In 2012, 4.8 million deaths were attributed to diabetes, and 471 billion USD was spent on diabetes-related healthcare, worldwide.\textsuperscript{1} The number of people with diabetes is increasing in every country,\textsuperscript{1} including the United States, in which diabetes affects 25.8 million people, or 8.3\% of the population.\textsuperscript{2} Furthermore, up to 25\% of people with diabetes will develop a foot ulcer during their lifetime,\textsuperscript{1} with one in five requiring an amputation.\textsuperscript{4} In 2006, about 65,700 non-traumatic lower-limb amputations were performed on people with diabetes.\textsuperscript{2}

An interdisciplinary team approach to limb salvage—toe and flow—involving primary care physicians, podiatric surgeons, vascular surgeons, orthopedic surgeons, plastic surgeons, infectious disease specialists, diabetologists, general surgeons, and pedorthist/prosthetists has been shown to lower amputation rates and complications in people with diabetic foot wounds.\textsuperscript{5,6} A combined vertical and horizontal strategy for wound healing incorporates the primary components of a comprehensive amputation prevention program.\textsuperscript{7}

The vertical strategy refers to covering important structures and filling defects with negative pressure wound therapy (NPWT), while the horizontal strategy includes the use of skin grafting, bio-engineered skin substitutes, and aggressive off-loading.

The formation of a diabetic foot ulcer is largely the result of repetitive, moderate stress applied to a neuropathic foot during ambulation.\textsuperscript{8} In lacking the ability to adequately respond to pain, patients with neuropathy often sustain breaches in their skin the way insensitive people may wear holes in their socks. Thus, it can be said that these patients lack the "gift of pain."

While there is no treatment available that completely mitigates the effects of neuropathy, the prevention and treatment of wounds in people with diabetes is largely based on a redistribution of pressure. Several off-loading modalities exist which, to varying degrees, redistribute pressure in the diabetic foot. However, there is only a small number of case series which explore the frequency and rate of wound-healing associated with these devices.

In general, total contact casting (TCC) is considered to be the gold-standard, offloading modality with respect to diabetic foot wounds.\textsuperscript{9} TCC involves a well-molded, minimally padded cast, which maintains contact with the entire plantar foot and lower leg. It has been shown to reduce pressure at the site of ulceration by 84\%–92\%.\textsuperscript{10} and has demonstrated healing rates, in noninfected, nonischemic, plantar diabetic foot wounds of 72\%–100\%.\textsuperscript{11-16} Throughout gait, peak plantar pressures are highest in the forefoot; thus, the true effectiveness of TCC may lie in its ability to transmit pressure from the forefoot to the rearfoot, or cast wall.\textsuperscript{17,18}

Besides off-loading, TCC has several implicit features which make it especially effective in preventing and healing diabetic foot wounds. For example, TCC can protect the foot from infection, and may play a role in edema reduction.\textsuperscript{19} Perhaps, most importantly, TCC is irremovable, which guarantees patient compliance. Cases involving soft tissue infection, os-
teomyelitis, and ischemia are typically contraindications for TCC,\textsuperscript{20} and it may not be an appropriate treatment for heel wounds.\textsuperscript{16}

Furthermore, TCC can make activities such as sleeping and bathing difficult for patients, and as such can be regarded as a nuisance.\textsuperscript{21}

**Other Factors**

Cost of materials and lack of reimbursement are important factors which may limit the widespread use of TCC. Many offices and wound centers lack the skilled personnel and resources necessary for a comprehensive off-loading program involving TCC. Wu, et al.\textsuperscript{22} reported in 2008 that among 895 centers involved in the active treatment of diabetic foot ulcers, only 1.7% used TCC for the majority of their treatment. Moreover, using data extrapolated from the “Eurodale” Study,” Prompers and colleagues\textsuperscript{23} found that among a subgroup of patients with neuropathic plantar forefoot or midfoot ulcers, TCC was prescribed in only 18% of cases. Remarkably, as reported by Fife et al.,\textsuperscript{24} the average cost of treatment with TCC is about half as much, per patient, as the cost of treatment without TCC. There are several products currently available which facilitate the simple, easy, and fast application of TCC (Figure 1).

**Removable Cast Walkers**

Removable cast walkers (RCW) may provide a good alternative to TCC. Pressure reduction with certain RCWs has been shown to be equivalent to TCC\textsuperscript{10}, and more recently, Faglia, et al.\textsuperscript{25} reported RCW to be as effective as TCC in reducing wound size and increasing healing rates in diabetic foot ulcers. RCW allows for frequent wound inspection, as well as more consistent application of topical and advanced wound care modalities. Patients generally feel more comfortable in RCW and enjoy the freedom that its name implies. However, the ability of patients to remove the offloading device represents a potential pitfall of RCW. In a study conducted by Armstrong et al.,\textsuperscript{26} in which the activity of patients undergoing treatment for diabetic foot wounds was recorded using hidden accelerometers, patients were found to have worn their offloading device less than 30% of the time.

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In an effort to maintain the off-loading capacity of RCW and encourage patient compliance, an instant total contact cast (iTCC) has been described, which involves wrapping an RCW with a layer of cohesive bandage, plaster or fiberglass (Figure 2).\textsuperscript{27} Thus, it is difficult for patients to remove the offloading device more than 30% of the time.
move. In a randomized controlled trial conducted by Katz et al., wound healing was demonstrated as often in patients undergoing therapy with iTCC as with TCC (80% vs. 74%). Furthermore, Armstrong and colleagues noted substantial differences in wound healing between patients being offloaded with iTCC and traditional RCW (83% versus 52% at 12 weeks).

There are many other off-loading modalities which redistribute pressure in the diabetic foot, such as half shoes, healing sandals, and felted foam; and it has even been postulated that changing the strut height of an RCW (i.e., ankle vs. knee-high) may improve patient comfort and stability without significantly affecting off-loading (Figure 3). It is also important to realize that what is designed for wound prevention may not necessarily translate into wound healing. For example, therapeutic shoes may allow as much as 900% more forefoot pressure, as compared to the offloading capability of TCC and RCW.

Recently, advanced wound care and diabetic limb salvage has been marked by incredible advances in biotechnology and engineering. However, the so-called “low-technology” treatment of diabetic foot ulcers—wound care, debridement, and pressure reduction—may represent the true keys to success. Furthermore, the key to off-loading may depend as much on selecting the appropriate device as it does on patient comfort and compliance. Finding the right balance is paramount.

The key to off-loading may depend as much on selecting the appropriate device as it does on patient comfort and compliance.

References

Figure 3: Mean pressure reduction based on strut height in RCW. From: Crews RT, Sayeed F, Najafi B. Impact of strut height on off-loading capacity of removable cast walkers. Clin Biomech (Bristol, Avon). Mar 30, 2012.


