravenous feeding. Severe cases will require surgical intervention to resect sections of gangrenous bowel, or if perforation occurs.

Surgery may include anastomosis of the remaining healthy gut leaving a surgical wound which will heal by primary intention with an uncomplicated pathway. Alternatively it may be necessay to create a stoma(s). Sometimes only the jejunum is brought through the abdominal wall as the proximal stoma, with the distal stoma being closed and left in the cavity, but more often the two stomas are evident. The proximal stoma is the functioning stoma and the distal is non functioning or a mucous fistula allowing decompression of the lower bowel. The stomas themselves can be sited along the laparotomy incision or sited through separate incisions to reduce the potential for infection. These will eventually be reverted, but this can be many months after the initial surgery once the bowel has recovered and there has been sufficient weight gain³³.

Immediate postoperative care of the stoma(s) may involved the use of Jelonet[®] (Smith & Nephew) and gauze so that the sites can be observed for bleeding or discharge. However this product is hydroscopic and repels water so if it is allowed to adhere to the wound it will cause trauma on removal. Mepitel[®] (Mölnlycke) is a much more patient friendly product and will not adhere, so is atraumatic and painfree on removal. It also does not leave any greasy residue on the surface of the skin which would

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interfere with the adhesive properties of monitoring devices.

Once the stoma is active, the surrounding skin must be protected from the acidic intestinal contents and an appropriately sized bag can be fitted. The area should be cleaned with water and gauze, not cotton wool, as the fibres can adhere to the surface of the stoma or wound edges, and then dried with gauze or paper towels. The size of the stoma can be measured with the template provided with the stoma bags, which must be cut accurately to ensure a snug but not tight fit. This should be rechecked at each change of bag as the stoma can become odematous or reduce in size. By rubbing a finger round the edge of the cut hydrocolloid flange material any sharp edges can be smoothed out and then this should be warmed between the hands to soften it, making it more pliable. If the infant is very small the outer aspects of the flange may need to be trimmed as well to allow it to attach comfortably on a small abdomen. The backing material is then removed and the bag is carefully placed over the stoma, rubbing gently to ensure good adhesion. Pressing down on the bag to attempt better adhesion is not recommended as this is not tolerated by the infant. The bags should be positioned to the side so that contents drain away from the stoma. Bags which can be emptied are recommended initially so that there is no unnecessary removal of the adhesive flange which may damage the delicate wound area.

At each care time, the stoma should be checked for perfusion, bleeding, prolapse and functioning ability, and each time the bag is changed the surrounding skin should be examined for signs of contact irritation, excoriation or break down. Barrier products such as Cavilon® (3M) can be applied prophylactically to protect the skin, although this should be carried out with caution in the very preterm infant as the consequence of any percutaneous absorption has not been established.

Should break down of the peristomal area occur Orobase[®] (Convatec) can be applied to protect the skin underneath the adhesive flange as it does not interfere with its adhesive properties.

Dehiscence of the abdominal incision can occur if there has been some leakage of abdominal contents through a fistula as the acidic properties can break down the healing wound. Conventional stoma bags are not appropriate due to the open wound and the potential for bowel contents to collect in the wound. Craven and Fowler³⁴ discuss how an infant with eight prolapsed stomas in a dehisced wound was treated using a bag constructed from a double faced adhesive faceplate. This challenged even these experienced wound and ostomy nurses, but after six months' treatment the stomas were closed. As dehiscence of an abdominal wound can have serious consequences, advice from the surgical team must be followed and is outside the remit of this article.

Conclusion

Research has made a significant contribution to improving the evidence base on which to develop guidelines and improve practice for these most vulnerable infants. There still needs to be further specific work carried out in the area of wound care as practice has developed through experience, with little evidence to support it. Not all practice can be transferred from other patient groups, even from paediatrics, as the preterm infant is unique in that skin development has not been completed prior to birth, so requires specialised care and specific products which will not cause further damage. With the improving survival rates for the infant born at the edge of viability these problems will become more widespread and support from the manufacturers of wound contact materials must not be seen in commercial terms, but in improving the quality of care which can be offered.

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