Hydrocolloid dressings in the management of acute wounds: a review of the literature

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ABSTRACT

A review of the literature suggests that the application of self-adhesive hydrocolloid dressings, most commonly associated with the treatment of ulcerative conditions such as pressure ulcers and leg ulcers, may also offer benefits in the management of acute wounds of all types, for example decreasing healing times of donor sites by about 40% compared with traditional treatments. Healing times of superficial traumatic injuries and surgical wounds are similarly enhanced but in the treatment of burns, the principal benefit appears to be a reduction in wound pain, an effect that has also been reported in virtually all other wound types. The impermeable nature of hydrocolloids provides a protective covering to the wound, permitting washing or showering while helping to prevent the spread of pathogenic microorganisms. There also appear to be significant cost–benefits associated with the use of hydrocolloids. In recent years, hydrocolloid dressings have been replaced by other products such as foams for the treatment of more heavily exuding wounds but for more lightly exuding wounds they still offer many practical advantages and as such will undoubtedly continue to meet an important need in wound management practice.

Key words: Healing rates • Hydrocolloid dressings • Literature review

Key Points

- the term 'hydrocolloid' was coined in the 1960s during the development of mucoadhesives, based upon carboxymethyl cellulose (CMC) combined with adhesives and tackifiers that were used as a treatment for mouth ulcers
- it was subsequently adopted to describe a new type of dressing, based upon this technology, in which a hydrophilic gelable mass was applied in a semisolid to form a flexible semipermeable carrier

INTRODUCTION

The term 'hydrocolloid' was coined in the 1960s during the development of mucoadhesives, based upon carboxymethyl cellulose (CMC) combined with adhesives and tackifiers that were used as a treatment for mouth ulcers. It was subsequently adopted to describe a new type of dressing, based upon this technology, in which a hydrophilic gelable mass was applied in a semisolid form to a flexible semipermeable carrier.

The first preparation to be described in this way was Granuflex, launched in the UK in 1982 and then subsequently introduced in the USA as Duoderm in 1983 and as Varihesive in some other European markets. The first formulation of Granuflex/Duoderm tended to produce a viscous mobile gel in the presence of exudate and in 1993 a new formulation was introduced that sought to overcome this perceived problem. Initially called Granuflex E or Duoderm CGF, this eventually replaced the original formulation. Numerous other products followed such as Comfeel (Coloplast, Humlebaek, Denmark), Tegasorb (3M, St. Paul, MN) SureSkin (Euromed, Orangeburg, NY) and Restore (Hollister, Libertyville, IL). All of these products are broadly similar in appearance and are used for the same range of clinical indications, despite some difference in their structure and composition.

Originally produced in small square pieces, in 1985, a bordered hydrocolloid was introduced followed by a number of shaped dressings designed for specific anatomical sites. In 1989, a 'thin' version was developed that consists

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of a semipermeable membrane, coated with a thin layer of a hydrocolloid adhesive as an alternative to the acrylic-based adhesives more commonly used on film dressings. These dressings have little or no fluid retention ability in their own right and tend to be less permeable than the standard films. For this reason, they are used as postoperative dressings or as secondary retention products over primary dressings such as alginates or hydrogels as alternatives to semipermeable polyurethane films.

The term hydrocolloid has more recently been used to describe other very different products, including an amorphous hydrogel dressing and a fibrous dressing made from modified CMC, both of which are totally dissimilar in structure and appearance to the adhesive sheet dressings that were first described in this way.

While it is possible to argue, from a scientific perspective, that hydrogels are in fact colloidal dispersions, by extending the use of the term to materials with totally different physical characteristics designed for totally different clinical indications has caused confusion in the market place and devalued the use of the term 'hydrocolloid dressing' as a descriptor for what was previously a discrete and well-recognised class of wound management materials. The present review, however, is restricted to those products that were originally described in this way.

Although hydrocolloid dressings are most commonly associated with the treatment of chronic wounds such as leg ulcers and pressure ulcers, they can also be used with good effect for the treatment of a variety of acute wounds, where their ability to facilitate debridement, absorb excess fluid and provide a barrier to infection is equally valuable. This review was commissioned to examine the literature for the use of this unique family of dressings for such indications.

METHODOLOGY

The project was not intended to take the form of a systematic review, but rather to provide a digest of all the information published in the area with critical commentary where appropriate.

Information on the use of hydrocolloid dressings in acute wounds was sought from a variety of sources, including online databases, medical, wound management and nursing journals and other publications. Manufacturers of hydrocolloid dressings were also contacted directly and requested to supply details of publications relevant to the subject matter.

In such a project, the multiplicity of existing brands and presentations, further complicated by the use of different proprietary names in various geographical locations, can sometimes make interpretation of published literature difficult. For this reason, within this review, brand names are quoted throughout to distinguish between the different types of dressings but where publications have made reference to Granuflex, Duoderm or Varihesive, for reasons of consistency the dressings will always be referred to as Granuflex/Duoderm.

Burns

An early account of the use of hydrocolloids in the treatment of thermal injuries was provided by Hermans and Hermans (1). They described the use of Granuflex/Duoderm in the management of 24 patients, 7 of whom had multiple burns which enabled comparisons to be made with other treatments. In 1986 and 1987, these data formed the basis of two further publications (2,3) involving 66 and 75 patients, respectively. They concluded that healing rates with hydrocolloids compared very favourably with silver sulphadiazine cream (SSD) and allografts in both superficial and deep partial thickness burns.

Phipps and Lawrence (4), in a prospective randomised controlled trial, compared Granuflex/Duoderm with a chlorhexidine-impregnated paraffin gauze dressing (Bactigras; Smith and Nephew, Hull, UK) in 196 patients with burns involving less than 5% body area. Dressings were changed at weekly intervals or earlier if they became displaced or leaked. A total of 119 patients were followed to complete healing, which took 14·2 days for wounds dressed with hydrocolloid compared with 11·8 days for the alternative therapy, but the authors acknowledged that these times were imprecise because of the extended intervals between dressing changes. Although the hydrocolloid had a tendency to leak, patients reported that it was comfortable to wear and provided relief from pain.

Wright *et al.* (5) similarly treated 98 patients with partial-thickness burns suitable for outpatient management with Granuflex/Duoderm or Bactigras to compare the safety, efficacy and performance characteristics of the two products. A total of 31 patients were withdrawn for various reasons leaving 67 evaluable patients.

Key Points

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- the present review, however, is restricted to those products that were originally described in this way
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Although time to healing was comparable in this study (median 12 days in each case), the quality of healing was rated as 'excellent' in 56% of patients treated with Granuflex/Duoderm compared with only 11% in the group treated with the conventional dressing ($P < 0{\cdot}0001$). Both investigators and patients showed a significant preference for the hydrocolloid despite greater problems of leakage with the hydrocolloid, leading the authors to suggest that Granuflex/Duoderm 'should be used as the first-choice dressing in the management of partial skin thickness burns'. Following a brief review of the literature, this view was supported by Smith *et al.* (6), who concluded that superficial burns without necrosis or infection might benefit from the moist wound environment produced by the application of a hydrocolloid.

Wyatt *et al.* (7) compared Granuflex/Duoderm with a standard burn treatment, silver sulphadiazine cream (Silvadene; Marion Laboratories, Kansas City, MO), in the outpatient management of 50 patients with second-degree burns. Healing times were $10{\cdot}23 \pm 0{\cdot}68$ versus $15{\cdot}59 \pm 1{\cdot}86$ days ($P < 0{\cdot}01$) for Granuflex/Duoderm and Silvadene, respectively. Granuflex/Duoderm-treated burns required fewer dressing changes, caused less pain and produced fewer restrictions upon mobility, leading the authors to conclude that Granuflex/Duoderm was superior to Silvadene cream for this indication.

In a similar prospective, open, randomised and parallel group trial, Afilalo *et al.* (8) compared Granuflex/Duoderm with Bactigras and silver sulphadiazine (Flamazine; Smith and Nephew) used together in the outpatient management of small partial skin thickness burns. Forty-eight patients with burns less than 48 hours old and below 15% total body surface area (TBSA) were randomly allocated into the two treatment groups. Eighteen subjects dropped out leaving 15 in each group. The wounds were followed until complete reepithelialisation occurred. Time to healing was $10{\cdot}7 \pm 4{\cdot}8$ days for Granuflex/Duoderm group versus $11{\cdot}2 \pm 4{\cdot}2$ days for SSD/Bactigras – this difference was not statistically significant although statistically significant differences were reported in other areas. The hydrocolloid was found to be easier to apply but harder to remove than the control. Fewer dressing changes were also required with a mean of three changes per subject in the hydrocolloid group compared with eight in the SSD/Bactigras group ($P = 0{\cdot}117$). Two burn wounds became infected in the hydrocolloid group and one in the SSD/Bactigras group. The authors concluded that the design of the protocol, which required wounds to be assessed at set intervals of increasing length, meant that a difference in healing rates may not have been detected. Despite this limitation, the two treatments appeared equally suitable and effective for small partial skin thickness burns.

The potential advantages of combining a hydrocolloid dressing with SSD in the management of scalds and other thermal injuries were investigated by Thomas *et al.* (9). A total of 54 burns on 50 patients were randomly allocated to treatment with a hydrocolloid alone (Granuflex/Duoderm E), hydrocolloid and silver sulphadiazine, or a medicated paraffin gauze dressing (Bactigras). All wounds were swabbed frequently during the treatment period. Wounds dressed with Bactigras required an average of 4·1 dressing changes and had a mean healing period of 11·1 days. Those dressed with hydrocolloid alone required an average of 2·3 dressings per patient and healed in an average of 10·6 days; the hydrocolloid- and cream-dressed wounds required an average of 3·9 dressings per patient and took an average of 14·2 days to heal. The difference in healing rates between the hydrocolloid and the hydrocolloid/cream-dressed wounds was statistically significant ($P < 0{\cdot}05$) but no significant difference was detected between the hydrocolloid and the medicated paraffin gauze. The bacterial burden of the wounds in all three groups increased during the course of treatment with the smallest increase in the medicated paraffin gauze group. The increase in the number of pathogenic organisms was similar in all three groups.

Cassidy *et al.* (10) compared a hydrocolloid dressing, Granuflex/Duoderm, with Biobrane (Bertek Pharmaceuticals Inc., Morgantown, WV), which is widely used for the treatment of superficial or partial-thickness burns. Biobrane is a composite dressing consisting of a silicone film and nylon fabric laminate to which collagen has been chemically bound. Seventy-two patients aged 3–18 years with burns, which covered less than 10% of the total body area, were included in the study. Although the authors found no significant difference either in pain scores or in the time to heal, $11{\cdot}21 \pm 6{\cdot}5$ versus $12{\cdot}24 \pm 5{\cdot}1$ days for Granuflex/Duoderm and Biobrane,

respectively ($P = 0{\cdot}47$), they reported that the hydrocolloid is statistically less expensive than Biobrane and should be considered a first-line treatment option for intermediate-thickness burn wounds in children.

Donor sites

In patients with extensive burns, delayed healing of skin donor sites may be both costly and life threatening. A donor site dressing should facilitate healing without increasing the risk of a local infection, which may either slow the healing process or ultimately convert the donor site to a full-thickness wound (11). Donor sites have traditionally been dressed with simple materials such as gauze, sometimes impregnated with white soft paraffin or soaked in saline solution, all of which tend to adhere to the wound surface causing pain and trauma upon removal.

In 1985, Biltz (12) compared Granuflex/Duoderm with saline gauze in the treatment of 24 patients with donor sites and reported a significant reduction in average healing rates ($7{\cdot}2 \pm 1{\cdot}1$ versus $13{\cdot}3 \pm 1{\cdot}6$ days; $P < 0{\cdot}01$). In addition, patients treated with Granuflex/Duoderm reported a statistically significant reduction in pain scores ($2{\cdot}1 \pm 1{\cdot}9$ versus $6{\cdot}5 \pm 2{\cdot}0$; $P < 0{\cdot}01$). Madden *et al.* (13) also compared Granuflex/Duoderm with fine mesh gauze in the treatment of 20 donor sites and reported comparable benefits in terms of healing rates (7·4 versus 12·6 days; $P < 0{\cdot}001$), accompanied by greatly reduced infection rates.

Champsaur *et al.* (14) compared Granuflex/Duoderm with paraffin gauze in 20 patients with virtually symmetrical donor sites. The hydrocolloid-dressed wounds healed in $6{\cdot}8 \pm 1{\cdot}1$ days versus $10{\cdot}4 \pm 1{\cdot}7$ days with paraffin gauze ($P < 0{\cdot}01$). They could also be reharvested 5 days earlier, in 10 versus 15 days.

Doherty *et al.* (15) reported similar benefits from the use of Granuflex, following a small study involving 14 patients with donor sites, 13 of which healed in 7 days compared with the 10–14 days normally required for paraffin gauze. They also reported that the hydrocolloid produced better cosmetic results as the healed donor sites were soft and supple in marked contrast to the dry sensitive areas that had formed beneath the conventional dressing. They concluded that the accelerated healing rates, and the reduced time spent in hospital, more than offset the high initial cost of the hydrocolloid. The advantages of hydrocolloid dressings over standard paraffin gauze in the treatment of donor sites were highlighted in further small-scale studies by Donati and Vigano. (16) and Demetriades and Psaras (17).

Tan *et al.* (18) in a prospective, randomised controlled study involving 60 patients with split skin graft donor areas compared Granuflex/Duoderm E with a fine mesh paraffin gauze dressing impregnated with 5% scarlet red. When the wounds were inspected on the tenth postoperative day, 27 (90%) of Granuflex/Duoderm wounds had healed compared with 17 (57%) in the scarlet red group ($P < 0{\cdot}01$). All wounds were completely healed by day 15. Donor site comfort was also significantly better in patients treated with the hydrocolloid. No clinical infections occurred in either group although wounds dressed with the hydrocolloid dressing required more frequent dressing changes than those dressed with scarlet red.

Smith *et al.* (19) compared Granuflex/Duoderm with a bismuth tribromophenate-impregnated gauze dressing (Xeroform; Sherwood Medical, Waterburg, CT) and found that healing rates in 25 evaluable patients were significantly different, whereby 4/12 (33%) of hydrocolloid-dressed wounds were healed in 5–8 days compared with 1/13 (8%) of the Xeroform-treated wounds. Infection rates were also less in wounds dressed with hydrocolloid (0% compared with 25%).

Leicht *et al.* (20) investigated the use of Granuflex/Duoderm as a dressing for donor sites on the scalp in a study involving 18 children with minor burns. Wounds dressed in this way healed normally, with a median healing time of 7·1 days enabling the patient to be mobilised very quickly after the operation. Good cosmetic effects were also achieved as the scar is hidden and invisible one month after the operation.

Hydrocolloids have also been compared with other more 'modern' dressings. In one study, Granuflex/Duoderm was compared with a second hydrocolloid (Sureskin, Euromed) and paraffin gauze (21). Ten patients with donor sites (minimum size 12×4 cm) had their wound dressed with portions of all three dressings placed side by side. Punch biopsies taken on day 8 from the central part of each wound were examined histologically. Healing times for Granuflex/Duoderm and SureSkin

were identical (8·5 ± 0·8 days), but wounds dressed with paraffin gauze took 12 ± 1·6 days to heal. This difference was highly significant ($P < 0·0035$). The authors concluded that compared with the conventional treatment, hydrocolloids reduce healing times by 33%, but suggested that the frequent dressing changes associated with hydrocolloids limited their acceptability.

Leicht *et al.* (22) compared Granuflex/Duoderm with Omiderm, a highly permeable, hydrophilic, polyurethane membrane in patients with mirror image donor sites on both thighs. The trial was terminated when eight patients had been treated as the Granuflex/Duoderm dressing resulted in solid reepithelialisation almost 3 days earlier than Omiderm, 7·8 (range 7–10) versus 10·6 (range 9–13). Granuflex/Duoderm was also more comfortable for the patients as crusts formed under the Omiderm, which made it uncomfortable and difficult to remove. No such crusting occurred with the hydrocolloid, but leakage was a major problem from Granuflex/Duoderm during the first 2 days, which resulted in additional dressing changes. No signs of clinical infection were noted with either dressing.

In 1991, Feldman *et al.* (23) compared Granuflex/Duoderm with Biobrane and Xeroform in a prospective randomised study of 30 donor sites. Wounds dressed with Xeroform healed in an average of 10·5 days, which was significantly less than Granuflex/Duoderm (15·3 days) or Biobrane (19·0 days). Unfortunately, the results of this study were of limited value because the wounds dressed with the hydrocolloid were only examined at 7-day intervals, which artificially extended the recorded healing times in this group and thus the validity of this part of the study. Granuflex/Duoderm was reported to be the most comfortable dressing in use. No infections occurred in wounds dressed with Xeroform, but two wounds dressed with Biobrane became infected. One patient with Granuflex/Duoderm developed a donor site infection during a drug-related neutropenic reaction. Xeroform was the least expensive dressing to use ($1·16 per patient), followed by Granuflex/Duoderm ($54·88 per patient) and Biobrane ($102·57 per patient). The authors concluded that their study confirmed the usefulness of Xeroform as a donor site dressing as it promoted relatively rapid healing and was inexpensive and easy to use. Granuflex/Duoderm was considered to be ideal for smaller wounds when pain could be significantly reduced with minimal increase in cost. Biobrane was not considered suitable for routine use as a skin graft donor site dressing.

Porter (24) compared hydrocolloid dressings with alginate dressings in 65 patients to investigate the rate of epithelialisation, the discomfort experienced by the patients and the convenience of the dressings in clinical use. The alginate dressings were applied to the raw donor areas and held in place by layers of dry gauze, plaster wool and a crepe bandage. At the time of the first dressing change, 87% of the donor areas dressed with the hydrocolloid and 86% of the donor areas dressed with the alginate were found to be more than 90% healed. The mean time from operation to the observation of complete healing was 10·0 days for the donor areas dressed with the hydrocolloid and 15·5 days for wounds dressed with alginate; this difference was found to be statistically significant. The relatively poor performance of alginates in this study was probably because of the use of an inappropriate secondary dressing system that caused the alginate to dry out during the later stages of the treatment. The healing times quoted in this investigation were greater than in most other studies because dressings were left undisturbed for longer periods. The investigators acknowledged that many wounds might have been healed long before they were inspected. They concluded that alginates are to be preferred as they are easier to apply and the need to achieve haemostasis before application is not as critical as with hydrocolloids.

In a prospective randomised controlled study Tan *et al.* (25) compared Zenoderm, an acrylamide gel sheet containing a polysaccharide and a phospholipid, with Granuflex/Duoderm E in the treatment of split skin graft donor areas in 64 patients. Patient comfort was similar in the two groups but by the tenth postoperative day, 97% of wounds dressed with the hydrocolloid had healed compared with 75% of those dressed with Zenoderm ($P = 0·02$). Two patients in the Zenoderm group developed infection in their donor sites.

Surgical wounds

Hydrocolloid dressings also have a role in the management of surgical wounds, both as primary and secondary dressings for sutured

wounds and for those healing by secondary intention. One early report described the successful use of Granuflex/Duoderm to promote granulation in five patients following extensive excision of skin and subcutaneous tissue for large perianal lesions of hidradenitis suppurativa (26) and a second described the use of Granuflex/Duoderm Extra Thin as a dressing following partial and total nail avulsions (27).

Hydrocolloids have also been used following excision of pilonidal sinuses. Viciano *et al.* (28) compared Comfeel with Varihesive/Duoderm and conventional gauze in a prospective randomised trial involving 38 patients. The median healing time was 68 days (range 33–168) in the control group, compared with 65 days (range 40–137) in the two hydrocolloid groups combined. There were no differences between the hydrocolloid groups. A third of the postoperative cultures in the control group grew pathogens compared with 1/23 patients treated with hydrocolloid dressings ($P = 0{\cdot}03$). This was considered to be of no clinical relevance. A significant number (14/23) of wounds dressed with hydrocolloids developed leaks. Pain was significantly less in the first four postoperative weeks among the patients in the hydrocolloid groups compared with those in the control group ($P < 0{\cdot}05$). The authors concluded that although the use of hydrocolloid dressings leads to a reduction in pain, they had no statistically significant effect upon healing times.

More positive results for hydrocolloids in this indication were reported by Estienne and Di Bella (29) who compared Granuflex/Duoderm with traditional dressings (hypochlorite irrigation and packing with paraffin gauze) in 40 patients for the treatment of pilonidal fistulae. The Granuflex/Duoderm was first applied on the third postoperative day after removal of an iodoform gauze pack, which was applied in theatre. Granuflex/Duoderm granules (gel-forming particles, similar in composition to the adhesive mass on the hydrocolloid sheet) were introduced into the wound for the initial dressings, although subsequently the sheet was used in isolation. Initially, dressings were changed on alternate days, but this interval was later extended to 3–5 days. Wounds dressed with Granuflex/Duoderm achieved complete healing in an average of 6 weeks compared with the 10 weeks required for traditionally treated wounds.

Standard hydrocolloids have also been used successfully as postoperative dressings following primary closure. Hulten (30) described the successful use of Granuflex/Duoderm in a series of 100 patients following colorectal surgery, and Young *et al.* (31) reported the results of a small randomised study involving 49 patients with 54 wounds in which the performance of Granuflex/Duoderm was subjectively compared with that of unspecified standard treatments following clean elective surgery. In both investigations, it was concluded that hydrocolloid dressings offer an acceptable alternative to conventional products following primary closure.

Hermans (32) reported upon the clinical benefits of Granuflex/Duoderm Extra Thin in an open non comparative multicentre trial involving a total of 95 patients with 102 sutured wounds of varying aetiologies. The study focused on patient quality of life issues, safety (incidence of infection), effectiveness (healing time) and ease of use. A total of 160 dressings were applied with an average wear time of 6·84 days (range 1–18). The overall incidence of wound infection was 2%. However, the dressing was not thought to be a causal factor. In five wounds, treatment had to be stopped before the scheduled time. Overall, patients rated the comfort of the dressing as 'good' or 'very good' in 95% of cases and they were able to shower with the dressing in place. In all of these studies, the hydrocolloid was reported to be easy to use while increasing patient mobility and reducing pain.

Granuflex/Duoderm Extra Thin was compared with Xeroform in 28 patients with 40 wounds who had undergone elective surgery (33). One-half of every incision was covered with each of the dressings under investigation so that each patient served as their own control. Wounds were evaluated after 2–3 days, 7–10 days, 4 weeks and 7 months postoperatively. None of the incisions showed any evidence of infection. At the time of suture removal, the hydrocolloid dressings' ability to contain exudate, protect the wound and facilitate mobility and personal hygiene were more highly rated compared with the gauze-type dressings ($P < 0{\cdot}001$, for all variables). At the 4-week review, both the patient and the surgeon rated the scar segments covered with the hydrocolloid dressing better with respect to colour, evenness and suppleness, but these

differences were no longer apparent 7 months after surgery.

The hydrocolloid, Comfeel, was compared with a conventional postoperative island dressing (Mepore) in a prospective randomised study involving 73 patients with clean incisions longer than 5 cm (34). The hydrocolloid was left in place until the sutures were removed but the Mepore was removed 2 days postoperatively. A total of 29 patients were withdrawn from the study, 20 dressed with Mepore and 9 with Comfeel. Wound infections developed in one patient in the Comfeel group and five in the Mepore group ($P = 0{\cdot}2$). The authors concluded that 'occlusive dressings stay in place and stay transparent, and do not increase the risk of wound infection', but the somewhat unusual design of the study and the large number of withdrawals made the result of this investigation of limited value.

Hulten (35) found that the waterproof backing of a hydrocolloid (Granuflex/Duoderm Extra Thin) offered particular benefits to 340 patients who had undergone surgery to form a stoma. Problems of soiling and maceration that commonly occur when such wounds are dressed with traditional gauze were not encountered in 89% of hydrocolloid-dressed wounds, and wound infections were limited to 8% of patients studied.

Several authors have described the use of hydrocolloid dressings following cardiac surgery with varying results. Alsbjorn *et al*. (36) compared healing rates achieved with a hydrocolloid, (Granuflex/Duoderm) and paraffin gauze on drainage wounds in 21 patients each of whom had two drains introduced through incisional wounds in the infrasternal area. The drains were removed 1–2 days postoperatively resulting in two identical wounds about 30×15 mm that were dressed with the products under examination. An operator, unaware of the nature of the treatment provided, examined the wounds on postoperative day 10. At this point, 13 hydrocolloid-dressed wounds had healed compared with six wounds dressed with paraffin gauze. No differences in wound infection rates were detected.

Wikblad and Anderson (37) dressed the wounds of 250 patients undergoing heart surgery to treatment with Granuflex/Duoderm, Cutinova Hydro (Smith and Nephew) or gauze and tape in a randomised controlled study. The conventional absorbent dressing was more effective in wound healing than Cutinova Hydro, and there were also fewer skin changes and less redness in the wounds. The differences were not significant with the hydrocolloid dressing. The conventional dressing was less painful to remove than Cutinova Hydro and Granuflex/Duoderm. More frequent dressing changes, however, were needed when using the conventional dressing. Despite this, it was the least expensive alternative.

Wynne *et al*. (38) described a study in which 737 patients were randomised to treatment with a Granuflex/Duoderm Thin, a simple island dressing (Primapore; Smith and Nephew) or a semipermeable film dressing Opsite (Smith and Nephew) following a median sternotomy for cardiac surgery. The dressings were assessed in terms of their ability to protect against infection and promote healing and patient comfort. There was no difference in the rate of wound infection or wound healing between treatment groups, but the Primapore dressing was judged to be the most comfortable and least painful to remove. Granuflex/Duoderm Thin required the most frequent dressing changes ($P < 0{\cdot}001$) and tended to be associated with the most discomfort upon removal. It was also the most expensive treatment of the three ($P < 0{\cdot}001$).

According to Wilson (39), thin hydrocolloid dressings can be used effectively as an alternative to sutures for graft fixation where the more traditional techniques are difficult or inappropriate. They have the additional advantage that they decrease slough and are less conspicuous than most other dressings.

Traumatic wounds

In addition to their role in the treatment of major acute wounds, hydrocolloid dressings have also been used with success in the management of superficial sports injuries and other traumatic wounds.

One report described how pieces of Granuflex/Duoderm were used to treat 39 soldiers who developed a total of 70 abrasions to their feet during a 160 km, 4-day road hike (40). Estimation of pain levels before treatment showed that 28% had severe pain, 4% moderate pain and 8% no pain. Of those with initial severe or moderate pain, 92% reported good and 8% moderate pain relief after application of the dressings. The pain relief provided by the dressing enabled 35 of the 39 soldiers to complete the exercise.

A review of the pathophysiology, prevention and treatment of blisters that appeared in the journal *Sports Medicine* (41) recommended the use of hydrocolloids for treating deroofed blisters, stating that this treatment 'provides pain relief and may allow patients to continue physical activity if necessary'.

Hermans (42) recorded how racing cyclists who had suffered partial thickness abrasions were either treated with an occlusive hydrocolloid dressing or a more traditional product. Twenty-three individuals with 38 abrasions were treated with a hydrocolloid dressing and 24 individuals with 41 abrasions were treated with paraffin gauze. The results showed that the occlusive dressing produced a shorter healing time (5·6 versus 8·9 days), reduced pain (91% versus 30% pain free) and had a lower incidence of infection (0% versus 10%). Athletes could also shower with the hydrocolloid in place, and comfort was judged to be good in 94% of instances. Showering comfort for wounds dressed with paraffin gauze was judged to be bad in 100% of cases.

The application of a hydrocolloid dressing can also offer other advantages to the sportsman for even relatively minor wounds such as lacerations that commonly occur during competitive contact sports and may limit the ability of the athlete to continue competition. Hazen *et al.* (43) described how Granuflex/Duoderm Thin was used to protect injuries received during competitive wrestling. They reported that the dressing was able to support the skin, protect the laceration from further injury, shield the wound from exposure to infectious agents and prevent transmission of blood or serum to other wrestlers. Such protection enabled two wrestlers to continue competition and/or practice without adverse effects.

Knapman and Bache (44) described the use of a hydrocolloid dressing (Comfeel) in an accident and emergency setting in the treatment of three patients with severe friction burns and gravel rash. They concluded that compared with conventional dressings the hydrocolloid appeared to promote healing and reduce discomfort experienced by the patient.

Similar benefits resulting from the use of a hydrocolloid dressing in the treatment of excoriations was reported by Andersson *et al.* (45) who showed that seven patients dressed with a hydrocolloid experienced less pain or discomfort than nine dressed with paraffin gauze.

Heffernan and Martin (46) compared Granuflex/Duoderm Extra Thin with a non adherent dressing (perforated film absorbent dressing) in the management of 96 patients with lacerations, abrasions and minor operation incisions. Although time to heal was similar for both groups, patients using Granuflex/Duoderm Extra Thin experienced less pain ($P < 0{\cdot}001$), required less analgesia ($P = 0{\cdot}0154$) and were able to carry out their normal daily activities including bathing or showering without affecting the dressing or the wound.

This important practical benefit associated with the use of hydrocolloid dressings was also noted by Hermans and van Wingerden (47) following the use of Granuflex/Duoderm bordered dressing in a prospective study involving 30 patients with minor industrial wounds. Of these, 28 were partial thickness burns, one a combined cut/abrasion and one a combined cut, burn and abrasion. In 28 of the 30 wounds, treatment with the hydrocolloid commenced immediately; in the remaining instances, the wounds received 2 days of pre-treatment with an antiseptic because of heavy contamination. Two patients had their treatment discontinued because of suspected infection and one because of a suspected allergic reaction to the dressing (not confirmed). Over 80% of patients rated the dressing as comfortable or very comfortable, enabling them to continue their daily activities.

Paediatric wounds

Hydrocolloid dressings offer important practical advantages in paediatric wound management, promoting healing and reducing pain (48).

Eisenberg (49) dressed a total of 44 wounds on three children who suffered from recessive dystrophic epidermolysis bullosa with an impermeable hydrocolloid, paraffin gauze or a perforated plastic film dressing (Telfa). The HT50 (time to heal 50% of wounds) with hydrocolloids was 3·0 days, for Telfa 4·2 days and for paraffin gauze 12·6 days. In addition to the enhanced rate of healing, the use of the hydrocolloid also resulted in pain-free movement of the injured part, fewer dressing changes and a reduction in scar tissue formation. (It is unlikely that an adhesive dressing would now find widespread use for this indication, as products made from silicone tend to be used for the treatment of very fragile skin.)

Schmitt *et al.* (50) compared a hydrocolloid dressing with adhesive skin tapes on a variety

Key Points

- the results of this review strongly support the proposition that compared with more basic dressings such as paraffin gauze (both plain and medicated), hydrocolloid dressings produce improved healing rates in partial thickness wounds such as burns, donor sites, superficial traumatic injuries and some types of surgical wounds
- there is also a body of evidence to suggest that their use is associated with a reduction in wound pain, enhanced quality of life, (including the ability to wash or shower) and also an improvement in the quality of the healed wound
- many of the papers included in this review were published before the introduction of foam dressings, which in many centres have largely replaced hydrocolloids for the treatment of moderate to heavily exuding wounds
- nevertheless, the more occlusive nature of the hydrocolloids and their proven ability to conserve moisture, prevent infection and promote healing means that they remain worthy of very serious consideration for the treatment of all types of superficial wounds in which the production of excess exudate is unlikely to be a significant problem

of postoperative wounds in 170 children. Although effective skin closure was comparable in both, the hydrocolloids were more secure, remaining in place in 69 children (81·2%) compared with 38 (44·7%) in the control group ($P < 0{\cdot}001$). No product-related maceration, infection or adverse events were reported during the study. The cosmetic results achieved in both groups was said to be very satisfactory.

Similar benefits associated with the use of a hydrocolloid were reported by Rasmussen *et al.* (51) when they compared Granuflex/Duoderm with their standard treatment, which consisted of adhesive wound closures (Steristrip; 3M) covered with an island dressing with a non woven fabric back (Cutiplast; Smith and Nephew) in a randomised trial that focused on the psychological aspects of the treatment of 88 children who had undergone minor outpatient surgery. They found that the hydrocolloid dressing required fewer dressing changes and readily permitted bathing or washing, while minimising the physical and psychological trauma to the infant or child and reducing the disruption to the child's and the parents' daily routines.

Hydrocolloids also have a very useful role to play in the treatment of skin lesions resulting from meningococcal septicaemia. The traditional approach of allowing such areas to dry out and demarcate before surgery or autoamputation may be appropriate where vascular studies have shown that a significant portion of a limb has become totally ischaemic and will definitely require amputation. For isolated areas or digits where the full extent of the damage cannot be accurately determined, intervention at an early stage with the application of a simple dressing such as a hydrocolloid that prevents further desiccation and the formation of dry eschar is worthy of serious consideration (48,52).

Nagai *et al.* (53) described the successful use of a hydrocolloid (Duoderm) as an alternative to elastic bandages following urethroplasty for repairing hypospadias in 12 infants and suggested that the use of the dressing offers significant clinical advantages and a reduction in complications.

DISCUSSION

The results of this review strongly support the proposition that compared with more basic dressings such as paraffin gauze (both plain and medicated), hydrocolloid dressings produce improved healing rates in partial thickness wounds such as burns, donor sites, superficial traumatic injuries and some types of surgical wounds (Table 1). There is also a body of evidence to suggest that their use is associated with a reduction in wound pain (7,12,14,15,18,20,25,28,40–42,44–46,49,51), enhanced quality of life, (including the ability to wash or shower) (33,35,39,40–47) and also an improvement in the quality of the healed wound (5,16,29,30,33,34,49).

With the exception of Biobrane, the hydrocolloids tended to be more expensive than products with which they were compared, although a number of authors proposed that the reduction in treatment time resulting from their use more than compensated for this increased initial cost (10,15,23,25,33).

The principal advantage offered by this unique group of products is that in their intact state, they are virtually impermeable to water vapour and therefore provide an effective barrier to transepidermal moisture loss when applied to intact skin or devitalised tissue. In the presence of exudate, the dressings absorb liquid and form a gel. As they do so, they become permeable to moisture vapour that further increases their ability to cope with wound exudate. In most instances, however, they still require frequent replacement if applied to heavily exuding wound such as donor sites in the early stages of treatment as illustrated in this review. In contrast, alginates combined with appropriate secondary absorbent layers are well able to cope with such wounds initially, but as exudate production diminishes after the first couple of days of treatment, the fibrous dressing has a tendency to dry out leading to adherence and the possibility of secondary trauma. A logical approach to the management of these wounds would therefore seem to be the initial application of alginate, followed by a change to a hydrocolloid as exudate production is decreased in order to continue the provision of a moist wound healing environment.

Many of the papers included in this review were published before the introduction of foam dressings, which in many centres have largely replaced hydrocolloids for the treatment of moderate to heavily exuding wounds. Nevertheless, the more occlusive nature of the hydrocolloids and their proven ability to conserve moisture, prevent infection and promote healing means that they remain worthy of very

Table 1 Comparative healing rates for hydrocolloids and traditional dressings

Author	Wound type	Hydrocolloid	Comparator	*n*	Healing time days (hydrocolloid)	Healing time days (comparator)	Significance (*P*)	Difference in healing time
Wyatt *et al.*(7)	Burns	Duoderm	SSD	50	10·2 ± 0·68	15·6 ± 1·86	<0·01	−34%
Phipps and Lawrence (4)	Burns	Granuflex	Bactigras	119	14·2	11·3	—	+25·5
Afilalo *et al.*(8)	Burns	Duoderm	SSD and Bactigras	48	10·7 ± 4·8	11·2 ± 4·2	ns	−4·5
Thomas *et al.*(9)	Burns	Granuflex E	SSD/Bactigras	54	10·6	14·2	<0·05	−25·4
			Bactigras			11·1	ns	−4·5
Cassidy *et al.*(10)	Burns	Duoderm	Biobrane	72	11·2 ± 6·5	12·2 ± 5·1	ns	−8·2
Wright *et al.*(5)	Burns	Granuflex E	Bactigras	67	12 (median)	12 (median)	ns	
					50% excellent	11% excellent	<0·001	
Biltz (12)	Donor sites	Granuflex	Saline gauze	24	7·2 ± 1·1	13·3 ± 1·6	<0·01	−45·9
Madden *et al.*(13)	Donor sites	Granuflex	Gauze	20	7·4	12·6	<0·001	−41·3
Champsaur *et al.*(14)	Donor sites	Duoderm	Paraffin gauze	40	6·8 ± 1·1	10·4 ± 1·7	<0·01	−34·6
Steenfos *et al.*(21)	Donor sites	Duoderm E	Paraffin gauze	30	8·5 ± 0·8	12 ± 1·6	<0·01	−29·2
		SureSkin			8·5 ± 0·8		<0·01	
Tan *et al.*(18)	Donor sites	Duoderm E	Paraffin gauze/Scarlet red	60	90% healed (at day 10)	57% healed (at day 10)	<0·01	
Smith *et al.*(19)	Donor sites	Duoderm	Xeroform	25	4/12 healed at days 5–8	1/13 healed at days 5–8	<0·01	
Feldman *et al.*(23)	Donor sites	Granuflex (examined every 7 days)	Biobrane	30	15·3	19		−19·5
			Xeroform			10·5		+45·7
Leicht *et al.*(20)	Donor sites	Duoderm	n/a	18	7 (median)	—		
Doherty *et al.*(15)	Donor sites	Granuflex	n/a	14	7	—		
Donati and Vigano (16)	Donor sites	Duoderm	n/a	10	8·5	—		
Porter (24)	Donor sites	Hydrocolloid	Alginate	65	10 days for 100% healed	15·5 days for 100% healed		
Tan *et al.*(25)	Donor sites	Duoderm E	Zenoderm	64	97% healed at day 10	75% healed at day 10	<0·05	
Viciano *et al.*(28)	Pilonidal excisions	Comfeel	Gauze	38	65 (40–137)	68 (33–168)	ns	
		Varihesive						
Estienne and Di Bella (29)	Pilonidal excisions	Duoderm	'Traditional'	40	42	70	—	−40
Hermans (42)	Abrasions	Duoderm	Paraffin gauze	41	5·6	8·9		−37·1
Eisenberg (49)	Epidermolysis bullosa	Hydrocolloid	Telfa	44	3	4·2		−28·6
			Paraffin gauze			12·6		−76·2

SSD, silver sulphadiazine cream; n/a, not applicable; ns, not significant.

serious consideration for the treatment of all types of superficial wounds in which the production of excess exudate is unlikely to be a significant problem. The 'thin' versions of the hydrocolloid dressings are essentially similar to the standard semipermeable film dressings and are probably best reserved for use as secondary dressings (54).

In Table 1, the effect of dressing choice on healing rate has been summarised by calculating the difference in healing times for both groups and expressing these as a percentage change relative to the time taken by comparator B. A negative value indicates a reduction in healing time associated with the hydrocolloid; a positive value indicates an increased healing time. Given the diverse nature of the wound types and dressings used as comparators, no statistical analysis has been attempted on these data, but there appears to be an obvious advantage associated with the use of the hydrocolloid in most reported studies. Where healing times appeared to favour the alternative therapy (studies of Phipps and Lawrence 4 and Feldman *et al.* 23), this was probably caused by poor experimental design as discussed earlier in the text.

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