WOUND Management

Continuing Medical Education

Transitional Off-Loading—Part 1

Here's an evidence-based approach to pressure redistribution in the diabetic foot.

Objectives

After participating in the educational activity, the participant should be better able to:

1) Relate diabetic foot problems to the need for using off-loading devices

2) Distinguish between the various types of dressings and off-loading devices used for diabetic foot wounds.

3) Apply the "transitional approach" to off-loading the diabetic foot.

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*Following this article, an answer sheet and full set of instructions are provided (p. 132).—**Editor***

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Introduction

The term pressure redistribution was originally introduced to improve the terminology used to describe the mechanical attempts clinicians make to reduce forces on the patient's site of ulceration. This was an attempt to improve the language and provide a more inclusive term that would encompass both "pressure reduction," used primarily in discussions of pressure ulcers, and "off-loading," a term more commonly used with the diabetic foot. The proper application of medical devices to reduce pressure on wounds, improve gait, warn patients of time spent on delicate tissues, and monitor activity goes far beyond simple insole and footwear modifications. Clinicians are actually trying to help prevent further tissue breakdown and create an environment where uninterrupted tissue healing can occur.

This article will review the available evidence on off-loading devices and teach the clinician steps on how to apply a transitional approach to off-loading the diabetic foot.

The 6 "W" Approach

To help practitioners be more inclusive in their evaluation of the component causes of wounding, the author proposes a 6 "W" approach to evaluating the pressure redistribution needs of the diabetic foot. These are as follows:

1) Who the patient is
2) What the patient wears
3) When the patient walks
4) Where the patient walks

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5) Why the patient walks
6) The "Way" the patient walks.

Who a patient is represents the intrinsic component causes that include the patient's inherent biomechanics, the amount of time the patient has had diabetes, the degree of neuropathy from which the patient suffers, and the patient's basic metabolic and physiologic status. What the patient wears includes the array of shoes worn and any orthosis that may have been prescribed. When the patient walks encompasses the temporal issues of activity modification and includes scheduling and time management to reduce the amount of walking done in a day. Where the patient walks is very important to understand the stresses the foot is subjected to in a day.

An individual's home and work environment and the surfaces walked on can create very different stresses. This can also present a source of modification that can reduce the cumulative stresses the foot is subjected to each day. Why the patient walks addresses the issues of motivation and adherence. The patient's understanding of his/her disease and how well he/she is motivated to adhere to, or, better yet, cooperate with, the clinician's prescribed therapies will impact the success of treatment and outcomes more than any single variable.

Lastly, clinicians need to see the patient walk and examine issues concerning how or the way they walk. A patient's gait encompasses parameters of cadence, stride, and step length. These are measures of a patient's aggressiveness and assertiveness when walking and greatly affect the amount of stress placed on the tissues of the foot. Younger patients often have very fast aggressive gaits that can be detrimental to their feet. Older patients or those who have had neuropathy for many years develop a slower, more tentative gait. Regardless of the patient's gait, distinct changes can be made to reduce pressures and shear forces that the foot encounters. Gait and balance training and ambulatory aides, such as canes and crutches, can be used to greatly reduce stress on the foot during ambulation and standing, and significantly change the way a patient walks.

The concept of using different off-loading devices during the different phases of healing is all important and too often neglected by the practitioner.

Who Are Patients with Chronic Wounds?

According to Krasner, et al.,[1] several factors contribute to the development of a chronic wound. Individuals with chronic wounds are generally older, have coexisting medical conditions, take drugs that interfere with healing, and often have pain that is not adequately controlled. Their quality of life is poor, and they have an inability to participate in normal activities of daily living, often leading to clinical depression. These factors put the patient at a disadvantage when he/she is trying to follow the clinician's instructions regarding off-loading and caring for his/her wound.

Healthcare practitioners have a tendency to want patients to adhere by following orders. As pointed out by Krasner, et al,[1] this is a "provider-centered" and not "patient-centered" approach to care. When a patient understands why the clinician wants him/her to do something and what the consequences are if he/she chooses to deviate from the recommended plan, he/she is more apt to cooperate and enter into a relationship of trust and adherence to the suggestions made.[2]

Dealing with patients as isolated entities is never the best way to deal with a chronic wound. Whenever clinicians involve a patient's caregivers, family, and friends, a much better overall outcome will be achieved. To paraphrase Sibbald et al.,[3] "It is important to treat the whole patient and not just off-load the hole in the patient." Wound healing itself is an orderly transition from one phase to another, involving specific tissue types, wound growth factors, and signaling molecules involved. These changes in the wound require a similar "transition from one device to another" during the phases of wound healing.

The concept of using different off-loading devices during the different phases of healing is all-important and too often neglected by the practitioner. Because of time constraints in a busy practice, years of convention in treatment, and relentless patient pressure to minimize the size and appearance of tissue protection devices, clinicians often compromise what they know is best practice and settle for trying to heal the wound with a single device that they remove the second a micron of healthy epithelium is observed.

Figure 1: a) Diabetic Foot Ulcer b) Foot Deformities

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Etiology of the Diabetic Foot Wound

The etiology of a diabetic foot wound is both complex and multifactorial. It is difficult to determine which of the many variables that combine to produce the final breakdown and subsequent chronicity of the neuropathic wound are key factors in wound development. The clinician's understanding of the component causes of wounding that lead to the sufficient cause of the wound itself are ever-expanding, but clinical approaches to management are often lagging behind the data that have accumulated.[4] Each contributing factor plays a role in the development of the neuropathic foot wound.

Neuropathy

Several patterns emerge with regard to combinations of factors that take a relatively balanced foot and create an imbalance that results in a breakdown of the skin, which then progresses from a shallow wound to one that is deeper and complicated by infection. The obvious first cause would be neuropathy in most cases, but the density of that neuropathy and the extent of involvement can be quite variable.[5]

Lavery, et al.[6] looked at patterns of contributing factors in 2008. They found that neuropathy, coupled with deformity, callus formation, and elevated peak pressure, was the most common pathway to the development of a diabetic foot ulcer (Figure 1a).[6] Even though this has been confirmed by other studies, no one has presumed to be able to predict the onset of one of these wounds in a real patient prior to its actual occurrence.

For years, it was believed that pressure was the key to tissue breakdown, with several studies implicating peak pressure as a predictor of foot wounds and even stating there was a predictive value for a threshold pressure for ulcer development.[7]

Other studies were unable to pinpoint a specific threshold pressure that could be used to identify risk of ulceration, demonstrating that wounds occur across a pressure spectrum.[8]

Prospective Studies

Prospective studies have confirmed the importance of a combination of neuropathy and peak pressure as causative factors; however, the exact origins of pressure elevations, such as foot type and specific biomechanical deformities, are often ignored in the studies.[9] Footwear has been implicated as the precipitating cause in toe ulcers and a significant contributor to wounds elsewhere on the foot.[10]

Figure 2: Collapsed Arch

On the other hand, shoes have not been shown to be an independent predictor of wounding without accompanying foot deformity either related to imbalances created by the patient's inherent foot type or muscle atrophy associated with glycosylation of motor nerves to the muscles. Nonetheless, properly prescribed and used therapeutic footwear has been shown to reduce the incidence of foot ulceration.[11]

Muscle atrophy in the patient with diabetes usually happens first to the distal intrinsic muscles and later to the larger extrinsic muscles of the leg.

Muscle Atrophy

Muscle atrophy in the patient with diabetes usually happens first to the distal intrinsic muscles and later to the larger extrinsic muscles of the leg.[12] This is not, however, a rigid construct, and muscle involvement can be quite variable.[13] As the smaller intrinsic muscles of the foot become weakened, their ability to stabilize the proximal phalanges of the foot becomes compromised, and the larger, more powerful flexors and extensors of the toes gain mechanical advantage. The toes begin to deform, producing hammer, mallet, contracted, or curly-toe deformities, depending on the patient's foot type and preexisting biomechanical imbalances (Figure 1b).[14]

As the toes deform, the dorsal, distal, and interdigital pressures increase from shoe or bone-to-bone contact, resulting in increased pressure and shear to the skin. Loss of toe function will lead to increased direct plantar pressure and shear at the metatarsal heads in the patient's gait. As all this is happening, glycosylation is also having a deleterious effect on the connective tissues of the entire foot. Digital capsules and tendons are becoming stiffer, resulting in less flexibility in the digits. The Achilles tendon becomes stiffer, and the posterior muscle group loses flexibility.[15]

Consequently, this causes a relative loss of dorsiflexion at the ankle and an increase in forefoot pressures. Although Achilles tendon glycosylation is a major contributing factor in increased forefoot pressures in patients with diabetes, it is not the only factor with an increase in foot stiffness; inherent foot type or posture and gait changes also play important roles.[16]

If the dorsiflexors of the foot lose their strength, the posterior group quickly takes advantage and forefoot pressures increase. Loss of posterior tibial power leads to a worsening of the ability of the foot to resist the tendency to pronate, and the arch collapses (Figure 2).

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Loss of medial arch height leads to a midfoot collapse and dorsal midfoot interosseous compression syndrome (DMICS) with increased bone-on-bone pressure, resulting in spurring and hypertrophy across Lisfranc and Chopart articulations.[17]

Charcot Neuroarthropathy

To date, no one has proposed that foot type and biomechanics play an important role in which patients develop Charcot neuroarthropathy. There are three main theories of etiology of Charcot arthropathy: the French or neurovascular theory, the German or neurotraumatic theory, and the combined theory. The neurovascular theory stated that the primary cause of the breakdown of the skeletal structure was the weakening of the bones caused by the osseous hyperemia resulting from diabetic autonomic neuropathy.[18,19]

The neurotraumatic theory stated that the problem was purely mechanical and due to progressive microfractures produced by mechanical overload in the absence of pain produced by diabetic peripheral neuropathy.[20,21]

When a patient has a severe autonomic neuropathy with osseous hyperemia, the pressure from DMICS, in this author's opinion, may be one of the contributing factors to a progression from microfracture to macrofracture and the devastating osseous destruction noted in Charcot arthropathy. DMICS is much more common in certain foot types, such as the anterior cavus foot type as classified and defined by Whitney.[22]

When these patients develop neuropathy, the loss of bone strength due to osteopenia and the constant overload made possible by the loss of pain and proprioceptive sense result in a breakdown of the midfoot at Lisfranc or Chopart articulations seen in the major sites of Charcot breakdown (Figure 3). Thus, a more inclusive term for the theoretical etiology of Charcot neuroarthropathy might be neurobiomechanical, which would encourage the clinician to include a careful examination of the foot type in the assessment of the Charcot foot.

Figure 3: Charcot Breakdown

As the output from sweat and apocrine glands in the skin decreases with increased autonomic dysfunction, the ability of the skin to resist injury and infection decreases.

Autonomic Neuropathy

Autonomic neuropathy also has a significant effect on the skin. As the output from sweat and apocrine glands in the skin decreases with increased autonomic dysfunction, the ability of the skin to resist injury and infection decreases.[23] Dry skin cracks easily, and the loss of fatty acid content in the skin makes it more vulnerable to bacterial and fungal invasion. Although the skin flora of the patient with diabetes is not significantly different from the patient without diabetes, skin changes result in a dry skin that is less resilient and more susceptible to friction and pressure injury.

Figure 4: Limb-threatening Ulceration

When the skin eventually ulcerates, bacteria aided by an impaired cell-mediated immunity quickly invade and colonize the wound.[24] Calluses form quickly and increased pressure on the dermal and subcutaneous tissues leads to interdermal and subdermal hemorrhage with fluid accumulation between and below tissue layers.

Small accumulations of blood and transudate associated with the injuries coalesce and lead to tissue maceration or blistering of the overlying skin layers. In weight-bearing areas, fluid pockets are constantly compressed, and accumulations of fluid under pressure dissect laterally into neighboring tissues. Large accumulations of blood from ruptured capillaries and transudate can dissect up into intermetatarsal spaces or around medial and lateral aspects of the foot, creating massive bullae that result in larger areas of tissue loss.

Once these bullae rupture and open to the outside, opportunistic bacteria quickly invade this rich fluid medium and begin to divide. The bacteria add to the fluid accumulation and have the added threat of tissue destruction from proteolytic enzymes with extension into deep spaces. Pus accumulations in these areas can further dissect into the tissues with continued weight bearing in the insensate foot. Without early detection, callus debridement, timely drainage, and off-loading, these innocent-appearing calluses and areas of maceration can become limb-threatening problems (Figure 4).

Ideally, off-loading should be a

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therapy designed to prevent the development of ulcerations. All too often, it is used as a therapy to address the already ulcerated limb.

Diabetic Foot Infections

Diabetic foot infections are one of the major reasons for hospitalization of the patient with diabetes. According to the Pennsylvania Health Care Cost Containment Council "Diabetes Hospitalization Report 2003," diabetes was the principal diagnosis in more than 23,000 admissions to Pennsylvania hospitals, and accounted for almost 134,000 hospital days and more than $641 million in hospital charges. That same report stated that the number of American adults with diabetes has increased 61% since 1991 and is projected to more than double by 2050.25 According to the Centers for Disease Control and Prevention, in 2003, the national age-adjusted discharge rate for an ulcer was 6.9 per 1000 diabetic population, making it the most common lower-extremity reason for admission.[26] At the present time, there are approximately 23.6 million people or 7.8% of the population who have diabetes. Of those, 17.9 million people are diagnosed, and 5.7 million people are undiagnosed. There are 57 million people now classified as prediabetic, and approximately 1.6 million new cases of diabetes are diagnosed each year.[27]

Figure 5: Total Contact Cast

During a 2000-2002 survey, an estimated 11.8% of U.S. adults with diabetes reported a history of a foot ulcer.[28] The problem of diabetic ulceration is not about to disappear, and clinicians are likely to see continued high numbers of ulcerations for some time. The necessity of early screening, regular foot care, and early off-loading intervention in the presence of even minor tissue damage of the foot is essential to preventing the complications described.

What You Wear: Off-Loading Techniques

Total Contact Cast

For many years now, the total contact cast (TCC) has been considered the criterion gold standard for off-loading a diabetic foot wound, with healing rates as high as 90% (Figure 5).[29-31] Despite rather convincing evidence to support its use, the International Working Group on the Diabetic Foot and several others have concluded that relatively few practitioners use this modality on a routine basis.[32,33]

Based on strict criteria for the use of the TCC, a number of patients should not be treated with casting. They include patients with documented PAD, an ankle brachial index of less than 0.7, or an active infection.[34] Other contraindications include cast claustrophobia, known non-adherence, fluctuating leg edema, active skin disease, a sinus tract with deep extension into the foot, or when the clinical staff has inadequate training and confidence to administer the treatment. In those cases, other treatment modalities should be performed. Most studies of the TCC have demonstrated healing rates as high as 90% at 12 weeks.[31]

Most practitioners treating diabetic wounds are aware of these data, but because of the complications mentioned, in addition to the time and complexity of application and the cost of materials for the device, they use one of several alternative devices.[35-37] These include the remov-

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Figure 6: Removable Cast Walker

Figure 7: Molded Ankle Foot Orthosis

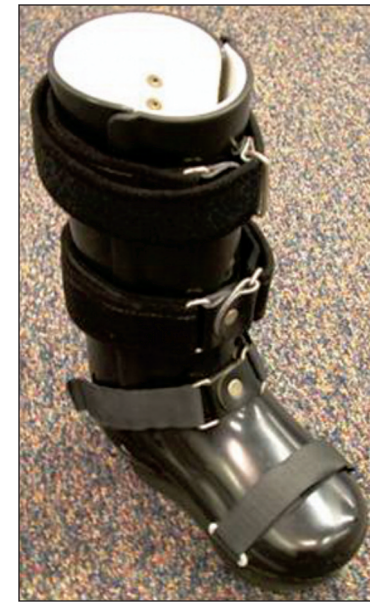

Figure 8: Charcot Restraint Orthopedic Walker

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able cast walker (RCW) (Figure 6), the non-RCW or instant TCC (iTCC), the molded ankle foot orthosis (Figure 7) with or without a patellar tendon-bearing addition, Charcot restraint orthopedic walkers (CROWs) (Figure 8), a Carville healing sandal (Figure 9), the felted foam technique (Figure 10), the football dressing (Figure 11), and commercial off-loading shoes, such as the half or wedge shoe (Figure 12), post-operative shoe, and depth or custom-molded footwear (Figure 13).

Although several excellent algorithms or classifications have been produced to aid the practitioner in choosing between these modalities, most practitioners choose between these devices based on their individual experience with a particular modality, clinical availability, patient preference, or even insurance reimbursement.[36,38]

Instant Total Contact Cast

If the clinician is not comfortable with the application of the TCC, or if the patient has one or more of the established contraindications to its use, pre-fabricated RCWs and non-RCWs have been shown to be comparable to the TCC in their ability to off-load the diabetic foot and close wounds in a similar time frame. Armstrong, et al.[39,40] have been the pioneers in the use of the non-RCW or what they have called the iTCC. Lavery, et al.,(41), Pollo, et al.,(42), and Lawless, et al.[43] have studied pressure redistribution in commercially produced removable diabetic walkers and found them to be comparable to the TCC and superior to other off-loading devices in their ability to reduce pressure on specific areas of the foot.

Figure 11: Football Dressing

The real key to healing with almost any of the off-loading devices is the ability to improve patient adherence by restricting removal of the devices. Patients with diabetes consistently remove or fail to use prescribed off-loading devices. In a recent study by Knowles and Boulton,[44] when patients were given specialized footwear free of charge, only 20% of the patients actually wore the shoes.

When Armstrong, et al.[45] conducted a similar study evaluating the use of RCWs, they found that the RCW was worn during only 28% of daily activity.

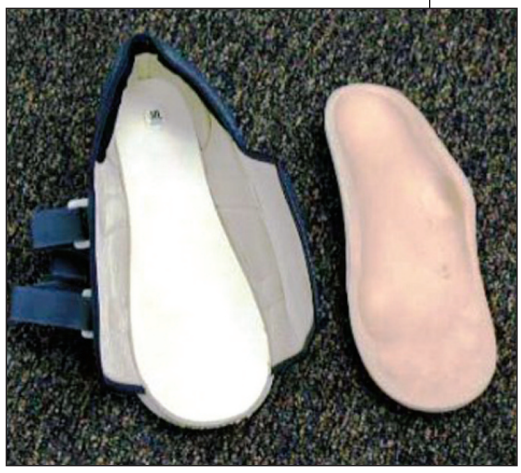

Figure 9: Modified Healing Sandal

Figure 10: Felted Foam Technique

Removable Walkers

Removable walkers have been secured with cast material, or by applying a simple cable tie connector to prevent patients from taking off the devices. There are certain dressing techniques that rely on the fact that the patient cannot remove the off-loading device. Felted foam or football dressings fall into this category. When studies have been done to compare removable with non-removable techniques, the non-removable devices have been able to improve healing rates and the clinician's ability to close wounds within the 12-week standard window.[46-49]

In addition to off-loading, numerous advanced wound dressings and tissue grafts have been developed to reduce bioload, enhance extracellular matrix deposition, and hasten epithelialization of the chronic wound. Most of these devices require several applications over a designated period or regular applications to the wound to ensure effectiveness. Removable devices allow relatively easy access to the wound at any time during the healing process, which makes it easier to use such products.[50]

Felted Foam and the Football Dressing

Alternative non-removable dressings that have support in the literature for management of open wounds are the football dressing and the felted foam dressing, provided the clinician is familiar with their application. Felted foam dressings (FFDs) have been used successfully for many years by practitioners trained in the technique. One-quarter-inch adhesive felt is applied directly to the foot around the ulcer to reduce pressure on areas of ulceration.

Skin barriers, such as rubber cement or collodion-based products, are applied to prevent irritation from the adhesives used on the foam. A modified surgical shoe with a molded insole, wedge shoe, or even a pre-fabricated walker can then be used to protect the foot.

Dressings are changed as prescribed and the protective pads are reapplied weekly until the wound is

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healed (Figure 10). Birke, et al.[49] compared FFDs with a TCC, healing shoes, and a walking splint with regard to healing times for forefoot ulcers. Results indicated that 93% of the ulcers treated with the FFD were healed within 12 weeks (mean time to healing of 20.9 days) compared with 92% (31.7 days) in those treated with the TCC. This study also found healing sandals and depth shoes to be fairly effective, with 81% to 83% healed at 12 weeks.[49] The football dressing developed by Rader and Barry[48] has had fewer acceptances by clinicians and has limited data to support its widespread use; however, it remains a viable option for patients or clinicians where a TCC is contraindicated and a cast walker cannot be obtained because of insurance limitations or other circumstances (Figure 11).[49]

The football dressing uses several layers of cast padding (this author prefers polyester), secured with woven gauze roll bandage, overlaid by more padding, additional gauze, and finally a layer of self-adherent wrap to finish the dressing and keep it in place. The only real problem the author has faced with the dressing is its tendency to shift during ambulation, which was overcome by using a 34-in polyurethane foam layer against the foot followed by cast padding, gauze, and self-adherent wrap. The author also has used the football dressing successfully in numerous cases in conjunction with RCWs. The heavily padded football dressing can be fabricated to fit into an existing cast walker, increasing its effectiveness. This also alleviates the feeling of claustrophobia some patients experience when they are restrained in a non-removable device. If the patient takes the RCW off the football dressing, which most patients perceive as a bandage, the dressing will protect the foot if a few limited steps are taken outside the device.

A common problem among practitioners is to allow the patient to return to standard or depth footwear too early, which can result in a recurrence of the ulcer. Many of these early recurrences are not recorded in the literature because they seem to be an extension of the original wound and are included in the time-to-closure data. Even still, recurrence of ulcers after healing is a big problem. In a study by Steed, et al.,[51] 69% of wounds healed with a growth factor recurred within 30 months after closure. Matricali, et al.[52] had a similar result when they looked at recurrence after healing using a TCC. After approximately 22 months of follow-up, 67% of the patients had developed recurrent ulcers.

A common problem among practitioners is to allow the patient to return to standard or depth footwear too early, which can result in a recurrence of the ulcer.

Figure 12: Half Shoe

Figure 13: Custom-Molded Shoe

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EXAMINATION

Continuing Medical Education

See answer sheet on page 133.

1) According to the 6W evaluation approach to the diabetic foot the "Why" you walk section of the exam focuses on:
- A) Motivation
- B) Adherence
- C) Compliance
- D) All of the Above

2) Physical therapists can be a valuable referral for the diabetic patient by:
- A) Gait training
- B) Balance training
- C) Use of Ambulatory Aids
- D) All of the above

3) The concept of "Transitional Offloading" is based on:
- A) the orderly progression of the natural phases of wound healing
- B) changing one off-loading device for another
- C) altering the styles of the patient's offloading devices
- D) using the available evidence to make offloading choices

4) Compliance is a term that does not adequately describe the ideal doctor-patient relationship. What term is better to use regarding the process by which a patient listens and then acts on your suggestions?
- A) Acceptance
- B) Adherence
- C) Contrition
- D) Conditioning

5) According to a study by Lavery the most common pathway to the development of a foot ulcer is:
- A) Neuropathy, deformity with callus, and elevated peak pressure
- B) Elevated peak pressure, hemorrhage in a callus, reduced ABI
- C) Compromised vascular supply, poor footwear, and direct trauma
- D) Neuropathy, compromised vascular supply, direct trauma

6) Footwear has been implicated as a cause and used as a treatment for the diabetic foot ulcer. With regard to the etiology of diabetic foot wounds:
- A) Footwear has never been proven to be the cause of diabetic foot ulcers
- B) Shoes have not been shown to be an independent predictor of wounding without accompanying foot deformity
- C) Depth shoes have been shown to prevent foot ulcers when worn consistently
- D) Sneakers are an appropriate substitute for a depth shoe

7) According to the Centers for Disease Control and Prevention, in 2003, the most common lower-extremity reason for a diabetic being admitted to a hospital was:
- A) Cardiomyopathy
- B) Ketoacidosis
- C) An ulcer
- D) Diabetic coma

8) A removable cast walker can be secured in such a way as to make it non-removable. The proper term for this technique is:
- A) Diabetic walker
- B) The instant total contact cast
- C) The Football dressing
- D) The felted foam technique

9) The total contact cast is considered the gold standard for offloading diabetic foot ulcers. Most practitioners:
- A) Use this device as their first choice for offloading
- B) Make the device out of fiberglass casting material
- C) Apply the wound isolation technique when fabricating the device
- D) Fail to use the device for a variety of reasons

10) People have stated that the total contact cast (TCC) is the "gold standard" for offloading the diabetic foot ulcer. Which of the following is true?
- A) The removable cast walker is equal to the TCC in most comparison studies)
- B) No other device has been able to achieve the healing rates seen with the total contact cast
- C) Numerous studies have shown the felted foam technique to be equal to the TCC in healing rates
- D) The TCC has never been shown to be inferior to any other off-loading device

11) When choosing an off-loading device:
- A) A single aggressive off-loading device such as a total contact cast should be used through all phases of the healing process
- B) Modifications to the patient's footwear are the best way to assure that they will adhere to the offloading regime
- C) Multiple devices should be used during the healing process to assure that the wound is effectively unloaded and the healed wound protected during the first few weeks after wound closure
- D) The Carville healing sandal with the proper modifications is an appropriate offloading device for most diabetic ulcers

12) The biggest impediment to the use of the proper offloading device is:
- A) Cost
- B) Availability
- C) Local practice norms
- D) The clinician and the patient's resistance to change

13) Peak pressure measurements:
- A) Predict accurately the site of a future ulcer
- B) Can be used to tell whether a certain pressure will result in the development of a wound or not
- C) Are helpful pieces of data but cannot be used to effectively identify the risk of ulceration
- D) Demonstrate that heavier patients are at higher risk for ulceration than those who weigh less

Continued on page 132

Continuing Medical Education

EXAMINATION

(cont'd)

14) The proper term for the effects of long-standing elevated glucose on the various tissues of the body is:
A) Cross-linking
B) Inflammatory scarification
C) Glycosylation
D) Neuroarthropathy

15) One of the major deforming forces present in the majority of diabetic patients with forefoot ulcers is:
A) Hammering of the digits
B) Bunion development
C) Pronation
D) Equinus

16) All of the following are theories of the etiology of Charcot Neuroarthropathy except:
A) The French Theory
B) The Italian Theory
C) The German Theory
D) The Combined Theory

17) The Charcot etiological theory that states that the loss of protective sensation leads to the progressive development of microfractures due to mechanical overloading:
A) The French Theory
B) The Italian Theory
C) The German Theory
D) The Combined Theory

18) According to a 2000-2002 CDC survey, approximately what percentage of those people with diabetes reported a history of a foot ulcer?
A) 5%
B) 12%
C) 25%
D) 37%

19) According to Knowles and Boulton, what percentage of patients actually wear their prescription footwear?
A) 60%
B) 40%
C) 30%
D) 20%

20) Removable cast walkers work much better when they are rendered non-removable, thereby assuring compliance. When Armstrong looked at what percent of their daily activity patients who were allowed to remove their walkers actually spent in their devices it was a surprising:
A) 12%
B) 28%
C) 40%
D) 58%

See answer sheet on page 133.

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EXAM #6/10
Transitional Off-Loading—Part 1
(McGuire)

Circle:

1.	A	B	C	D	11.	A	B	C	D
2.	A	B	C	D	12.	A	B	C	D
3.	A	B	C	D	13.	A	B	C	D
4.	A	B	C	D	14.	A	B	C	D
5.	A	B	C	D	15.	A	B	C	D
6.	A	B	C	D	16.	A	B	C	D
7.	A	B	C	D	17.	A	B	C	D
8.	A	B	C	D	18.	A	B	C	D
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10.	A	B	C	D	20.	A	B	C	D

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