Treating Skin Traumas Using PolyMem

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ISSUE BRIEF

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Executive Summary

One exciting facet of healthcare is that every once in a while a product, service or intervention surfaces that takes a leap forward in producing a better clinical and/or financial outcome. This issue brief tells the story of one such innovative solution and how it treats skin trauma.

Ferris Mfg. Corp.'s line of PolyMem® multi-functional wound care products improves clinical outcomes and is convenient to use. PolyMem dressings are easily applied and maintained by professionals and laypersons alike, even patients. PolyMem reduces treatment time and expense when compared to traditional wound care approaches. In short, PolyMem provides medical professionals with the solution they have been looking for in a single proven product.

This issue brief covers important skin healing challenges and strategies. The analysis also details the clinical healing attributes of PolyMem. For example, specific clinical trials and documented studies are discussed that demonstrate the clinical efficacy of using PolyMem dressings to protect, cleanse, debride and moisturize; and reduce pain and infection rates.

Other topics addressed in this brief:

- Why are skin traumas a clinical challenge?
- What are the major types of skin traumas?
- How can PolyMem make a difference?
- How does PolyMem improve outcomes?

This paper is intertwined with several helpful case examples and anecdotes. For instance, PolyMem's benefits have been substantiated in situations where wound treatment and dressing management were not possible by wound care professionals, but were instead accomplished by the patient's family and/or para-professionals. This paper highlights how fewer wound dressing changes, combined with improved healing, can create an environment where clinical and treatment resources are effectively leveraged over a wider treatment group while achieving superior outcomes. Readers also will be briefed about the properties of PolyMem for burn victims.

In summary, the analysis provides an objective and documented overview of how PolyMem literally can change the practice of medicine and transform patient care. PolyMem's approach to wound care and its successful track record is one of the best-kept secrets in healthcare. This brief concludes by clearly stating why PolyMem is a best-practice intervention.

PolyMem's approach to wound care and its successful track record is one of the best-kept secrets in healthcare.

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Why Are Skin Traumas a Clinical Challenge?

Skin traumas are among the most common wounds. Generally created by sudden and disruptive contact with a foreign entity, skin trauma ranges from simple lacerations to burns and twisting tears. The common factor among all skin traumas is the exposure of sub-dermal structures and organs for which the skin is the natural defense against infection and the environment. The skin's surface is critical to the preservation of body fluid homeostasis and thermoregulation; and is the primary protection against infection. Additionally, skin performs immunological, neurosensory, and metabolic functions such as the metabolism of vitamin D (Church et al., 2006). Without skin or an effective replacement, most affected sub-dermal tissues have no defense from infection or the environment, and the sub-layers will recede or atrophy.

Skin is the human body's largest organ, covering virtually every exposed surface. Skin's proportionate size, in relation to any other body organ, subjects it to multiple insults from multiple sources, and is constantly being assaulted from the environment in which it survives. Provided with a set of basic resources, skin can most often repair itself sufficiently to continue to operate as well as originally designed, even subsequent to serious trauma.

Virtually every living animal experiences some level of skin wound during its life cycle.

The Human Factor

Human skin is highly susceptible to disruptive wounds. Wounds, such as tears, can be brought about by a very slight variation in exposure to external elements it normally encounters, such as clothing or bedding. Wounds often encompass large, highly exposed areas. Damaged areas of the skin are constantly subject to external environmental irritations. The greater the area damaged by trauma, the greater the cumulative susceptibility to additional environmental or bacterial damage.

While skin is one of the few human organs that can regenerate when partially destroyed, it must be protected and treated when damaged to allow regeneration to occur. Covering wounded skin with a treatment that effectively simulates the skin's functions is critical to healing, and sometimes the survival of the patient.

Several factors decrease the skin's ability to effectively defend the human body against environmental assault. Age, exposure to sun, and diet are several of the factors that geometrically decrease the skin's effectiveness. Typically these types of factors cause the skin to thin and loose pliability (Baranowski, 2000). Thinner or less pliable skin covering is more vulnerable to different types of trauma, as highlighted below (e.g., lacerations, abrasions, burns and ulcerations). Skin tears are often associated with a related deterioration of sub-dermal structures, but lacerations may be deep and actually separate supporting muscle and connective tissue, and affect blood flows needed for the healing process. Sub-dermal connective tissue, muscle, bone, tendons, and nerve structures necessary to hold skin tissues together may require primary repair before the wound damage can, or can be allowed to, heal (Atiyeh et al., 2002).

Skin Healing Strategy

The most effective treatment for some categories of wounds is to protect sub-dermal tissues until their supportive functions are restored, prior or subject to the rebuilding of the dermis and epidermis layers. "Most wounds should be covered with a protective, non-adherent dressing …until there is enough epithelialization to protect the wound from gross contamination." (Singer, 1997)

In some cases, epithelialization may be delayed by comorbid diagnoses, such as diabetes. In these cases PolyMem's unique product emulates the skin's protection and moisture management of the exposed areas, particularly from infections. "Maintaining

a moist environment around the wound has been shown to speed the rate of epithelialization." (Singer, 1997) Wound treatment may, therefore, become a multiple-phase, multiple-system process requiring a treatment protocol that can address each part of the process.

Wounds may also occur over large areas of the body. They may include multiple simultaneous incidents, or in some cases a mixture of wound categories from a single incident. Each wound type and stage of healing traditionally requires its own set of dressings, topical treatments, care regimens, and treatment schedules. PolyMem drug-free dressings provide a single treatment modality that, without additional topical treatments or additives, is effective for all phases and virtually all types of wound care.

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What Are the Major Types of Skin Traumas?

Laceration

Skin lacerations are extremely common, and range from inconvenient to fatal. "Each year in the United States, more than 12 million traumatic wounds are treated in emergency departments. Traumatic lacerations occur most often in young men, typically on the face, scalp, and hands." (Singer, 1997) Lacerations typically result from external insult, usually with a foreign object, resulting in a combination of skin wound and a breakdown of supporting tissue layers.

Skin damage from lacerations often extends into supportive sub-dermal and connective tissues. The skin's healing process may be required to become secondary to stabilizing and repairing supportive or connective tissues. Deep wounds with injury to multiple systems require simultaneous healing of multiple systems, such as in a stab or broken glass wound. Supportive tissue damage may extend beyond a single organ system and include organs and systems, such as bone, tendons, nerves and vessels (Atiyeh et al., 2002).[i] PolyMem's adaptive technology equally addresses internal, deep wound, infection management, and skin replacement trauma care.

Disruption of the supportive tissues destroys the foundation for the dermis, and requires simultaneous multiple-system healing. "Full thickness skin injuries breach the full thickness of the dermis and will therefore try to heal by secondary intention if the edges are not re-opposed or larger defects resurfaced by other means." (Barnard & Allison, 2009)[ii]

Lacerations are often accompanied by edema, bruising and pain. Swollen tissues covered by wound care products significantly increase the physical size of the wounded tissues. The increase in size is not initially compensated for by visual sensory input. Instead, the body uses its proprioceptive memory to define the size or location of damaged tissue. Proprioceptive misperception further endangers wounded tissues to external insults by exposing them to additional impact, crushing, or trauma based on the body's inability to judge the location or limits of the wounded area.[iii]

Abrasion

Abrasions tend to destroy the epidermis. This type of trauma often includes multiple wounds over large surface areas competing for healing resources. "Abrasions are the result of friction forces removing variable depths of tissue from epidermis through dermis to underlying structures. They are often contaminated with grit and dirt, which must be removed to prevent infection and tattooing. The zone of injury may involve deeper tissues than is first evident, particularly if there has been sufficient shearing force to deglove deeper tissues …" (Barnard & Allison, 2009).

General disruption of covering over large areas exacerbates the normal complexity of the healing process due to the geometric decrease in the tissue's ability to resist infection and fluid loss. Damaged tissue often becomes dry and necrotic, leaving large margins without adequate natural tissue for re-bonding.

Ulceration

Although not exclusive to senior populations, ulceration occurs at an alarmingly high frequency in this age group. In addition, high-profile deaths of persons such as actor Christopher Reeves have focused attention on ulcerations and their complications.

Generally, ulcerations are caused by damage to a body part that is subject to limited blood circulation, leading to tissue atrophy. In the case of pressure ulcers, necrotic tissues generally develop between a bony point and the skin in areas of the body where pressure is concentrated.[iv]

Untreated, infections within the ulcer and associated necrotic tissues may spread to neighboring organs or structures. Osteomyelitis is an example

of a common secondary condition caused by an undertreated ulceration. In 1996, the average cost of treating a single ulceration was approximately $2,900 dollars. When secondary infections resulted in osteomyelitis, this figure jumped to $59,000 per patient.[v] When ulceration-initiated osteomyelitis is combined with other chronic conditions such as diabetes, the average lifespan of the patient is reduced to less than five years (Fitzgerald, 2009). Further, diabetic osteomyelitis caused by ulceration cost $11 billion in treatment resources in 2001 alone.

The deterioration of sub-dermal and supportive muscle, bone, and sub-dermal structures make surface tissues vulnerable to twisting motions, often affecting large sections of epidermis. Deteriorating substructure conditions are endemic to ulceration, but extend to conditions such as cancer, depression, aging, rapid weight loss, or even stress. Even common medications such as anti-coagulants or steroids predispose individuals to skin tears. Skin tears are treated in all cases, but in these cases the primary focus of treatment is inevitably the stabilization of the primary diagnoses, with the skin wound being relegated to a secondary or collateral diagnosis.

Skin ulcers, regardless of original cause, have important consequences both for patients and the healthcare system. They can lead to severe or intolerable pain, are prone to infection, and are associated with high mortality rates. They also inflict a considerable economic burden on the healthcare system (Livesley & Chow, 2002). Acute ulceration is often misdiagnosed as a chronic condition. Treatments for chronic ulcerations, particularly in the elderly or terminally ill, tend to focus on stabilizing the condition and making the patient as comfortable as possible, with little hope of healing or reversing the initial ulcer. The National Institutes of Health suggest the most effective treatment for skin damage is gentle cleansing, debridement, isolating from external infection, and moisturizing (Margolis et al., 2002).

Burn

Burns represent a significant category of skin trauma, often resulting in permanently disfigured tissue. Burns are most commonly caused by heat, but can also be the result of over-exposure to chemicals, light, or electricity. Burn injuries are described in terms of their 'depth' and 'extent.' The extent is defined by the percentage of total body area that has sustained burns. The depth of the burn is expressed in terms of first, second or third degree, or as superficial, partial skin thickness or full skin thickness.

The most common categories of burns include: scalds, which are caused by hot liquids; flame burns; flash burns, caused by radiant heat in explosions; contact burns, resulting from touching a hot object; chemical burns; electrical burns; and radiation burns (Van Rijn et al., 1989). Many aspects of burn damage, however, are secondary to the original damage from exposure to the aggravator, and can be reduced or eliminated using PolyMem wound care products. Application of PolyMem bandages shortly after the occurrence of a burn has been shown to dramatically improve the overall healing process.

Case studies of both superficial and second-degree facial burns found that application of a PolyMem covering within one hour of injury helped "to manage excess fluid and reduce edema while cleansing the wound and decreasing or eliminating wound pain." They also served to prevent infection and minimized scarring (Haik et al., 2011).

Critical issues in burn management are fluid resuscitation, nutritional support, pulmonary care, burn wound care, and infection control. Seventy-five percent of burn wound deaths are related to sepsis from burn wound infection (Church et al., 2006). Burn infections are primarily due to the deterioration of the skin as the primary barrier to microbial host invasions. Burns to the face, neck, hands and perineum are particularly dangerous due to the secondary shrinkage and then necrosis of secondary stasis and hyperemia tissue layers.

Nociceptors are agitated during trauma. Their primary function of increasing swelling and heightening nerve impulse reduces bleeding at the wound site, and draws attention to the wound in the body's instinctive defense to isolate and treat the damage. Uncontrolled, however, nociceptor response creates excessive swelling and pain in regions surrounding the primary wound. Swelling decreases blood flow, which limits the body's healing and cleansing resources from addressing the wound. Excessive swelling robs surrounding tissue of life-giving resources, leading to atrophy

and eventually necrosis. Without sufficient blood flow, affected tissue is more susceptible to external insult and infection. Increased pain causes a shift in utilization, often overstressing other systems, increasing the demand on the heart, and decreasing normal reactive functions such as balance and cognition. These factors combined create significant 'secondary' areas of damage, often reaching far into surrounding tissues not originally affected by the burn (Demling, 2005).

PolyMem's polymeric membrane reduces nocieptor responses, particularly in periwound and adjacent tissues. The wound care product reduces swelling and pain immediately, without requiring additional product or medication. Surrounding tissues are not affected by the negative cycles of secondary damage. Damage is limited to the originally impacted area, which is immediately addressed by PolyMem's adaptive wound care. Infection in the burned region is reduced by PolyMem's structure, enhanced through embedded microbial silver, fluid loss is reduced by embedded glycerin and the gas-permeable outer layer, and cleansing is accomplished through the surfactant cleanser.

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How Can PolyMem Make A Difference?

For over 25 years PolyMem's multifunctional dressings have been used successfully in the treatment of all types of skin wounds. PolyMem's results have been substantiated in more than 150 documented, independent case studies and several clinical trials since its original patents were granted in 1988.

The 'just in time' adaptability of the PolyMem polymeric structure has proven highly effective in the treatment of various types of wounds, ranging from superficial abrasions, burns, and lacerations to deep tissue disruptions and ulceration. The membrane's components allow adaptation to wound conditions, making PolyMem a single modality to be used in wound treatment that is capable of effectively adapting its properties to meet the changing wound needs throughout the healing continuum.

The polymeric membrane contains four key components that serve to temporarily replace the skin, resist infection, absorb natural exudate, moisturize, cleanse, debride, protect, and reduce edema, bruising and both persistent and procedural wound pain. PolyMem replaces, or augments, a wide range of traditional treatment products and requirements, such as topical antibiotics and extensive debriding during dressing changes. The only additional product typically required to augment a PolyMem treatment implementation is secondary adhesive or wrap to hold the covering in place in the event that the practitioner selects a non-adhesive PolyMem product.

The same single PolyMem dressing techniques may be applied from triage through epidermal restructure. There are PolyMem dressings designed to be used in deep cavity wounds or tunnels, in nasal cavities or externally, and can include optional embedded microbial silver to restrict or eliminate risk of infection.

Reducing Dressing Changes

Typical wound care includes multiple dressing changes throughout the healing continuum. Dressing changes generally include removing particles of the previous dressings from the wound. Healing tissues grow around the strands of the gauze or cotton coverings, causing further disruption to newly formed tissues.

"A common problem in wound assessment and care is the removal of adherent dressings. Not only is it painful and distressing for the patient, it also causes significant trauma to both healthy and nonviable tissues and can be time consuming in a busy triage clinic. Current evidence in wound healing supports the use of non-adherent dressings and maintenance of a moist, but not wet, wound environment." (Barnard & Allison, 2009)

The disrupted wound must then carefully be cleaned to protect against infection introduced into the newly exposed tissues. Necrotic and dry edges must be debrided from the wounded area to allow healthy tissue to grow in the wounded areas. Finally the wound must be re-treated with topical anti-bacterial coatings or moisturizing compounds and then re-covered with fresh dressings (Atiyeh et al., 2002). PolyMem creatively disrupts these expensive cycles, many of which require highly trained staff in clinical settings.

PolyMem is extremely durable and remains a stable topical wound covering over the span of multiple days. Internally, the polymeric structure does not shed strands of fabric, and is highly resistant to bonding with the vulnerable subcutaneous tissues. Dressing changes can be accomplished with no tearing of the healing tissues, or secondary destruction of these tissues through extensive cleaning and debridement.

Promoting Healing Through Fluid Absorption

Excessive wound fluids often can slow down the healing process by constantly bathing healing tissue in contact with lymphocytes and exudate containing dead or damaged tissue. Excessive exudate tends to over-moisturize the wound area, restrict natural debriding and cleansing, and restrict the healthy exchange of gases and nutrients to the wound area. Periwound maceration is reduced through absorbing excess exudate away from the wound surface into the outer margins of the membrane. PolyMem wound care products absorb up to ten-times their weight in exudate or moisture. This tremendous absorption capacity is enhanced by the absorbent polymeric matrix. An external semi-permeable membrane coats the outside of the dressing, deflecting external moisture and infections while providing bidirectional interchange of healing oxygen and wound gases.

PolyMem contains embedded components that are activated in a timely manner based on wound need. A single dressing may adapt to the changing needs of the wound, such as addressing original absorption of exudate, isolate excess fluids from inhibiting the healing cycle, and then cleansing and debriding the wound. That single dressing may therefore span several wound-healing cycles. The components dynamically react with the wound based on exudate level in the wound and the moisture level in the dressing. The synergistic action of the components has been shown to function as a nociceptor inhibitor, thus reducing bruising, edema and wound pain. Several components, mixed with the topical characteristics of the polymeric membrane, constantly and gently cleanse and debride the wound, leaving healthy new-growth tissue undisturbed and undamaged during dressing changes. These cycles decrease the time required for the wound to heal by reducing the trauma of the actual dressing changes, and allowing the healing cycles to continue without disruption.

Pursuing a Multi-Dimensional Approach to Wound Care

Effective wound care requires an effective balance of professional triage, stabilization of the wound and patient, and then an extended treatment regimen normally including at least five external functions. Once triage is successfully addressed, a consistent regimen of wound care becomes the priority. The five external functions of addressing wound exudate, cleansing, debriding, moisturizing, protecting the wound, and addressing infection must be addressed. These functions must be balanced to address the specific dynamics of healing based on the patient's unique balance of health, age and chemistry.

Typically, addressing the multiple healing domains requires multiple topical and protective products. The PolyMem polymeric membranes do not require additional topical or protective products. Multiple components are incorporated into the polymeric membrane to support wound healing. Wound components built-in to the dressing release elements that are part of the treatment process in a direct response to need. This creates a dynamic array of perfectly customized delivery to the areas in contact with the dressing, and addresses the wound's recovery needs throughout the healing continuum.

As highlighted throughout this issue brief, PolyMem contains multiple components. Embedded absorbing agents combine with the polymeric membrane to absorb up to 10-times the weight of the wound covering. The nature of the absorption pulls the exudate upwards throughout the polymeric membrane, and disburses it over an expanded area of the covering. Embedded absorbing agents move the exudate away from the wound to allow the wound to heal separated from the exudate in a clean environment, and without the detrimental effects of periwound maceration.[vi] By helping to concentrate the beneficial contents of the exudate, like regeneration-enhancing growth factors and bacteria-fighting macrophages in the wound, PolyMem dressings can actually help to speed-up the healing process.

Using a Nontoxic Wound Cleanser

A proven wound cleansing and infection-resistant substance is incorporated into each PolyMem product to constantly, but gently, cleanse and debride the wound. While cleansing and debriding mitigates the introduction of additional bacterium and irritants, it also works to remove excess exudate (Chardon, 2011).

In Rodeheaver's research, he found that "mechanical cleansing of experimental wounds with a sponge soaked in this surfactant prevented the development of infection. This beneficial result had been encountered without any local or systemic sign of toxicity." (Rodeheaver et al., 1980)

Applying an Effective Moisturizer

Incorporated glycerin in PolyMem maintains the ideal balance of moisture for healing tissues. "A moisture-balanced wound environment promotes wound healing and can potentially increase the rate of reepithelialization by 50%." (Okan et al., 2007)

E.D. Smith (1940) lists seven key properties that make glycerin an effective compound to both cleanse and moisturize the healing wound. "Several properties of glycerin contribute to its effectiveness as an accessory drainage agent in a variety of surgical conditions. Osmotic action by reducing edema inhibits lymphatic extension of infection and increases the number of available phagocytes. Hygroscopic action cleans the wound by removing discharge. It is antiseptic to numerous pathogenic organisms." In addition to these benefits, Glycerin provides many additional benefits to the body, even for diabetics and others with comorbid diagnoses (Lee et al., 1998). The availability of glycerin within the dressing allows it to act as a nutrient and energy substrate, which helps create a more optimal healing environment that is otherwise almost impossible to achieve in diabetic patients (Tao et al., 1989). Glycerin is a simple sugar, which means it can be utilized directly as an energy source by the healing tissues in the wound, even in diabetic patients, who do not make insulin or are insulin resistant; and any patient that has poor circulation (Goldberg, 1999; Frank, 1981). "Glycerin is relatively non-irritating and nontoxic to body cells. It reduces surface tension. It prevents drying of the wound." (Smith, 1940)

PolyMem's unique polymeric structure gently, but continually, cleanses and debrides the wound. The artificial cleansing action between the membrane and healing skin accelerates the body's natural sloughing cycle of old and damaged skin. Constant debriding of the wound leaves the tissues soft, clean, moisturized, and smooth, reducing interfacial tension between wound and the PolyMem dressing.

Improperly moisturized tissue contracts capillary circulation, eliminating the skin's ability to be replenished by the blood supply. In the absence of blood supply, the margins of the wound die and become rigid and coarse. These margins increase the potential to snag the healing tissue on adjacent materials; potentially reinjuring the wound. In contrast, properly moisturized wound tissue reduces fibrinolysis while promoting and supporting angiogenesis in the granulation tissue. Wounds with balanced moisture levels heal with fewer interruptions, loss of marginally damaged or at-risk tissues, and without causing softening and breaking down of granulation tissues.

A urethane film is used to cover the outer layer of the PolyMem products. Urethane is highly resistant to external assaults of potentially damaging environmental factors such as fluids, bacterium, or even repeated damage. The polymeric matrix further serves to isolate the healing tissues from proprioceptive miscalculations reducing opportunity to damage or impact healing tissue. The polymeric membrane dressing acts as a soft barrier between the wound and the environment, helping to protect the wound from further damage.

Creating Anti-Bacterial Defenses

Anti-microbial silver is optionally incorporated into PolyMem applications.[vii] Anti-microbial silver acts as a highly effective barrier to the propagation and proliferation of bacteria (Lo, 2009). In Lo's meta-analysis of eight key studies, he found that the reduction of infection, odor and the associated nuisances generally improved patient's lives. PolyMem's 'silver' products are based on the same core multi-compound embedded polymeric membrane that is the foundation of all PolyMem wound care products.

Supporting Urgent Care Needs Effectively

PolyMem is particularly effective for a wide-range of urgent care applications. For example, emergency room (ER) staff can perform initial treatment with reasonable expectations that the initial intervention will continue to provide effective treatment over days and weeks. Patients can continue the treatment regimen without costly repeat ER visits. Treatment regimens can be completed over time without significant dependence on referred professionals. These benefits combine to provide professionals some assurance that their initial treatment can be extended into treatment plans with reasonable expectation of completion in any given medical situation.

Using More Flexible Staffing Models

The PolyMem polymeric membrane performs most of the functions typically performed by professionals during dressing changes. This includes cleansing—done by a combination of PolyMem's constant debriding and through the micro-membrane covering restricting the introduction of foreign substances into the wound. Debriding happens constantly throughout the healing cycle; thus, the wound is clear of necrotic tissue during dressing changes. In addition, the polymeric composition does not adhere or bond with the recovering tissue, and therefore does not cause secondary damage during the removal of the dressing. Dressings can be prepared using household-available tools, and applied by non-professionals using over-the-counter adhesives. Use of non-professionals allows limited medical resources to be leveraged over an extended patient base, thus reaching a wider population with effective care by using trained professionals for those duties most centric to their specialty.

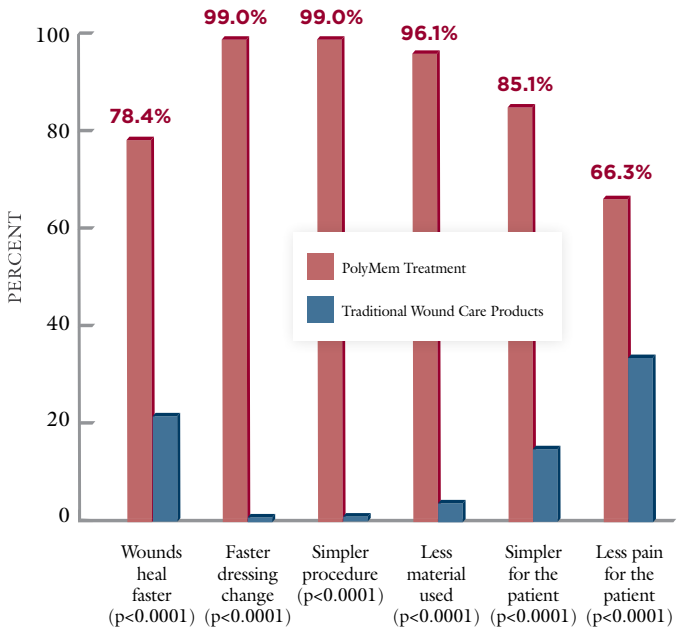
Patients can continue the treatment regimen without costly repeat ER visits. Treatment regimens can be completed over time without significant dependence on referred professionals.

How Does A Multi-Function Dressing Improve Outcomes?

Promoting a Shorter, More Effective Healing Process

Perhaps the greatest obstacle to healing is keeping the patient on his or her treatment plan throughout the continuum of treatment. If this challenge is not sufficiently daunting, it is exacerbated by treatment phases, medications, topical coverings, variations in application, and a plethora of products and instructions attendant to each. In wound care, PolyMem addresses these issues by providing a single product with components that dynamically adapt to the continuum of healing. This product can be applied and maintained by the patients or their helpers, even those with limited capacity and medical knowledge. Consequently, continuity of treatment is maintained and healing is correspondingly accelerated.

Table A: Comparison of PolyMem Polymeric membrane wound treatment systems to Traditional Wound Care



PolyMem also enhances uninterrupted, continuous treatment throughout the healing process. PolyMem doesn't 'make' a wound heal, but enhances the body's natural healing cycles and abilities. The unique combination of materials and functions that make-up PolyMem products often eliminate ancillary complications such as infection, tissue loss and damage from external scrubbing and debriding. Secondary damages are limited because PolyMem materials do not bond with the new healing tissues, eliminating damages from extensive debridement during covering changes. Perhaps the most critical factor decreasing healing time is PolyMem's unique ability to adapt its properties to the healing cycle.

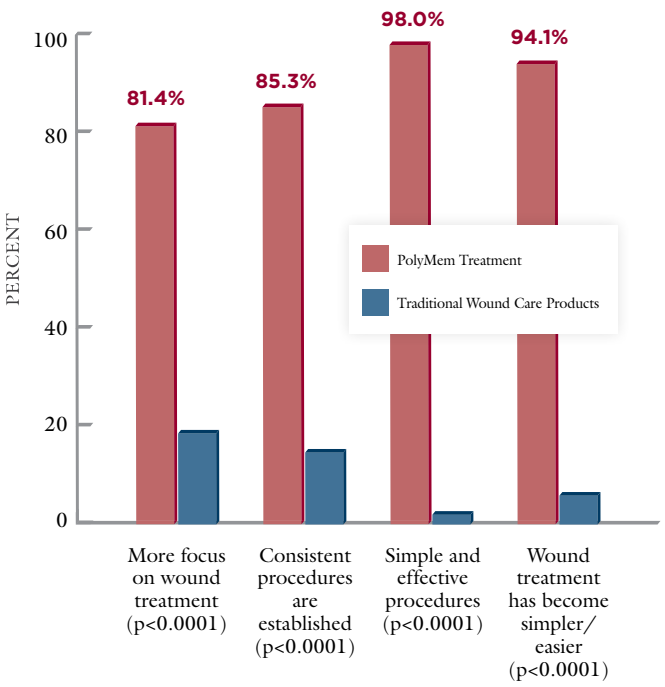
PolyMem supports wound treatment dynamically throughout the healing process. Natural healing cycles continue uninterrupted—even enhanced—due to PolyMem's ability to maintain and adapt to the healing environments depending on the wound's needs and without the addition of other products or agents.

PolyMem also increases ambulatory freedom for patients. Dressings can be maintained by the patient or their helper so they are not 'tied' to a medical professional. The products allow the patient to have normal interaction with the environment while dynamically adapting to and protecting the wound. PolyMem has also been shown to decrease side effects of wounds, such as odor and bulky wraps. PolyMem's flexibility and adaptability are particularly well suited for rural or senior populations with limited access to treatment facilities.

Eliminating Unwanted Residual Effects

What makes PolyMem multi-functional dressings unique in the wound care arena is that its single-product treatment not only enhances primary healing of the wound, but also works to reduce external collateral damages originating from the

Table B: Improvement in Wound Care continuity with prescribed treatment plan



wound. By empowering the body to heal, and isolating external disruptions to those healing cycles, secondary conditions such as osteomyelitis, infection, ulceration, and deep fistula do not gain a foothold.

PolyMem dressings decrease primary residual effects such as infection, necrotic tissue, bruising and swelling, but also alleviate patient reticence through reduced pain. PolyMem modulates the spread of nocieptor nerve impulses to surrounding undamaged tissues, cutting back on collateral edema and bruising. This reduces pain and its consequences such as metabolic change and sleep interruption, allowing the body to focus its resources on healing the wound.

PolyMem's anti-microbial silver resists infection. In 2009, seminal research on the properties and effectiveness of anti-microbial silver were conducted by a group of scientists. The researchers state that, "… meta-analysis confirms the effectiveness of silver dressings in wound healing and improving patients' quality of life." (Lo et al., 2009) PolyMem's 'silver' line adds anti-microbial silver to its range of polymeric coverings, shapes and preformed appliances. These products can be introduced during primary treatment, and then seamlessly switched to products without silver once the tissue has granulized and is capable of fighting secondary infections through natural defenses.

Empowering a Balanced Approach

PolyMem naturally balances two key elements for the healing of wounds—moisture in and around the wound, and constant cleansing debriding of damaged tissues within and around the wound. The combination consistently keeps the wound clear of dead and necrotic tissues. Balanced moisture allows the tissues around the wound to remain alive and supple, promoting healing and bonding of separated tissues.

"Exclusively using occlusive dressings (such as transparent films with or without hydrocolloid, or absorbent acrylic dressings) on multiple-denuded sites is costlier from the outset because occlusive dressings fill quickly, leak, and can cause periwound maceration, requiring daily dressing changes." (Chardon, 2011) PolyMem dressings provide a visual indication of when they are to be changed in order to maximize the healing process and provide more cost-effective care.

Conclusion

For over 25 years, Ferris Mfg. Corp.'s PolyMem line of injury care products has provided effective, drug-free, time-saving, and cost-saving solutions in a variety of clinical settings.

For medical professionals, patient health is always a primary concern. PolyMem multi-functional dressings represent a unique opportunity to optimize the healing process with a cost-effective product that adapts to the wound's healing cycles and is easy enough to be applied and maintained by the patient and their family.

A review of clinical trials demonstrates that PolyMem wound coverings may require more frequent changes initially. The polymeric compound-embedded matrix rapidly wicks exudate containing dead or damaged tissue from the wound surface, while maintaining a natural moisture balance. Once the wound trauma is stabilized, PolyMem dressings require 33% of normal dressing changes often per week when compared to traditional gauze wound care products. In over 200 studies reviewed, the average healing time was reduced by 43.8% in all categories. (Bolhuis, 2011) Reduced dressing changes with decreased healing time yield an average 85% decrease in the cost of treating a wound, based on the costs of materials and labor in wound care.

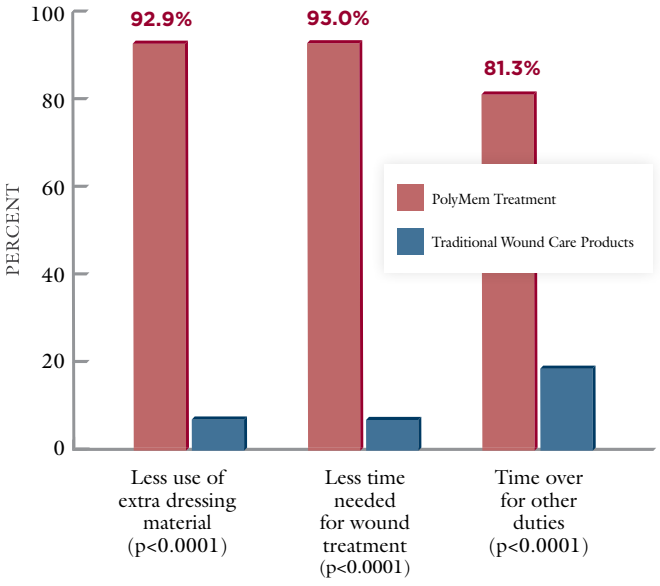
Typical skin ulcer treatment costs an average of $2,900 (Livesley & Chow, 2002). PolyMem wound treatments reduce nursing time and number of required dressings by 85%. As a result, the 85% decrease of an average cost of $2,900 per wound yields an estimated savings of $2,465 per ulcer. For a nursing facility, treating 150 wounds per year, this estimated decrease yields a $369,750 annual reduction in operating costs. Reduction of the hard costs for dressings and ancillary supplies decreased the cost of ulceration treatment an average of over $100 per cubic cm of wound closure.

The easiest way to enhance healing is to keep patients doing what they are supposed to do. Completion of the treatment plan reduces re-admissions and contingent diagnoses. Though difficult to quantify, as an example, an ulcerated wound with diabetic co-morbidity has been shown to reduce life expectancy to less than five years (Fitzgerald, 2009). The cost of non-compliance, particularly when it leads to secondary diagnoses, certainly has a quantifiable impact on direct healthcare costs. It also impacts life span, productivity and loss to society in amounts that are geometrically higher than the calculated savings in healthcare costs.

Patients need easy processes they can integrate into their everyday lives. The demand for medical services is expanding faster than the current influx of trained professionals can address. This leaves a simple, yet challenging, alternative: Do more with less.

PolyMem is adaptable and economical. It provides highly effective wound care through a single product. It is easily applied and maintained by para-professionals and even patients. PolyMem reduces treatment time and expense, thus leveraging professionals to critical cases most in need of their attention. In short, PolyMem provides medical professionals with the best practice solution they have been looking for in a single proven product.

Table C: Reduced costs through improved outcomes



Endnotes

i "Partial thickness skin injuries involve the epidermis and a variable portion of the dermis. These injuries should heal if sufficient dermal adnexal components remain to allow re-epithelialization, provided infection, desiccation or hypoxia does not increase the depth of injury. A partial thickness wound is likely to heal with conservative management if it has pinpoint bleeding, sensation, adequate capillary refill and is not contaminated." (Barnard & Allison, 2009) Disruption of the supportive tissues destroys the foundation for the dermis, and requires simultaneous multiple system healing (Ibid).

ii Healing is complicated by tension on the healing tissues as they struggle to seal, hold sub-dermal structures in place, and progress through their own healing cycles. A fingertip cut wound is an example of a wound that occurs due to constant proximate exposure to sharp cutting instruments. For certain professions (such as a chef), fingertip cuts can continue to be exposed to similar or repeated insult; even during the healing cycle.

iii A university of Arizona study found that proprioception, subliminal spatial perception, is more dominant than sensory input, such as sight (Bedford, 2006). Damaged tissue may be at enhanced risk of injury or re-exposure to the original insult due to the proprioception that 'remembers' the size and operation of the tissue before it was damaged. Proprioceptive lag, or the failure to adapt to the size or limitation of wounded tissue, requires an effective wound care treatment capable of protecting the wound from further damage while treating additional insult, such as the polymeric membrane that forms the core of all PolyMem products.

iv Lively found that as many as 11.3% of senior citizens being admitted to long-term care facilities were admitted with skin ulcers (Lively & Chow, 2002). Lively went on to say that, "Among those persons who did not have a pressure ulcer at the time of admission, the risk of a pressure ulcer developing after admission was 13% in the first year after admission and 21% by the second year."

v Ibid.

vi "Acute wound exudate is rich in growth factors, specifically, platelet derived growth factor (PDGF), fibroblast growth factor (FGF), and epithelial growth factor (EGF), which serve to promote the proliferation of fibroblasts, keratinocytes, and endothelial cells in both in vitro and in vivo studies." (Okan et al., 2007)

vii Novel wound dressings have been developed that use silver to help prevent wound infections. Silver nanoparticles are incorporated into the wound dressing, and the silver-enhanced wound dressings were found in vitro to consistently kill *Pseudomonas aeruginosa* cultures entirely and kill *Staphylococcus* aureus cultures with >99.99% efficiency (Ong et al., 2008). In mice, the silver-enhanced wound dressings were also found to reduce mortality from *Pseudomonas aeruginosa* wound infections from 90% to 14.3% (Ong et al., 2008).

Key Terms

Abrasion—A surface wound that goes no deeper than the outermost layer of skin, or epidermis. Mild abrasions are known as scrapes or grazes.

Angiogenesis—The development of capillaries in a wound.

Dermis—The capillary-filled sub-layer of the skin, immediately below the epidermis and above the subcutaneous tissues, which provides the primary strength (collagen), elasticity (elastin), moisture, and nutrition (glycosaminoglycan) for the epidermis.

Edema—An abnormal accumulation of fluid beneath the skin that produces swelling.

Epidermis—The outermost layer of the skin, which acts as the body's best defense against the outside environment.

Epithelialization—The regrowth or regeneration of skin over a wound.

Exudate—Fluid that exits a wound during the inflammatory stage of healing, and must be properly managed in order to ensure that a wound heals properly.

Fibrinolysis—Reduction of unhealthy blood clotting in wound tissue.

Hygroscopic Action—Ability of a substance to attract and hold water molecules from the surrounding environment through either absorption where the adsorbing material becoming physically 'changed,' or by an increase in volume, stickiness, or other physical characteristic of the material.

Laceration—A wound that cuts through tissue layers below the epidermis, often caused by trauma from a sharp object.

Necrotic Tissues—Result from the death of cells and tissues around a wound. Removal of necrotic tissue through debridement is necessary to ensure a wound heals properly.

Nociceptors—Are cells that can function as receptors for painful stimuli. Chemical, thermal, mechanical or any other damaging and stressful stimulus may prime these cells to activate. Activation of these cells results in bruising, swelling and pain associated with all tissue damaging injuries.

Osteomyelitis—Bone infection that can sometimes occur after an open wound or pressure ulcer becomes infected.

Phagocytes—White blood cells that protect the body by ingesting (phagocytosing) harmful foreign particles, bacteria, and dead or dying cells.

Polymeric Membrane—A matrix that allows for the selective separation and movement of gases and other materials. PolyMem polymeric membranes are designed to optimize moist wound healing while allowing gases to travel between the wound and outside air.

Polymeric Structure—The chemical structure that makes up a polymeric membrane.

Proprioception—The unconscious perception of the position of one's own body. Proprioception comes from the Latin *proprius*, meaning "one's own," and *perception*.

Sub-Dermal Tissue—Also known as subcutaneous tissue, this is the third deepest layer of tissue that lies below the epidermis and dermis.

Ulceration—A sore on the skin that can result in tissue loss through the layers of epidermis, dermis, and sub-dermal tissue. Ulcerations are most common in senior populations, where they are caused by long-term pressure to a body part.

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Skin is the human body's largest organ, covering virtually every exposed surface.