

# DERMATOLOGIC SURGERY

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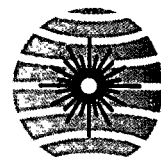
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# Moist Wound Healing with Occlusive Dressings: A Clinical Focus

WILLIAM H. EAGLSTEIN, MD

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The concept of moist wound healing, which is facilitated by the application of occlusive dressings, dates back to 1615 BC, and the technique is currently supported by a relatively large volume of data. It is clear that occlusive dressings are in many cases associated with more rapid reepithelialization, a reduced risk of infection, and more rapid wound healing than the alternatives. Nevertheless, many clinicians have been slow to accept this ther-

apeutic technique. This article traces the history of moist wound healing from its earliest inception, examines the theoretical mechanisms of its effect, and explores its advantages and disadvantages. It also reviews the literature supporting the use of occlusive dressings in a variety of wound settings and examines the possible reasons behind the apparent reluctance on the part of the medical community to accept a potentially valuable therapy.

THIS ARTICLE REVIEWS the history of dressings that facilitate moist healing and describes the various types of dressings and some of their clinical effects. Functionally an occlusive dressing can be defined as any material that keeps the wounded tissue moist, thereby promoting moist wound healing. It has been estimated that there are 1000 different types of occlusive dressings, and that sales of these dressings totaled \$350 million in 1995. Nevertheless, occlusive dressings are probably used in, at most, only 30% of cases in which they would likely be beneficial.

## Historical Perspective

Occlusive dressings are far from a new idea. One of the earliest notations of occlusive wound therapy is contained in the Smith Papyrus of 1615 bc, which asserted that closed wounds heal more quickly than open wounds and described creating dressings out of linen strips that were covered with a gumlike substance. However, Hippocrates contended that physicians should not endeavor to close chronic wounds. During his era physicians perceived chronic wounds as an indication that something harmful needed to exit the body. Indeed, until the 19th century, drainage was encouraged in chronic wounds and even in acute wounds, as reflected in the frequently used phrase "laudable pus."

It was Lister who connected pus with infection, and the link has become so inextricable in the collective medical mind that it is commonly believed that one is always indicative of the other. This is not always the case, however, and the association of pus and infection has interfered with acceptance of occlusive dressings due to the fact that such dressings encourage the movement of white cells into the fluid beneath the dressing. In 1948, Oscar Gilje<sup>1</sup> wrote a thesis in which he described what he called a "moist chamber effect" for healing ulcers. By treating half of an ulcer with adhesive tape occlusion and leaving the other half open, Gilje clearly demonstrated that the moist chamber effect was beneficial to wound healing.

In 1950, Schilling et al.<sup>2</sup> published the results of a study in which they treated common minor industrial wounds with new nylon films, one of which was highly occlusive and one of which was semioclusive. Because the wounds treated with the highly occlusive dressings did not fare as well, the investigators concluded that occlusion was not beneficial. However, the semioclusive dressing was much more effective than open treatment in promoting healing. Unfortunately, because the highly occlusive dressings were not as effective as the semioclusive dressings, this study actually set the field back. Most of the dressings that are called occlusive today are actually semioclusive.

In 1951 Beattie et al.<sup>3</sup> created a postoperative "window" dressing. They published their findings in the *British Medical Journal*, which at that time had a section devoted to new technologies called "Preparations and Appliances." Beattie et al. placed a plastic film over 300 abdominal and thoracic wounds. They thought of the film not as an occlusive dressing, but rather as a window through which to see the wound. The goal was

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simply to be able to avoid having to change the dressing in order to visualize the wound. Amazingly Beattie et al. were not afraid to treat major surgical sites with an occlusive plastic film, and there were no infections or problems in the nearly 300 cases they reported.<sup>3</sup>

Seven years later, in 1958, Odland,<sup>4</sup> a dermatologist, studied unbroken blisters and found that they healed much faster than opened blisters. He suggested that occlusion was the reason and that wounds were best kept moist.

George Winter is considered the father of moist wound healing. Smith & Nephew, Inc., Winter's employer at the time, was the first company willing to attempt to commercialize the information generated by Winter and his colleagues. In 1962 Winter published what is generally considered to be the landmark study comparing the effects of air drying to occlusive dressings on resurfacing (epithelialization).<sup>5</sup> His study, conducted in domestic pigs, showed a 30% difference between the two treatments, with occlusion providing the greater benefit.

These results were reproduced in humans by Hinman and Maibach,<sup>6</sup> who were at first quite skeptical that Winter's finding could be put into practical use. They argued that infection might preclude the practical use of occlusion because the dressings encouraged accumulation of moisture, which provided a fertile environment for reproduction of infectious organisms. In their 1963 publication in *Nature*, however, they suggested that "with the introduction of potent topical antibacterial agents, it might be practical to take advantage of such dressings." Given this attitude in the medical community, it would be a bold company that would be willing to manufacture a product based on the use of occlusion.

In 1972 the textbook *Epidermal Wound Healing* was published. This book, which brought together a great deal of information about healing, much of it dealing with moist wound healing, had a major effect on the field. David Rovee, one of the book's coeditors, was also the author of a chapter that documented more effective wound healing with occlusive therapy.<sup>7</sup>

Our group became involved in wound healing research in the mid-1970s, by which time we had developed a simplified method to study wound healing agents in pigs.<sup>8</sup> In order to determine whether our model would show the rapid resurfacing that others had reported with occlusion, we studied an occlusive film and a potent topical steroid and petrolatum. We demonstrated in 1978 that occlusion was associated with a shorter healing time than air exposure, but that the potent steroid slowed healing.

The commercial introduction of occlusive dressings rested as much on the innovations of nurses as it did

on the experimental data that had been generated. The literature contains many nurse-authored articles recommending occlusive therapy for wounds. Nurses were taking devices such as OpSite (Smith & Nephew, Largo, FL) and Incise Drape (3M, St. Paul, MN), both adhesive transparent films designed to be placed over the skin where a surgical incision would be made (the adhesive was intended to keep the bacteria on the skin from migrating into the body through the incision), and placing them on chronic wounds. The semioclusive nature of this film was important to its effectiveness: excessive occlusion under the hot operating room lights led to sweating, pooling, and peeling of the incision drapes. The drapes had similar benefits when nurses used them on decubitus ulcers; because the dressing was semioclusive, it allowed sufficient moisture to evaporate and thus prevented peeling. The nurse's rationale for using these products on decubiti was to break down what they called the "dry barrier of the wound."

Nurses also utilized hydrocolloids, a product intended as an adhesive for attaching enterostomal bags, for use in wound healing. Nurses described the absence of associated infections when hydrocolloids were placed on wounds, and companies began to consider marketing these products as occlusive wound dressings.<sup>9,10</sup> Alper et al.<sup>11</sup> published one of the first controlled studies on occlusive dressing-induced moist wound healing in chronic wounds.

Practitioners resisted using dressings for wound healing even after the availability of occlusion. Some practitioners contended that since dressings were placed outside wounds, they could not exert an effect on the inside, where healing takes place. Following the introduction of occlusive dressings to the market, some writers claimed that they had, at best, no benefit.<sup>12</sup> Although resistance to occlusive dressings has rarely been formal, there has been resistance nonetheless, based primarily on concern about the proliferation of bacteria in a wet environment.

It is true that bacterial counts are higher under conditions of occlusion. For example, in studies using the pig model, our group proved that there were more organisms in wounds treated occlusively; nevertheless, these wounds healed faster.<sup>13</sup> It appeared that we were actually seeing less infection under occlusion despite higher bacterial counts, so we wondered whether we might have been preventing bacteria from invading wounds. Studies conducted by our group in 1985 demonstrated that this was in fact the case with many of the occlusive dressings.<sup>14</sup>

Hutchinson<sup>15</sup> confirmed these findings 4 years later with a literature review demonstrating that fewer wound infections occurred in the presence of occlusive dressings than in the presence of conventional dressings. Hutchinson found that the incidence of wound infections was approximately 7% with conventional

therapy, compared to a 3% risk with occlusive dressings. This review illustrated that while wound infections occur with all treatments, the risk of infection is lower with occlusive dressings.

Brown and Zitelli<sup>16</sup> endorsed the use of occlusive dressings in dermatologic practice when they included the use of occlusion in their 1993 guidelines for treating acute wounds. A more important endorsement was issued a year later, with the publication of the US Agency for Health Care Policy and Research clinical guidelines for treatment of pressure ulcers.<sup>17</sup> The panel issuing the guidelines recommended occlusive dressings for both autolytic debridement and to obtain moist wound healing. While they pointed out that moist wound healing can be attained by changing wet gauze before it dries—the so-called “wet-to-wet dressing,” which keeps wounds continually moist—they also noted that this strategy demands a great deal of time and nursing effort compared with occlusive dressings. The guideline, endorsed by a federal agency and based on an extensive literature review, was historically significant, unequivocally confirming the efficacy of occlusive dressings.

### Advantages and Disadvantages of Occlusive Dressings

Occlusive dressings have several advantages. One major advantage is the rapid reepithelialization of acute wounds. Although such rapid reepithelialization does not always occur in chronic wounds, it remains an important advantage (first described by Winter in 1962<sup>5</sup>). Chronic wounds are more likely to develop granulation tissue and to heal when treated with occlusive dressings than when treated with standard methods, but the cure rate is still only about 50%.

Additional advantages of occlusive dressings in the treatment of both acute and chronic wounds include reduced pain and reduced risk of infection. Advantages specific to acute wounds include reduced scarring and reduced fibrosis. Inflammation is far less common in sutured acute wounds treated with occlusive dressings, which probably accounts for the reduced scarring.

Although the risk of infection is reduced with occlusive dressings compared to standard dressings, infection remains a possibility. Thus the fear of infection is the most significant disadvantage of occlusive dressings. Another disadvantage, in the case of chronic wounds, is the risk of inducing an exudative phase in an otherwise dry ulcer. The cost of occlusive dressings for acute wounds might be a deterrent.

### Types of Occlusive Dressings

Occlusive dressings can be categorized in several ways, but the most common is to classify them as follows:

films, foams, gels and hydrogels, hydrocolloids, alginates, and composites or specialty dressings (Table 1).

Most films are polyurethanes. OpSite was the first film to become commercially available (1978), but there are now many brands on the market, each with a different system for applying the dressing to the wound. Foams are also made of polyurethane. They are capable of absorbing large volumes of wound fluid, and some, such as Allevyn (Smith & Nephew, Largo, FL), have a film outer surface. Gels and hydrogels can be up to 90% water. Vigilon (Bard, Murray Hill, NJ), the first hydrogel, has a film layer on either side. The film on the side being applied to the wound is usually removed. Hydrocolloids are composed of a mixture of adhesive, absorbent, and elastomeric ingredients; carboxymethylcellulose is the most common absorptive ingredient. Some hydrocolloids contain pectin, and all have a top layer of film that renders them waterproof. Hydrocolloids absorb some wound fluid and have both wet and dry tack (ability to adhere). The alginates absorb fluid and turn into a gel, which keeps the wound bed moist. A composite dressing is an island dressing for which the absorbent portion is a textile-based material. Specialty dressings are also available that combine materials such as an alginate with collagen.

### Selecting an Occlusive Dressing

What factors guide the use of occlusive dressings? Although rigid guidelines do not exist, certain factors help to guide the clinician's selection from among the many categories of dressings. The most important is probably the clinician's personal standard. Physicians and caregivers should start by becoming accustomed to one dressing that is effective for the type of wound they treat most frequently. For many years, most clinicians chose hydrocolloids as their personal standard; now, however, many clinicians choose foams. Another important factor in guiding choice is the volume of wound exudate. When exudate is substantial, foams are the optimal choice.

Wound type is also important. For example, laser abrasion procedures are now being performed frequently to eliminate or minimize facial wrinkles. This procedure leaves a highly exudative wound, and some clinicians are finding that the hydrogels are particularly effective in this setting. Others report that a very thin foam that actually adheres to the face and can be cut and formed into a masklike dressing is very effective.

The condition of the skin surrounding the wound also influences dressing choice. If the skin is friable and easily damaged, the clinician might be reluctant to use a dressing with an adhesive, choosing instead a hy-

**Table 1. Types and Characteristics of Occlusive Dressings**

| Category                     | Characteristics                                                                                                                                                                                                                                                                                                                                                                                            | Best uses                                                                                                                                                                                                                                                                                       | Advantages                                                                                                                                                                                                                                                                                                                                                                                                              | Disadvantages                                                                                                                                                                                                                                                                                                                                                                         | Product examples                                                                                                                                                                                                                                  |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Films                        | <ul style="list-style-type: none"> <li>• Polyurethane based</li> <li>• Methods of delivery to wound differ</li> </ul>                                                                                                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>• Donor sites</li> <li>• Shallow wounds</li> <li>• Abrasions</li> </ul>                                                                                                                                                                                  | <ul style="list-style-type: none"> <li>• Transparent</li> <li>• Retains moisture</li> </ul>                                                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>• No absorption</li> </ul>                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"> <li>• Bioclusive<sup>a</sup></li> <li>• OpSite<sup>b</sup></li> <li>• Tegaderm<sup>c</sup></li> </ul>                                                                                                          |
| Foams                        | <ul style="list-style-type: none"> <li>• Polyurethane based</li> <li>• Capable of absorbing large volumes of wound fluid</li> <li>• Some have film outer surface to resist water and bacteria</li> <li>• Some are adhesive, some nonadhesive</li> </ul>                                                                                                                                                    | <ul style="list-style-type: none"> <li>• Heavily exudating wounds, especially during the early inflammatory phase following debridement and sloughing when drainage is at its peak</li> <li>• Some foams can be used in deep cavity wounds as a packing</li> <li>• Venous leg ulcers</li> </ul> | <ul style="list-style-type: none"> <li>• Comfortable and conformable</li> <li>• Highly absorbent</li> <li>• Does not stick to wound or harm viable tissue</li> <li>• No dressing residue in the wound bed</li> <li>• Nonadhesive foams are useful when surrounding skin is friable (as in the elderly) or painful (as in arterial leg ulcers)</li> <li>• Can absorb under compression stockings and bandages</li> </ul> | <ul style="list-style-type: none"> <li>• Generally requires a secondary dressing</li> <li>• In rare instances, foams may dry the wound if there is too little exudate</li> </ul>                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>• Allevyn<sup>d</sup></li> <li>• PolyMem<sup>e</sup></li> <li>• Sof-Foam<sup>f</sup></li> </ul>                                                                                                            |
| Amorphous gels and hydrogels | <ul style="list-style-type: none"> <li>• Available as sheets and amorphous gels</li> <li>• Can be more than 90% water based</li> <li>• All donate water to desiccated tissue; some absorb also</li> <li>• Soothing effect; are easily applied and removed without discomfort to patient</li> </ul>                                                                                                         | <ul style="list-style-type: none"> <li>• Rehydrating eschar and slough for easy removal from wound surface</li> <li>• Creating and maintaining a moist but not wet micro environment over the healing wound</li> </ul>                                                                          | <ul style="list-style-type: none"> <li>• Simple application and removal</li> <li>• Soothing to the patient</li> <li>• Maintains intimate contact with the wound surface</li> <li>• Creates a moist environment for cell migration</li> </ul>                                                                                                                                                                            | <ul style="list-style-type: none"> <li>• Amorphous gels always require a secondary dressing</li> <li>• Most hydrogels cannot handle heavily exuding wounds without leakage</li> </ul>                                                                                                                                                                                                 | <ul style="list-style-type: none"> <li>• Carrasyn<sup>g</sup></li> <li>• Lamin<sup>h</sup></li> <li>• IntraSite gel<sup>i</sup></li> <li>• Nu-Gel<sup>j</sup></li> <li>• SoloSite wound gel<sup>k</sup></li> <li>• Vigilon<sup>l</sup></li> </ul> |
| Hydrocolloids                | <ul style="list-style-type: none"> <li>• Composed of a mixture of adhesive, absorbent, and elastomeric ingredients</li> <li>• Carboxymethylcellulose most common absorptive ingredient</li> <li>• Some contain pectin</li> <li>• All have top film layer for waterproofing</li> <li>• Absorb some wound fluid</li> <li>• Both wet and dry tack</li> <li>• Also available in granules and pastes</li> </ul> | <ul style="list-style-type: none"> <li>• Granulating and epithelializing wounds that are draining low to moderate amounts of exudate</li> <li>• Promoting autolytic debridement</li> </ul>                                                                                                      | <ul style="list-style-type: none"> <li>• Waterproof and impermeable to bacteria and environmental contaminants</li> <li>• Conformable for easy application and comfort at the wound site</li> <li>• May be left in place for extended periods</li> <li>• Promotes autolytic debridement</li> </ul>                                                                                                                      | <ul style="list-style-type: none"> <li>• Moderate to heavy exudation will overwhelm dressing</li> <li>• Impermeable to oxygen; use with caution in wounds with suspected or known anaerobic infection</li> <li>• Some hydrocolloids break down; removal of residue from wound can be time consuming (varies among brands)</li> <li>• May have unpleasant odor upon removal</li> </ul> | <ul style="list-style-type: none"> <li>• Comfeel<sup>m</sup></li> <li>• Cutinova Hydro<sup>n</sup></li> <li>• Duoderm<sup>o</sup></li> <li>• RepliCare<sup>p</sup></li> </ul>                                                                     |

(Continued)

drogel or a foam that lacks strong adhesive properties. The same may be true if there is a risk of reinjury. Other factors that guide dressing selection include cost, the need for padding, the need to visualize the wound, and the presence or absence of sutures.

### Issues Regarding the Clinical Use of Occlusive Dressings

Among the many questions asked about occlusive dressing therapy, our group has studied the following:

1) What is the proper time to apply and remove occlusive dressings to attain rapid epithelialization? 2) Will occlusive dressings speed the healing of burns? 3) Are occlusive dressings able to speed the healing of simple skin biopsies?

Our group's studies in the pig model, which has proved to be highly predictive of conditions in humans, demonstrate that, to speed epithelialization, occlusive dressings must be placed on an acute wound within 2 hours and must be left in place for at least 48 hours. If the clinician waits more than 6 hours to place

Table 1. Continued

| Category            | Characteristics                                                                                                                                                                                                                                                    | Best uses                                                                                                                                                                                    | Advantages                                                                                                                                                                                                                 | Disadvantages                                                                                                                                                                                                                  | Product examples                                                                                                                   |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| Alginates           | <ul style="list-style-type: none"> <li>Composed of soft nonwoven fibers derived from brown seaweed</li> <li>Available as wound pads and ropes for packing of deep cavity wounds</li> <li>Absorb fluid and turn into a gel</li> <li>Keep wound bed moist</li> </ul> | <ul style="list-style-type: none"> <li>Wounds with moderate to heavy wound exudate</li> <li>Granulating and epithelializing wounds where some exudate is present (eg, leg ulcers)</li> </ul> | <ul style="list-style-type: none"> <li>Especially useful for packing exuding wounds</li> <li>Rope alginates are easy to apply</li> <li>Several alginates have good wet strength and can be removed in one piece</li> </ul> | <ul style="list-style-type: none"> <li>Always require a secondary dressing</li> <li>Risk of drying wound bed; not recommended for wounds with low-volume exudate</li> <li>Will not debride hard eschar</li> </ul>              | <ul style="list-style-type: none"> <li>AlgiSite<sup>a</sup></li> <li>Kaltostat<sup>†</sup></li> <li>Sorbsan<sup>‡</sup></li> </ul> |
| Composites          | Island dressing with textile-based absorbent portion                                                                                                                                                                                                               | Low to moderately draining wounds                                                                                                                                                            | <ul style="list-style-type: none"> <li>"All-in-one" dressing; no secondary dressing needed</li> <li>Textile materials are "familiar" to user</li> </ul>                                                                    | <ul style="list-style-type: none"> <li>May not "fit" all wound shapes and sizes</li> <li>May not always maintain a moist wound environment</li> <li>May "strike through" (when drainage penetrates through backing)</li> </ul> | <ul style="list-style-type: none"> <li>Airstrip<sup>†</sup></li> <li>Alldress<sup>‡</sup></li> </ul>                               |
| Specialty dressings | <ul style="list-style-type: none"> <li>Designed for a specific purpose, such as absorbency or stimulation</li> <li>Materials vary</li> </ul>                                                                                                                       | Depends on dressing purpose                                                                                                                                                                  | Depends on dressing                                                                                                                                                                                                        | Depends on dressing                                                                                                                                                                                                            | <ul style="list-style-type: none"> <li>Aquacel<sup>¶</sup></li> <li>Fibracol<sup>¶¶</sup></li> </ul>                               |

<sup>a</sup>Bioclusive (Johnson & Johnson, Arlington, TX)<sup>b</sup>OpSite (Smith & Nephew, Inc., Largo, FL)<sup>c</sup>Tegaderm (3M Worldwide Operations, St. Paul, MN)<sup>d</sup>Allevyn (Smith & Nephew, Largo, FL)<sup>e</sup>PolyMem (Ferris Manufacturing, Burr Ridge, IL)<sup>f</sup>Sof-Foam (Johnson & Johnson, Arlington, TX)<sup>g</sup>Carrasyn (Carrington Laboratories, Irving, TX)<sup>h</sup>Lamin (ProCytel, Kirkland, WA)<sup>i</sup>IntraSite gel (Smith & Nephew, Largo, FL)<sup>j</sup>Nu-Gel (Johnson & Johnson, Arlington, TX)<sup>k</sup>SoloSite wound gel (Smith & Nephew, Largo, FL)<sup>l</sup>Vigilon (Bard, Murray Hill, NJ)<sup>m</sup>Comfeel (Coloplast Sween, Marietta, GA)<sup>n</sup>Cutinova Hydro (Beiersdorf-Jobst, Charlotte, NC)<sup>o</sup>Duoderm (ConvaTec, Princeton, NJ)<sup>p</sup>RepliCare (Smith & Nephew, Inc., Largo, FL)<sup>q</sup>AlgiSite (Smith & Nephew, Inc., Largo, FL)<sup>r</sup>Kaltostat (ConvaTec, Princeton, NJ)<sup>s</sup>Sorbsan (Dow Hickam, Sugarland, TX)<sup>t</sup>Airstrip (Smith & Nephew, Inc., Largo, FL)<sup>u</sup>Alldress (SCA Molnlycke, Eddystone, PA)<sup>v</sup>Aquacel (ConvaTec, Princeton, NJ)<sup>w</sup>Fibracol (Johnson & Johnson, Arlington, TX)

an occlusive dressing on an acute wound, or if the dressing is permanently removed before 48 hours has elapsed, faster epithelialization is not obtained.<sup>18</sup>

With regard to burns, our studies in the pig model demonstrate that occlusive dressings do not speed epithelialization.<sup>19</sup> Further, in a large clinical study of human biopsy wounds, we found that while occlusive dressings did not speed the healing of full-thickness biopsies, they did accelerate the healing of partial-thickness biopsies. We also found that, in both types of wounds, hydrocolloid occlusive dressings decreased pain and did not increase the risk of infection compared to the control dressing, which was a standard adhesive bandage placed over antibiotic ointment.<sup>20</sup>

Phillips et al.<sup>21</sup> conducted a similar study a few years later, treating partial-thickness biopsy wounds with either a hydrocolloid dressing or a standard adhesive bandage and antibiotic ointment, and they found no difference in healing time. The reason for the differing findings of the two studies is not clear, although different hydrocolloids were used by each group. Advan-

tages of the hydrocolloid dressings noted by both studies included lower cost, greater comfort, and greater convenience (all such dressings were applied by the physician, so patients did not need to change them).

Occlusive dressing therapy has slightly different effects in chronic wounds than in acute wounds. In chronic wounds, occlusive dressings reduce pain, induce autolytic debridement (wherein the white cells perform the debridement), stimulate granulation tissue, and, compared to control treatments, are associated with a greater number of healed wounds. However, as previously noted, even in the most optimal settings, occlusive dressings are not capable of healing more than 50% of chronic wounds.

### Occlusive Dressings: Mechanisms of Action

By what mechanisms do occlusive dressings produce their effects? The first mechanism to be postulated, and one that is still cited and certainly has not been disproved, is that it is easier for epithelium to migrate

in a wet environment than in a dry environment. A second mechanism that has been suggested is that the growth factors that occur in wound fluid are more active, more available, or more easily synthesized in the environment beneath an occlusive dressing.<sup>22</sup>

A third proposed mechanism relates to the idea that matrix materials are more easily synthesized or available in the environment created by occlusive dressings. A fourth hypothesis that has been offered relates to the maintenance of an electric gradient in a moist wound. Upon injury of the skin, there is an internal battery and current that flows until the wound dries. Keeping the wound wet enables the current of injury to continue, which accounts for some of the effects seen with occlusive dressings.<sup>23</sup>

### Resistance to Occlusive Dressings

Given these plausible hypotheses for the mechanism of action of occlusive dressings, and given clear evidence that they support healing and do not increase the risk of infection, why has there been so much resistance to the medical progress that occlusive dressings represent? Earlier, lack of availability was a major impediment to acceptance of occlusive dressings. Clinicians could not simply tell patients to go out and buy an occlusive dressing because pharmacies did not stock them. Lack of availability remains a problem in some areas. Another explanation is the sheer variety—a potentially overwhelming variety—of occlusive dressings that are available, which paradoxically may have the effect of causing clinicians to simply dismiss their use.

Cost is also part of the problem. The direct cost of occlusive dressings may be relatively high, despite the fact that in the long term they are likely to be more cost effective. In addition, these dressings can be difficult to handle, and they require the handling of exudate and exposure to odor. In addition, they can reinjure the wound upon removal. There have been many attempts to overcome this problem; one is a product called Blister Film (Sherwood-Davis & Geck, St. Louis, MO), which has no adhesive on the portion of the dressing that is placed over the newly epithelialized portion of the wound.

Another problem is the sudden appearance of "yellow surface necrosis" that may occur beneath occlusive dressings. Yellow surface necrosis is fibrin on biopsy and is associated with microthrombi histologically. Healing is retarded by this necrotic event. Finally, some clinicians may be reluctant to use occlusive dressings because they do not offer compression.

In considering resistance to the broad acceptance of occlusive dressings, it should be noted that the effect of medical conservatism on the acceptance of important medical discoveries is not a new issue. As was

pointed out in a recent article in the *Journal of the American Medical Association*, "in the 1890s, doctors expressed dismay that the acceptance of medical innovation was neither uniformly prompt nor straightforward. For example, vital but undramatic work like blood analysis received insufficient recognition, while a glamorous innovation like roentgen rays easily found broad use."<sup>24</sup> Occlusive dressings are one of the undramatic advances of today. Lasers, by contrast, are widely used, with little or limited data supporting their safety and efficacy. Occlusive dressings have a strong database compared to lasers, but because the technology is not glamorous, their acceptance has been slow.

Nevertheless, many products have been made available in the last two decades, and their use has facilitated wound healing in a countless number of patients. In summary, while occlusive dressings are an important tool, their most important contribution to medical science may be in opening our minds to the possibility of controlling the repair process.

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