Diabetes carries the risk of developing complications that are largely irreversible. Approximately 10% of the population has diabetes mellitus. Between 2007-2010 diabetes was the seventh leading cause of death in the United States, with an annual mortality rate of 22.4/100,000 of population. Double the rate for non-diabetic adults. Diabetes decreases life expectancy on average by 5-10 years for diabetics.
For effective design solutions, in diabetic footwear it is important to understand the major complications of diabetes. Peripheral neuropathy and peripheral vascular disease. These two complications are presently the leading causes of disability in the United States. If left unchecked, diabetes is a relentless progressive disease, which extensively attacks the nervous system. Every Pedorthist is aware that diabetes seriously affects the feet. The feet are where the disease is obvious. In the feet the damage to the nervous system is initially sensory, presenting as numbness and often manifesting without further complications. This condition affects 26-47% of all patients with diabetes.

Nerve disease and blood vessel diseases are interrelated. With diabetes, there is profound damage to the small blood vessels resulting in ischemia, a reduction in blood supply to tissues. This causes a shortage of essential oxygen and nutrients needed to keep tissue alive and healthy. Blood vessels depend on adequate nerve function, and nerves depend on adequate blood flow. Whatever our intentions, in the production of footwear it is essential that we never compromise blood flow or nervous function. Any part of an assistive device that is tight fitting, compressive or unyielding must be addressed for the diabetic use.

Diabetic neuropathy adversely affects all peripheral nerves including pain fibers, motor nerves and the autonomic nervous system. No nerves, leads to less blood. Less blood and clearly less nerves. Less of both and we affect all tissue, resulting in nearly dead and easily injured, leading to dead tissue. Knowing this relationship we have an understanding of what neurovascular disease is, why there is neuropathy, why its effects are so widespread and particularly the feet, the most affected region of the body.

The outcomes of neuropathy include significant sensory malfunctions. The general term for abnormal sensation is Dysesthesia. With diabetes dyesthesia is common. Dysesthesia can indicate a reduced level of sensation. Commonly numbness and tingling in the extremities, or paresthesia. Think of sitting cross legged as a child, but with constant delivery.

Dysesthesia also indicates a condition characterized by heightened and exaggerated pain, sub categorized as hyperesthesia. In this case, think of sitting cross legged as a child, but with an infinitely worse and unrelenting sensation. As such, in accounting for the complications of sensory neuropathy, constriction and focal pressure are serious issues in your problem solving approach as a Pedorthist.

To complete the presentation of neuropathy we have to include: muscle weakness, burning or electric pain and the constant sensation of cold, all of which can present, in any combination with dyesthesia. Every Pedorthist must deal with these disorders and should keep an ongoing record of the patient’s status to provide responsive therapy.

Abnormal sensations present first in the toes on each foot. Closely associated with forefoot compromise. This presentation is often described as the “stocking” distribution of numbness, sensory loss and nighttime pain. The pain can feel like burning, pins and needles, the sensation of standing barefoot on marbles or gravel or extreme pain, all of which are common sensory disorders and worth noting. As a designer, what does this suggest? Toes need special consideration. The toes are where the disease has made its first disabling strike. Tissues are seriously compromised and are highly susceptible to continued breakdown.

Neuropathy includes extensive motor nerve and autonomic dysfunctions in combination with sensory disorders. A common complication of neuropathy is loss of proprioception. Proprioception is the sense of where a limb is in relation to the body and the environment. This is affected early in the development of diabetes. Affected diabetics cannot feel when they are stepping on a foreign body, such as a splinter, or when they are developing a callous from a bony deformity or from an ill-fitting shoe. These patients are at high risk for injury and limb loss. Discourage barefoot activity.

A loss of neuromuscular function can result in contraction of the digits, producing hammer toes. The difficulty of these patients can progress to forefoot valgus, drop foot, multiple fractures of the knee, ankle or foot, and to Charcot deformities. The loss of normal muscular and motor function is progressive. Charcot neuropathy progressive, we are dealing with potentially unstable and intensifying disease.

As a footwear designer what does this suggest to you? Consider how often you should revisit with these patients? This status of these patients can change rapidly. Your design solution of six months ago may be a disaster today. As a Pedorthist everyone will benefit if you monitor diabetic patients. You will most likely be the first to detect the signs of impending danger. Be assured, few physicians are trained to detect subtle changes in the foot that are obvious to you.

Pedorthist are required to help manage progressive diabetic/neuropathic disorders. Complex regional pain syndrome (CRPS) can exist separately or in parcel with diabetes. CRPS has been described under a number of different headings: reflex sympathetic dystrophy (RSD) or “causalgia”, reflex neurovascular dystrophy (RND), Sudeck’s atrophy, algoneurodystrophy, and amplified musculoskeletal pain syndrome (AMPS).

Complex Regional Pain Syndrome is multifaceted, with features of extreme sensitivity, blood flow problems, swelling and discoloration. Brain changes produce constant pain signals. It often
initially affects an arm or a leg and can spread throughout the body.8,9 If treatment is delayed, the disorder can quickly spread and may become irreversible. The prognosis is not always good. Johns Hopkins Hospital reports that 77% of sufferers have spreads from the original site or flares in other parts of the body, is painful and difficult to control. CRPS has the distinction of being described as the most painful long term disease state, above such events as amputation and childbirth11. Design thoughtfully.

Diabetes presents with the most common neuropathic arthropathy in the U.S., resulting in destruction of foot and ankle joints, Charcot joints. Charcot joints occur in 1/600-700 diabetics. Charcot arthropathy is a neuropathic degeneration of a weight bearing joint or joints, and is progressive disease marked by bony destruction, bone resorption, and eventual deformity. If the disease process continues unchecked, it can result in joint deformity, ulceration, infection, loss of function, and in the worst case scenario, amputation or death. Again, early identification of joint changes is the best way to limit morbidity.

Charcot neuropathic joint disease12, is a wild card disease and not limited to the foot. In those with foot deformity, approximately 60% are in the tarsometatarsal joints (medial joints affected more than lateral), 30% have metatarsophalangeal joints involved and 10% have ankle disease.13 This complex presentation suggests that every segment of a shoes design must be carefully considered, to avoid negative outcomes.

Pedorthic solutions, for a diabetic/neuropathic must be thorough. These are physiologically disregulated individuals. Nothing physically, with these people works as well as expected. Diabetics/ Neuropathic tissue, a break down easily, heals poorly, may be incapable of sensing injury, and balance and strength is impaired. In this progression injury leads to increased instability and increased susceptibility to further injury. Diabetics have extreme susceptibility to the forces of impact, shear, vectored compression and shear, abrasion, puncture and rest compression/pressure. Without optimal treatment diabetics cannot maintain a status quo.

The diabetic/neuropathic tendency is to become worse. At best, we provide temporary solutions. We must integrate contingencies in our design solutions to protect these patients from what has not yet occurred. As well as addressing present need we plan ahead, for the eventualities of the disease’s progression. A thorough understanding of diabetes and neuropathy will enhance the effectiveness of treatment modalities.

Noted resources for this article can be found online at www.pedorthics.org.