



**LOWER EXTREMITY REVIEW**

February 20 / volume 12 / number 2

# PRONATION

- Potential Risk Factor for Injury
- Orthotics and Control



LE&RN EXPERT COMMENTARY 41



**LYMPHEDEMA OF THE LOWER EXTREMITIES**

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### 33 TECH TAKES ON DIABETIC FOOT ULCERS

### 51 A NOVEL WAY TO IMPROVE COMMUNICATION WITH PATIENTS

### 13 FROM THE LITERATURE

- *Quick Screen for PAD? Ask About Claudication*
- *National Biomechanics Day Is April 8, 2020! Join the Fun!*
- *Laser Shows Positive Results for Onychocryptosis*
- *New! As Seen on LinkedIn Steps to Effective Exercise Rx*
- *Custom AFO Reduces Fear of Falling for Seniors*

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**GUEST EDITORIAL**

**9 UNDERSTANDING PRONATION**

As a podiatrist, athlete, coach, and independent running shoe proprietor, I have always had an interest in biomechanics and the impact on lower extremity overuse injuries and conditions. Perhaps the most well-known biomechanical term, pronation, is also the most misunderstood.



By Mark Mendezsoon, DPM

**FROM THE LITERATURE**

- 13 • One Claudication Question May Be Quick Screen for PAD**  
By Lynn Soban, PhD, MPH, RN
- Science Meets Fun on National Biomechanics Day: April 8, 2020**
- Study Shows Heel Lifts Affect Biomechanics, Muscle Function**
- 1064-nm Laser Technique Shows Positive Results for Onychocryptosis**  
By Keith Loria
- As Seen on LinkedIn: Steps to Effective Exercise Prescription**  
By Talysha Reeve
- Custom AFO With Walking Shoes Improves Balance, Reduces Fear of Falling for Seniors**



**EXCERPT**  
**MUSCLE CRAMPING DURING EXERCISE: CAUSES, SOLUTIONS, AND QUESTIONS REMAINING, PART 2**

Due to a production error, Part 2 will appear in the March 2020 issue. We apologize for any confusion.

**COVER STORY**



**23 FOOT PRONATION**

Over the past decades, pronation has been discussed as a potential risk factor for injuries or as the mechanism behind impact damping. However, little is understood about pronation. . . . Therefore, it seems important to reconsider the topic of pronation from novel perspectives.

By Benno Nigg, Anja-Verena Behling, and Joseph Hamill

**30 ORTHOTICS AND PRONATION CONTROL**

By Robert Weil, DPM

**AD INDEX**

**57 GET CONTACT INFO FOR ALL OF OUR ADVERTISERS**

**INDUSTRY SNAPSHOT**

**58 PRODUCTS, ASSOCIATION NEWS & MARKET UPDATES**

**CROSSWORD PUZZLE**

**62 TEST YOUR KNOWLEDGE OF INFORMATION FROM THIS ISSUE**

**LER FEATURES**

**33 TECH TAKES ON DIABETIC FOOT ULCERS**

Technology is making headway in the fight to not just treat but prevent diabetic foot ulcers. LER looks at several new and emerging technologies that were showcased at DFCON2019.



By Lynn Soban, PhD, MPH, RN

**41 EXPERT COMMENTARY LYMPHEDEMA OF THE LOWER EXTREMITIES**



Often overlooked, lymphedema of the lower extremities is becoming more common as aging, obesity, and cancer therapies all take their toll. Detection is key to getting appropriate treatment.

By Stanley G. Rockson, MD

**51 PATIENT PRESENTATIONS IMPROVE COMMUNICATIONS, INCREASE EFFICIENCY**

Communicating with patients all the details of a treatment plan can be time-consuming with too many details to remember. This clinician found a way to help him remember, to help patients better understand, and to improve practice efficiencies.



By Donald Peltó, DPM

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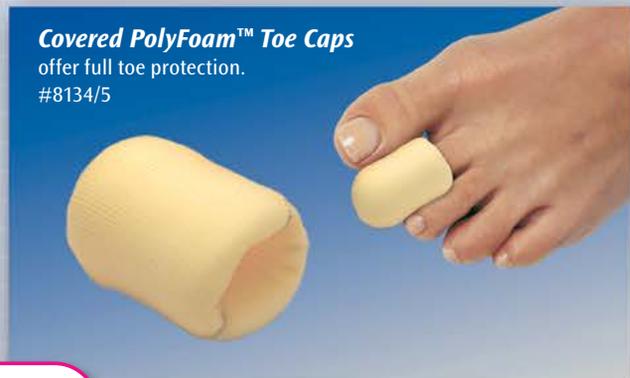
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Lower Extremity Review informs healthcare practitioners on current developments in the diagnosis, treatment, and prevention of lower extremity injuries. LER encourages a collaborative multidisciplinary clinical approach with an emphasis on functional outcomes and evidence-based medicine.

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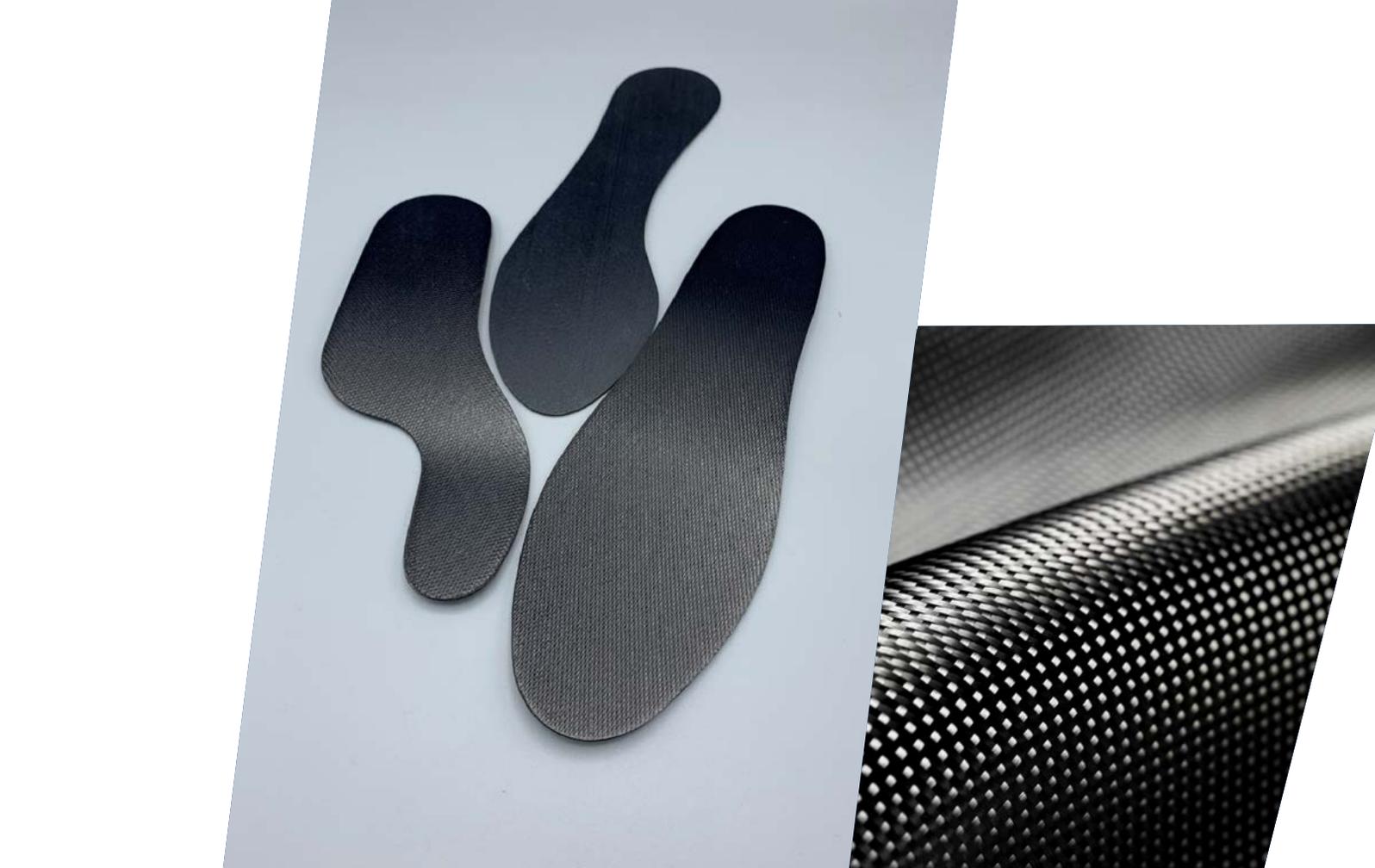
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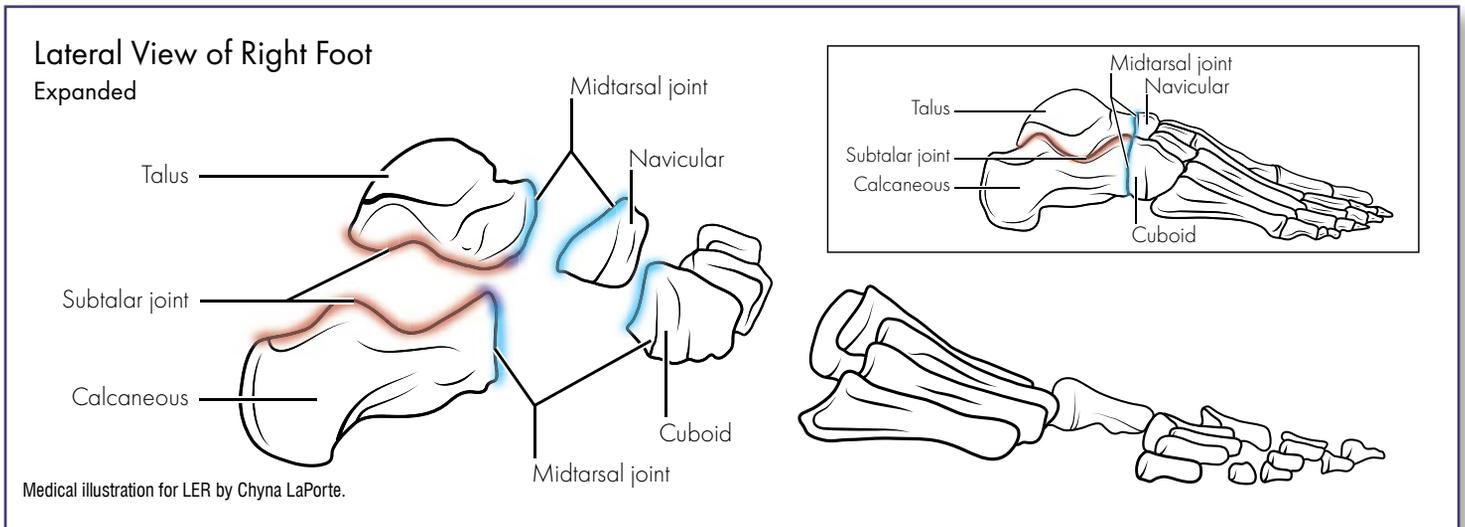
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## Understanding Pronation

BY MARK MENDESZOOM, DPM



As a podiatrist, athlete, coach, and independent running shoe proprietor, I have always had an interest in biomechanics and the impact on lower extremity overuse injuries and conditions. Perhaps the most well-known biomechanical term, pronation, is also the most misunderstood. In his recent article, Benno Nigg et al. (see *Foot Pronation*, pg 33-38)<sup>1</sup> confirm that pronation is an integral part of the gait cycle and has a direct impact on lower extremity injuries. After a thorough review of previous studies, Nigg confirmed that pronation is appreciated by the profession but still a theory and not an absolute science. While that may be true academically for clinicians, the importance of recognizing biomechanics is imperative in treating patients. It can also play a role in building one's practice.

In the second year of podiatric medical school, podiatrists are principally trained with Root's Foot Morphology Theory as the foundation of biomechanics. This theory emphasizes the integral relationship between the subtalar and midtarsal joints' anatomy and mechanics. Over the last several decades, however, Root's

theory has been challenged and proven to have inconsistencies due to the fact that pronation is still a misunderstood motion. What is certain is that pronation is a three-plane motion affecting both the subtalar and midtarsal joints and eversion of the subtalar joint is the primary motion of pronation in the frontal plane. Many times eversion is misconstrued as pronation. As a result, more recent theories, such as Kirby's Tissue Stress Theory and Dananberg's Sagittal Plane Facilitation Theory, have evolved and been more accepted by the profession. The astute practitioner will combine all three theories to assess and treat their patients.

The importance of applying biomechanics into your clinical practice is crucial. Regardless of any foot and ankle condition, a thorough biomechanics exam must be implemented to provide the best outcome for your patient. A complete head to toe exam should only take a few minutes by the skilled practitioner and thus provide many answers to help solve the problem at hand.

Initially, the practitioner would have the

patient evaluated by performing an open kinetic chain examination by sitting and lying down. In this portion of the exam the practitioner is evaluating joint mobility, range of motion, integrity of ligaments and soft tissues, joint range of motion, symmetry of contralateral sides, muscle strength, leg length, and painful areas. If the patient is able to stand and ambulate, then a closed kinetic chain exam is performed. In closed chain pronation, the tibia internally rotates, the talus plantarflexes and inverts, and the calcaneus everts. Evaluation of posture, spine position, hips, pelvic tilt, knee position, and gait pattern is noted. Lastly, evaluation of shoe gear and any foot orthoses or braces should be noted. Performing a thorough history and physical examination and reviewing diagnostic testing should allow the practitioner to establish a working diagnosis and create a treatment protocol.

Whether the patient needs conservative or surgical treatment, the fundamentals of biomechanics should be respected so that the patient may have optimal healing potential. Once the

*Continued on page 10*

pathomechanics of the condition are established and properly diagnosed, implementation of treatment is the rewarding part since we all know how valuable the need for ambulation and mobility are for the patient. The integration of human biomechanical concepts with human kinesiology, anatomy, physiology, surgical procedures, biomaterials, foundation of orthoses, shoe anatomy, and function and rehabilitation make our profession one of the most dynamic fields in medicine. Despite all the advancements of podiatry in the last few decades, the tenets of biomechanics are at the cornerstone of our success and should be valued and implemented as a fundamental component of patient care. 

*Mark Mendeszoon is a senior partner at Precision Orthopaedic Specialties Inc. located in Chardon, Ohio. He is the director of University Hospitals Richmond Heights Medical Center Advanced Foot & Ankle Surgery. In addition, he is the owner of three Achilles Running Shops in Northeast Ohio and Erie, Pa., as well as President of the Maple Leaf Track Club.*



#### Reference

1. Nigg B, Behling AV, Hammill J. Foot pronation. *Footwear Science*. 2019;11:3;131-134.

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The Editors of *Lower Extremity Review* want to highlight the work of thoughtful, innovative practitioners who have solved their patients' vexing problems. We are seeking reports of your most intriguing cases in the following areas:

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LOWER EXTREMITY REVIEW  
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## One Claudication Question May Be Quick Screen for PAD

BY LYNN SOBAN, PHD, MPH, RN

Peripheral Arterial Disease (PAD) affects more than 200 million adults around the world. If identified early, PAD is highly treatable and may prevent patients from suffering major adverse cardiac events (MACE) and major adverse limb events (MALE).

The most important criterion for definition of PAD is an ankle-brachial index (ABI) below 0.90. In practice, ABI measurements are rarely performed, unless claudication symptoms (a common symptom of PAD) have been mentioned by the patient. The use of screening questionnaires enables the identification of some symptomatic patients, but these are time consuming and not established in routine primary care practice. As a result, PAD remains an underdiagnosed silent killer.

The absence of simple and fast screening strategies to identify PAD contributes to the ongoing underdiagnosis.

A recent study published in *PLoS One* by the German Epidemiological Consortium of Peripheral Arterial Disease examined whether asking a single question about claudication might be more effective than use of multi-item questionnaires. The question is this: “Do you get a pain in either leg on walking?”

Using data from 7 population-based cohorts, the team used a random effects meta-analysis to examine the pooled results of data from 27,945 individuals (14,052 women, age range 20–84 years). Participants were included if they had valid data on claudication, ABI, and covariates.

### Findings:

- One question about claudication can identify individuals with a high likelihood of low ABI.
- The sensitivity of the single-item



questionnaire was 23.6% compared to 11.8% and 9.8% for the 5- and 6-item questionnaires respectively.

- The specificity of the single-item questionnaire is slightly lower, 93.3%, than those of the longer questionnaires, 98.6% and 99.1% respectively.
- The sensitivity of the single-item questionnaire increases as age increases
  - Sensitivity among adults 55–65 years old = 28.5% [22.5, 35.1]

- Sensitivity among adults > 65–74 years old = 32.6% [27.3; 38.2]

The authors recommend using this single, simple question as a first screening step in all patients who are at least 40 years old, as PAD prevalence already reaches 5% at this age in both women and men in high-income countries. If individuals answer “yes,” the next step should be an ABI measurement.

While a primary ABI screening in this group of patients would be preferable, it is

Age Group	35 to 74 Years	
	Sensitivity	Specificity
1-item questionnaire	23.6% [20.6; 26.8]	93.3% [92.9; 93.7]
5-item questionnaire	11.8% [9.6, 14.3]	98.6% [98.4; 98.8]
6-item questionnaire	9.8% [7.8, 12.2]	99.1% [98.9; 99.2]

**NOTE:** All questionnaires included the question: “Do you get a pain in either leg on walking?”

Continued on page 14

“...if we manage to motivate general physicians to ask their patients one question about claudication and thereby identify 20–30% of patients with mild PAD, this will be a huge step forward in comparison to the present situation, in which the percentage of patients with mild PAD recognized in general practices is close to zero.”

currently not feasible due to reimbursement issues.

The authors conclude, “...if we manage to motivate general physicians to ask their patients one question about claudication and thereby identify 20–30% of patients with mild PAD, this will be a huge step forward in comparison to the present situation, in which the percentage of patients with mild PAD rec-

ognized in general practices is close to zero.”

One question asking about pain in the leg(s) during normal walking could easily be integrated in the ascertainment of a routine medical history.

PAD awareness would be significantly improved if many patients could be identified by a single question of a general practitioner. 

*Adapted from: Kieback AG, Espinola-Klein C, Lamina C, et. al. One simple claudication question as first step in Peripheral Arterial Disease (PAD) Screening: A meta-analysis of the association with reduced Ankle-Brachial Index (ABI) in 27,945 subjects. PLoS ONE. 2019;14(11): e00224698.*

## Science Meets Fun on National Biomechanics Day: April 8, 2020

National Biomechanics Day (NBD) is a worldwide celebration of biomechanics in its many forms for middle- and high-school students and their teachers. Designed to introduce biomechanics science and its applications to young minds around the world, the event seeks to teach young people about all that biomechanics contributes to society with the hope of encouraging them to pursue it as a career.

Indeed, biomechanics helps people and it improves the quality of human life by making contributions to basic biology, medicine and health, human and animal movement and performance, biomedical engineering, prosthetics and human-machine interactions, among many other endeavors. It is a natural fit in STEM and STEAM learning (science, technology, engineering, art, math) and provides career potential including practical applications in commercial, medical, industrial, and other settings.

Now sponsored by the non-profit, The Biomechanics Initiative, the goal of NBD is to take biomechanics outside and say, “Hello World, this is Biomechanics!”

To learn more about how you can participate in local events or what has happened over the last 4 years, check out the new website, [thebiomechanicsinitiative.org](http://thebiomechanicsinitiative.org). 



**The Internationalization of National Biomechanics Day**

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## Study Shows Heel Lifts Affect Biomechanics, Muscle Function

Clinicians use a variety of in-shoe heel lifts to treat a range of musculoskeletal conditions. The mechanics of how these orthotic devices work, however, is unclear. So a group from LaTrobe University in Australia put together a study that asked this question: Do heel lifts affect lower limb biomechanics and muscle function during walking and running?

“There is currently a lack of evidence for the effectiveness of heel lifts and the mechanism by which they exert their therapeutic effect,” said lead author Chantel Rabusin, a director at Melbourne Podiatry Group and a PhD candidate at LaTrobe University, in an email to *LER*. “Our review synthesized reported findings and summarized the effects of heel lifts on lower limb biomechanics and muscle function.”

In their systematic review, the group started with 1,483 citations, assessed 801 articles for inclusion and ultimately examined 23 studies with a total of 377 participants. The studies looked at the effects of heel lifts on the following parameters: temporospatial, kinematic, kinetic, muscle function, and plantar pressures during walking and running in both asymptomatic and symptomatic participants. One key challenge was the wide range of protocols used by the various studies to examine walking speed.

While a large number of parameters were assessed across the numerous studies, few findings were statistically significant. Findings with significance include:

- In asymptomatic participants
  - o heel lifts of 10mm decreased duration of swing phase (standardized mean difference [SMD] = -1.3)
  - o heel lifts of at least 5cm decreased velocity (SMD = -0.93) during walking
  - o heel lifts of 15mm decreased maximum ankle dorsiflexion angle (SMD = -1.5)
  - o heel lifts of 12mm and 18mm decreased gastrocnemius muscle tendon unit length (SMD = -0.96) during running
- In participants with restricted ankle joint dorsiflexion, heel lifts of 6mm and 9mm increased medial gastrocnemius electromyography amplitude (SMD between 0.68 and 0.98) during walking
- In participants with hemophilia, heel lifts of 9mm increased ankle joint maximum range of motion (SMD = 1.6) during walking

Overall, the group found that heel lifts affect specific lower limb biomechanical and muscle function parameters during walking and running. See the Figure for a graphic summary of their findings.

“These parameters may be favorable in the management of disorders of the posterior lower limb,” said Rabusin. “This information is clinically relevant and will assist in clinical reasoning for the use of heel lifts in the prevention and management of lower limb musculoskeletal conditions.” 

**Source:** Rabusin CL, Menz HB, McClelland JA, et al. Effects of heel lifts on lower limb biomechanics and muscle function: A systematic review. *Gait Posture*. 2019;69:224-234.

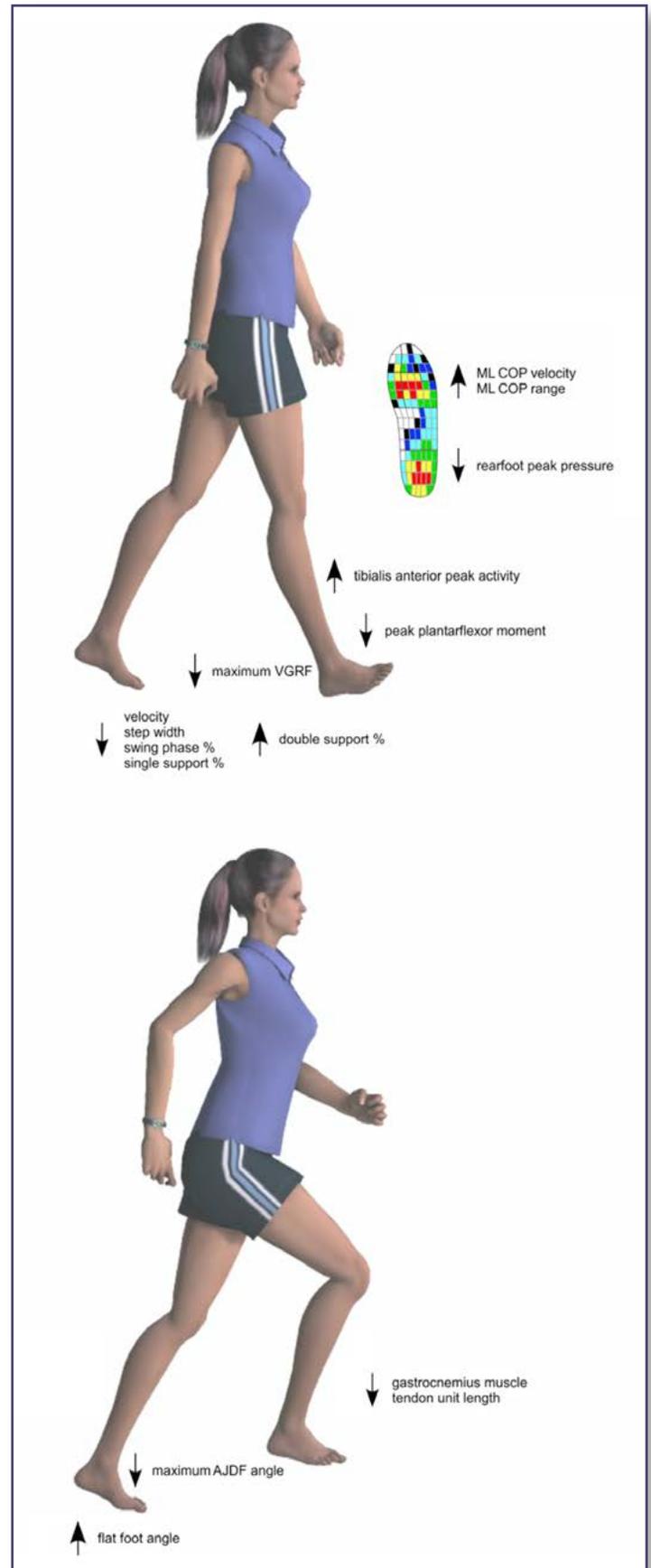


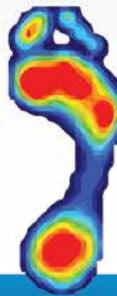
Figure. Pictorial summary of key findings.

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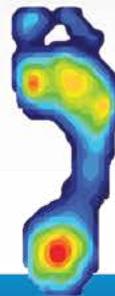
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# 1064-nm Laser Technique Shows Positive Results for Onychocryptosis

BY KEITH LORIA



Onychocryptosis, more commonly known as in-grown toenail, affects nearly 20% of all patients who present a foot problem to their doctor. Current treatments include incisional procedures and nonincisional procedures, such as chemical matrixectomies and physical matrixectomies using a carbon dioxide laser. Treatment innovations have been slow, with some current standards of care dating back to the 1940s, which is why there's rising interest in a new way to treat this recurrent problem.

In the past, the 1064-nm laser was used as a treatment for plantar warts and nail matrixectomies, so it seemed logical that it could be used for onychocryptosis.

Lluís Castillo Sánchez, master in surgical podiatry and professor of chiropodology and podiatric surgery at UManresa, led a study by Barcelona University to determine if the 1064-nm laser technique would be a good fit for onychocryptosis.

"The genesis of this study is that the laser 1064-nm was being used for a long time for the treatment of fungic infections of the nails, so we thought that also this laser could be effective for the matrixectomy in the nail surgery," Sánchez told *LER* by email. "Our goals were to describe this new procedure and its effectiveness, comparing also with one of the most used procedures in nail surgery like the fenol-alcohol technique."

In the publication, "Onychoplasty with 1064-nm Laser: Matrixectomy for Treatment of Ingrown Toenails," which was recently published in the *Journal of the American Podiatric Medical Association*, the authors provide details for the surgical onychoplasty using a physical matrixectomy with a 1064-nm laser applied by means of a 400-µm optical fiber and surgical removal of the posterior cauterized tissue to achieve healing by primary intention.

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- ✓ REITERATE
  - At the end of a consultation there may be info overload. Ensure you review everything in simple, easy to understand terms (the WHAT, WHEN, WHY & HOW) and the plan moving forward.
  - Ask the patient to explain the above back to you and then you fill in any information gaps that remain.

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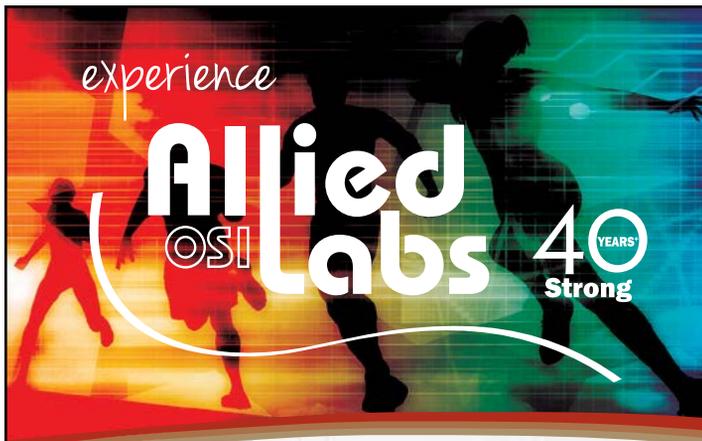
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Continued from page 19



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Sánchez explained the parameters studied were post-surgical pain (using the Visual Analog Scale [VAS]), infection, and inflammation and recurrence at 6 and 12 months post-procedure. The patients, who were from multiple centers, were randomized.

“We had 30 patients in the study (60% male and 40% female, with an average age of 32.4 years), and four variables were followed,” Sánchez said. “Looking at postoperative pain, 97% of patients reported having mild pain (VAS, 2-3), 3% reported having moderate pain (VAS, 5-6), and there was no case of severe pain.”

The second variable, postoperative infection, was reported in 5.3% of patients. Postoperative cicatrization time averaged 10 to 12 days for all patients.

“Our fourth variable was postoperative recurrence, and we saw no case of recurrence during the 12-month follow-up, although we will consider enlarging the sample in future studies,” Sánchez said.

He noted that the findings showed the 1064-nm laser technique decreases postoperative pain compared with previous methods and also provides a shorter postoperative period for patients, leading to a quicker return to daily routines when compared with incisional procedures, chemical matrixectomies, and carbon dioxide laser treatments.

“Our major takeaway is that this new procedure is very effective with a less post-surgical time than other techniques, with less pain and less recurrence,” Sánchez said. “So, this is a new application of this 1064-nm laser, and the clinicians can apply easily if they have this 1064-nm laser available to them.”

With the study showing positive results, the researchers are next planning to compare this technique with other procedures in more case series. <sup>(ler)</sup>

*Keith Loria is a Washington, DC-based freelance writer.*

*Source: Sánchez LC, Zalacaín-Vicuña AJ. Onychoplasty with 1064-nm Laser: Matrixectomy for Treatment of Ingrown Toenails. J Am Podiatr Med Assoc. 2019;109(5):401-406.*

## Custom AFO With Walking Shoes Improves Balance, Reduces Fear of Falling for Seniors

Research shows that one out of every four older Americans falls annually. Fall-related injuries continue to be a costly and debilitating health risk, costing the US healthcare system about \$50 billion annually. More importantly, falling once doubles an older adult's risk of falling again, increasing their fear of falling and negatively impacting quality of life.

To address this growing public health challenge, researchers from the Baylor College of Medicine and the Interdisciplinary Consortium on Advanced Motion Performance (iCAMP) sought to evaluate the effectiveness of daily use of bilateral custom-made ankle-foot orthoses (AFOs) on balance, fear of falling, and physical activity in older adults with concern about or at risk for falling. Their results, published in the journal *Gerontology*, show that daily use of custom-made AFOs and walking shoes are a core element in improving balance in seniors at risk for falls. The research found the use of the Moore Balance Brace (Arizona AFO, Mesa, AZ), a custom-fabricated light-weight, flexible therapeutic brace, can have a positive impact on stability and minimize the fear of falls.

The 6-month randomized controlled trial examined 44 seniors (age  $75.6 \pm 6.5$  yrs) who had concerns about or exhibited a risk of falling. A control group was provided with custom-fitted walking shoes (New Balance, Boston, MA). An intervention group was provided custom-fitted walking shoes and bilateral custom-made AFOs (Moore Balance Brace, Arizona AFO, Mesa, AZ).

Results highlighted the increased stability and confidence participants of the intervention group experienced—for example:

- Daily use of bilateral custom-made AFOs plus walking shoes reduced upright standing postural sway by 54.9% at 6 months compared to baseline and compared to walking shoes alone
- Participants using the AFOs in daily life reported a decreased fear of falling
- Physical activity increased amongst participants due to reduced fear of falling
- ~80% of participants perceived the AFOs to be “useful” when paired with walking shoes, an important indicator of patient acceptance and compliance. (ler)

*Source: Wang C, Goel R, Rahemi H, Zhang Q, Lepow B, Najafi B. Effectiveness of Daily Use of Bilateral Custom-Made Ankle-Foot Orthoses on Balance, Fear of Falling, and Physical Activity in Older Adults: A Randomized Controlled Trial. Gerontol. 2019;65(3):299-307.*

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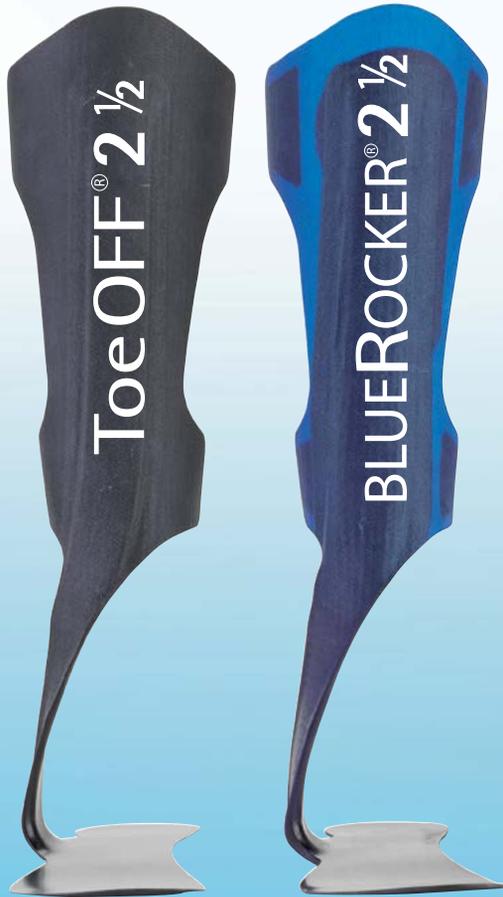
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# WHITE PAPER

# Foot Pronation

BY BENNO NIGG, ANJA-VERENA BEHLING, AND JOSEPH HAMILL

Over the past decades, pronation has been discussed as a potential risk factor for injuries or as the mechanism behind impact damping. However, little is understood about pronation. The objectives of this paper were to (a) define and differentiate between the terms of pronation and eversion, (b & c) underline the importance and problematic aspects of pronation.

The terms of pronation and eversion have often been used interchangeably in previous work. Both metrics describe rotations about two different axes of the foot. Due to the inaccessible location of the talus bone, mainly variables measuring eversion have been used to approximate the actual movement of pronation. However, the variety of surrogate variables does not facilitate the understanding of such particular foot

movement. Since pronation is natural and it is necessary to successfully perform dynamic tasks such as running, normative values were developed for most pronation-associated variables. However, the optimal amount of pronation remains unknown. Furthermore, various aspects of pronation are widespread among researchers and clinicians. Despite their popularity, they are mis- or not well understood such as the impact damping paradigm and its link to running injuries. Especially, the exclusive causality between pronation and running injuries has been shown in neither cross-sectional nor longitudinal study designs with sufficient sample sizes. Therefore, it seems important to reconsider the topic of pronation from novel perspectives.

*Continued on page 24*

The quantification of pronation and supination in real-life situations, such as running, is difficult, if not impossible since the talus bone cannot be accessed from the outside.

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## Background

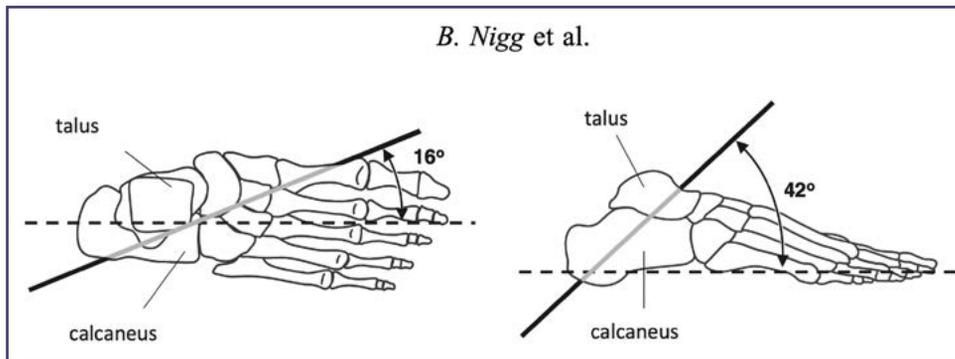
The objectives of this paper were to (a) define the terms of pronation/eversion and differentiate between, (b) underline the importance as well as (c) the problematic aspects of pronation.

The human foot consists of 28 bones, 33 joints, and more than 100 muscles, ligaments and tendons. The description of the movement of such a complex structure is complicated. The foot can be subdivided into rear foot, midfoot and forefoot.

In the past 40 years, biomechanical research has primarily concentrated on the rear foot. The rear foot has two major functional joints: the subtalar joint (ie, the joint between the calcaneus and the talus), and the talocrural or ankle joint (ie, the joint between the talus and the tibia). The ankle joint axis is close to a mediolateral axis through the ankle joint complex. The subtalar joint axis (Figure 1)<sup>1</sup> is a line pointing from the ground surface on the posterior and lateral side of the foot toward the medial anterior side of the foot and inclined by about 42 degrees.<sup>2</sup> The rotations about the subtalar joint axis are defined as pronation and supination:

- Pronation is the inward rotation of the rear foot about the subtalar joint axis.
- Supination is the outward rotation of the rear foot about the subtalar joint axis.

The quantification of pronation and supination in real-life situations, such as running, is difficult, if not impossible since the talus bone cannot be accessed from the outside. For this reason, scientists, athletes and clinicians have introduced variables with the goal to describe pronation-like movements in real-life situations. The most common ones are the rear foot angle<sup>3-5</sup> and Achilles tendon angle,<sup>6,7</sup> which can be seen in Figure 2.<sup>1</sup> Publications use these definitions inconsistently and might refer to the Achilles tendon angle as rear foot angle which appears to be the most often used term.<sup>8,9</sup> Many more variables were linked to pronation, such as the longitudinal arch angle<sup>10</sup> and Foot Posture Index.<sup>11</sup> However, these variables quantify movement about 'clinical axes' that are not the real physical anatomical axes. The most common clinical one is the longitudinal foot axis, which corresponds to the dotted



**Figure 1.** The subtalar joint axis is indicated by the solid line and the clinical longitudinal axis by the dotted line (adapted from Nigg,<sup>1</sup> with permission).

line in Figure 1. Rotations about this axis were used as surrogate variables for foot pronation (= foot eversion) and supination (= foot inversion) using the following definitions:

- Eversion is an inward rotation of the foot with respect to the longitudinal foot axis.
- Inversion is an outward rotation of the foot with respect to the longitudinal foot axis.

## Important Aspects of Foot Pronation

### Natural movement

Pronation and supination are normal and necessary components of the gait cycle to stabilize the foot during dynamic tasks.<sup>12-14</sup> During locomotion, whenever the foot contacts the ground, pronation occurs during the first 40–50% of foot contact.

### Is there an optimum degree of pronation?

As in any natural movement, the pronation movement should have an optimum, which is specific to each individual. There is no concrete indication, what this optimum might be. Too little or too much pronation may be a disadvantage. However, substantial movement in this area of the foot does not appear to be something of concern.

## Problematic Aspects of Foot Pronation

### Surrogate variables

A recent review of the literature found a total of 62 surrogate variables that have been used in scientific publications, all claiming to quantify something like pronation.<sup>15</sup> The same study also

found that these surrogate pronation variables were not correlated with each other except for internal correlations (correlations of the same variables at different time points). Consequently, these variables describe various different aspects of foot movement and may or may not be associated with actual foot pronation.

### Impact damping

Pronation of the foot has often been described as a method to damp the impact shock during walking and heel-toe running. This 'functional description' is inappropriate since the impact phase is completed at approximately 40–50 ms after heel strike, while the pronation (eversion) position has its maximum at about 150–200 ms in running and at about 250–350 ms in walking. This begs the question: How could something that happens much later during ground contact damp the impact, which happens early in the ground contact?

### Running injuries

'Excessive pronation' has often been associated with running injuries particularly overuse injuries. The terms 'over-pronation', 'hyper-pronation' or 'excessive pronation' have often been used in literature when describing injury risks in running (eg, James, Bates, & Osternig<sup>16</sup>). The actual mechanisms how the injury occurs due to 'over-', 'hyper-' or 'excessive' pronation is not well understood,<sup>17</sup> although several theories have been suggested. One major problem with the term 'over-pronation' is that there is no clinical definition.<sup>18</sup> The 'normal' degree of pronation is unknown: therefore, it is impossible to deter-



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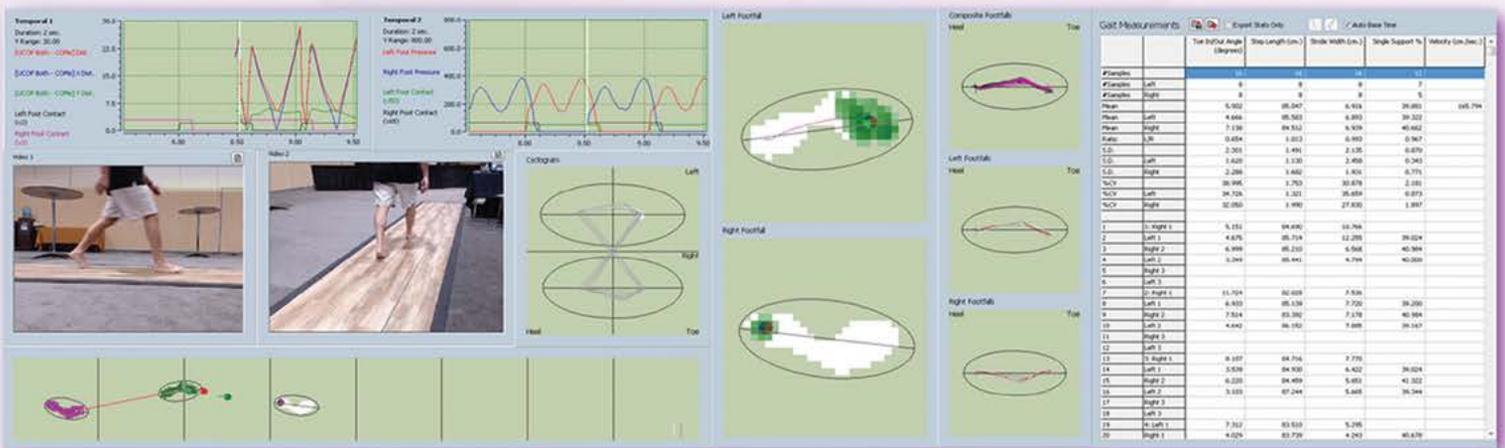
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mine what is in excess of 'normal'. Furthermore, pronation velocity has been discussed as a potential indication of an increased injury risk;<sup>19,20</sup> however, the findings regarding this variable are inconsistent<sup>19-22</sup> and epidemiological evidence is missing.

One reason pronation has been linked to the development of running injuries is the coupling between the rearfoot and the tibia. Foot pronation (eversion) produces an internal rotation of the tibia. Very high foot pronation (depending on the coupling) may result in a high internal rotation of the tibia, which may create problems at the knee of the athlete.<sup>23-25</sup>

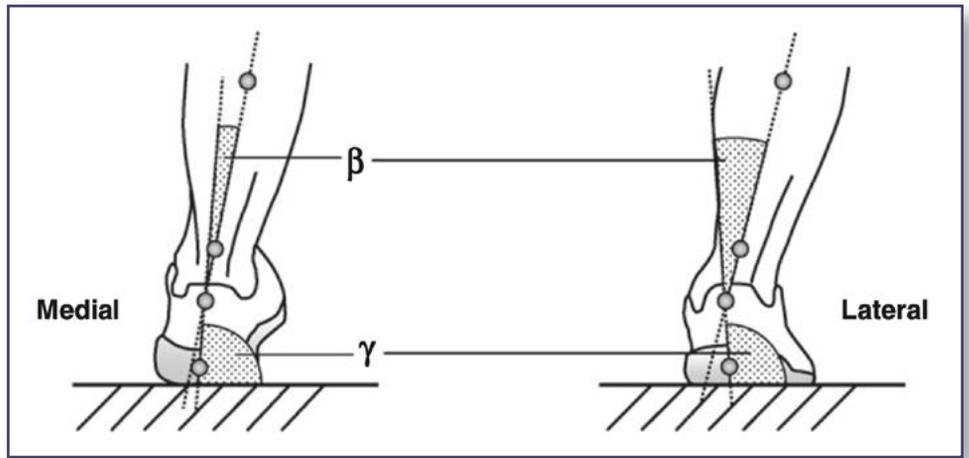
While it is appealing to associate 'over-pronation' or 'over-eversion' with an increased risk of injury, the results of the epidemiological and empirical scientific literature on this topic are inconsistent. Since it has been shown that pronation-variables are not correlated to each other, inconclusive results based on different methodologies (variables) are not surprising. The scientific support for a link between the magnitude of pronation and injury is weak. A major problem in the biomechanical studies of pronation and running injuries is that most studies have a small number of participants. Therefore, it is difficult to make generalizations about the relationship. In the past decade, more studies have refuted the association of 'over-pronation' and risk of injury.<sup>26-28</sup> In fact, Hintermann and Nigg<sup>29</sup> reported that between 40% and 50% of runners who 'over-pronate' are not at risk for overuse injuries. Thus, it could be that pronation may have an effect on certain injuries. However, pronation may not be the only factor influencing injury development.

## Final Comments

(1) Pronation is a natural movement of the foot, which corresponds to a term that is widely used, but not well understood. Pronation is often associated with running injuries; however, evidence for this association is weak.

(2) There is no clinical definition for 'over-', 'hyper-' or 'excessive' pronation. Thus, these terms should be avoided.

Many aspects of pronation are mis- or



**Figure 2.** While the actual movement in the ankle joint complex is foot pro- and supination, the literature quantified typically rear foot eversion,  $\gamma$ , or the Achilles tendon angle,  $\beta$ , when talking about foot pronation. This is what we see when looking from behind at an athlete running (adapted from Nigg,<sup>1</sup> with permission).

only partially understood. Therefore it seems important to reconsider the topic of pronation from different and novel perspectives to answer questions regarding injuries and their relationship with pronation. (ler)

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## ORTHOTICS AND PRONATION CONTROL

BY ROBERT WEIL, DPM

Prescription in-shoe orthotics have proven to be a major weapon in the treatment and prevention of foot-related ankle and knee problems that are often related to excessive or hyper foot pronation. Custom orthotics, optimally prescribed from neutral joint position plaster casts, (although not exclusively—scans are also used), have various uses and indications. As mentioned, controlling excessive pronation is a key one, as is to redistribute weight, or help enhance alignment.

A common misconception is that orthotics are “arch supports.” Proper custom devices do much more than support-like acting; they serve as positioning devices to get the foot in the right position during the various phases of gait.

Basically, the foot has three jobs in walking and running:

- Shock absorption when the foot hits the ground,
- Ground accommodation or shaping to the surface of the ground in stance, and
- Pushing off or propulsion.

Each of these actions demand particular motions of the foot itself as well as rotational motions of the lower and upper legs. These are complex motions taking place in the joints of the foot and lower ankle: three motions in three directions simultaneously.

It is important to understand that pronation (the outward rolling of the sole of the foot) and supination (the inward rolling of the sole of the foot) are NORMAL motions.

Problems can arise when the timing, velocity, or amounts of pronation or supination are off, often causing an individual to push off of an unstable foot, thereby straining the supporting muscles, tendons, and ligaments, and hampering performance.

Various inherited foot types and leg shapes create common problems for these motions. Examples are flat, or hyper-pronated feet, high arches, bowed legs, knock knees, or limb length shortages. All these examples will cause abnormal pronation or supination factors. When these abnormal motions and positions of the foot occur, abuse, wear-and-tear, and overuse problems are seen. Conditions seen by clinicians everyday—arch and heel pain (plantar fasciitis), shin splints, Achilles problems, and knee problems—are often, when persistent, related to excessive pronation.

It is important to know that these foot imbalance problems are more common than uncommon. Over 75% of us exhibit some minor to major foot or leg alignment syndromes. It's not surprising then, with so many people being very active walkers, runners, golfers, etc., that overuse-type problems have sky-

rocketed to epidemic proportions. Persistent or recurrent problems are often warning signs that these foot-imbalance biomechanical factors should be examined by a podiatrist or sports-related physician or therapist.

Orthotics are made from different materials: I prefer flexible polypropylene almost exclusively. Often the demands of the particular sport or activity will be a big factor. Many athletes and parents will ask, “Are custom orthotics needed?” Better questions often are: Would they be beneficial? Will they help prevent injuries and enhance performance? Often the answer to both questions is Yes!

Once it is understood what the true role of custom devices is—to capture the optimum alignment and functioning position of the feet and lower legs and to enhance normal motion and position of the various segments of the foot and ankle—it makes sense to take them seriously, especially if you've had overuse problems.

By the way, strengthen those feet and ankles!

*Robert Weil, DPM, a 2019 National Fitness Hall of Fame inductee, is a sports podiatrist, radio host of the “The Sports Doctor” on bbsradio.com, and author of the book, #HeySportsParents!*



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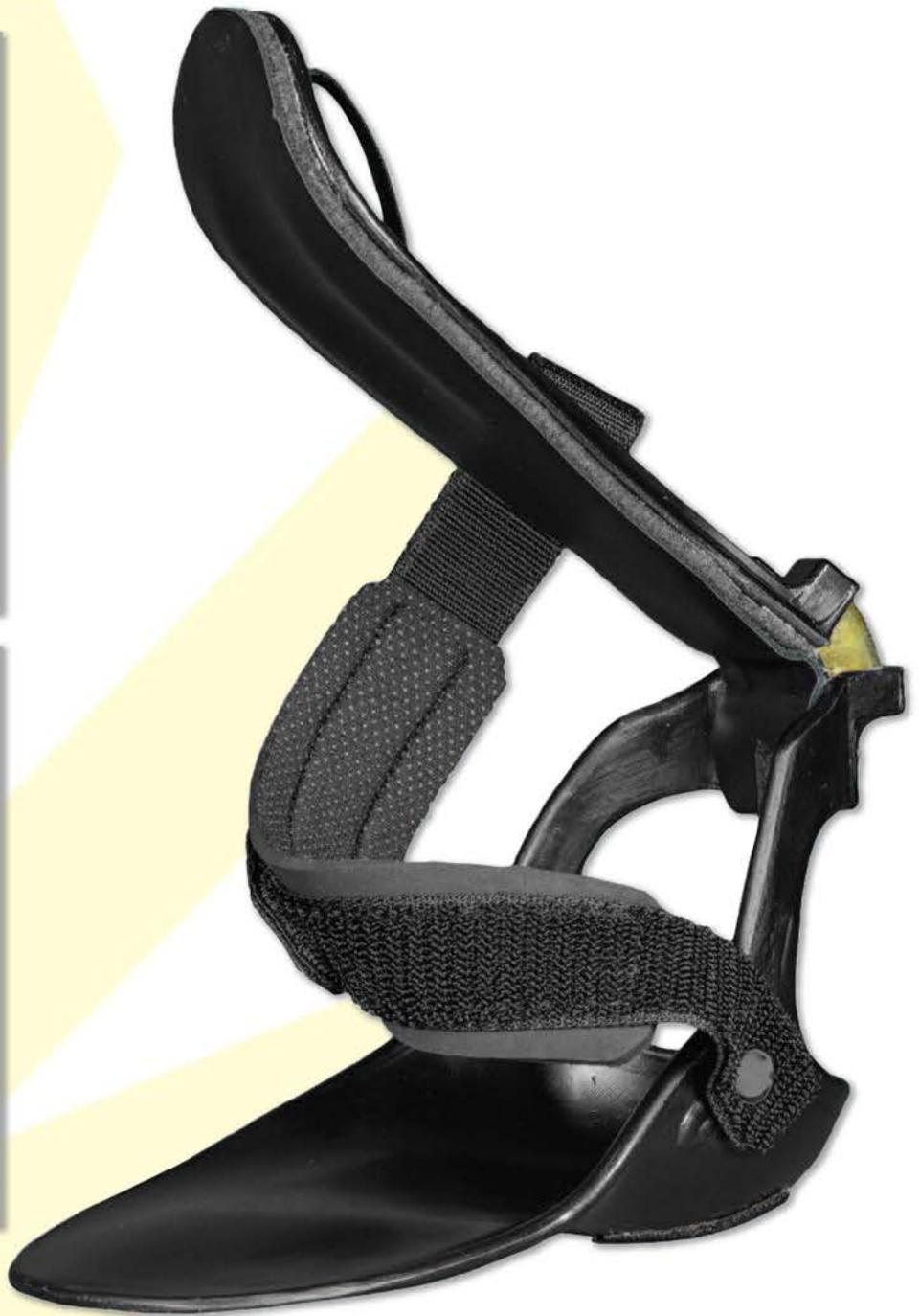
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# Tech Takes On Diabetic Foot Ulcers

DFCON2019\* showcased new technologies coming online to aid in the treatment and prevention of diabetic foot ulcers.

BY LYNN SOBAN, PhD, MPH, RN

Diabetic foot ulcers (DFUs) are the most common complication of diabetes. Up to a quarter of patients with diabetes will suffer at least one DFU in their lifetime which can lead to amputation or death.

These wounds are notoriously challenging to prevent and treat. Factors that contribute to this medical challenge include:

- Prevention requires tight control of blood glucose.
- Decreased sensation in feet results in development of DFUs from innocuous causes such as an ill-fitting shoe or a crease in a sock.
- Poor patient adherence to evidence-based practices for prevention and treatment including performing daily foot exams and adhering to offloading (Figure 1).
- Poor guideline adherence by clinicians to consistently perform annual foot exams for diabetic patients, even for high-risk patients.
- Peripheral artery disease, a common comorbidity among people with diabetes, raises the risk of infection, non-healing ulcers, and amputation.
- Once a patient develops a DFU, recurrence is very common: 40% chance

*\*This article is based on presentations from the Diabetic Foot Global Conference—DFCon 2019, which was held in Los Angeles in October 2019. The session, Sensors & Common Sensibility: A Romantic Notion or a Game Changer, was moderated by Bijan Najafi, PhD, and David G. Armstrong, DPM, MD, PhD. Presentations by the following authors are highlighted: Karen Cross, MD, PhD; Alberto Piaggese, MD; Nanshu Lu, PhD; Chiara Daraio, PhD; and Bert Van Hoof, Partner Group Manager of Azure IoT at Microsoft.*



**Figure 1.** Rates of patient-based foot screening. Data from Wallace D, Perry J, Yu J, Mehta J, Hunter P, Cross KM. Assessing the Need for Mobile Health (mHealth) in Monitoring the Diabetic Lower Extremity. JMIR Mhealth Uhealth. 2019;7(4):e11879. Published 2019 Apr 16. doi:10.2196/11879

of recurrence within one year and 60% chance within 3 years.

- Only 75% of DFUs heal which makes the possibility of a lower extremity amputation (LEA) a real and devastating consequence of a DFU.

Between 2009 and 2015, CDC reported a staggering 50% increase in LEAs. Even more grim is the fact that 75% of those who undergo a LEA will not survive 5 years. These LEA rates speak to the need to double down on prevention and early identification efforts. Use of technology to improve DFU prevention and treatment is rapidly gaining momentum and has the potential to be a game-changer for this intractable problem.

## Wearable Sensors and Remote Monitoring

Current practices for prevention and treatment of DFUs are hindered by gaps in patient self-management. Wearable sensors, which are among the most popular technologies developed to manage chronic conditions, target barriers

related to self-management. The development of wearable sensors to measure markers for development of DFU (temperature, oxygen saturation, and blood flow) has the potential to make the burden of self-management lighter and allow for early detection of DFUs.

“Adherence to offloading is a major reason for failure of DFU treatment”, said Bijan Najafi, PhD, Director at iCAMP (Interdisciplinary Consortium for Advanced Motion Performance) and Professor of Surgery, Baylor College of Medicine, Houston, Texas. “Sensors embedded in offloading devices such as shoe insoles are now able to provide real-time feedback and alerts to patients about their adherence to offloading; these can help us to tackle one of the most challenging barriers to DFU treatment.”

Another way that wearable sensors can revolutionize DFU prevention and treatment is through their use in remote monitoring. Increasingly, wearable sensors are able to transfer data to another machine through the use of cloud-based platforms such as Microsoft Azure. The availability of cloud-based platforms

Continued on page 34

has made the computing resource requirements for remote monitoring available and affordable. This was no small feat: a major barrier to remote monitoring was the prohibitive cost of computing power.

“By allowing creators of applications to build, manage, and deploy their apps on a highly secure, scalable network, Microsoft Azure has the power to democratize startups for chronic disease management such as DFUs,” explained Bert Van Hoof of Microsoft.

It’s anticipated that wearable sensors and remote monitoring will be able to improve DFU prevention and treatment through several means:

- Improve adherence to daily foot checking by making it easier, faster, and more accurate which can lead to earlier detection of DFUs.
- Equip providers with remote monitoring capability to track patients more closely and detect DFUs at an earlier stage, possibly even before they are visible.
- Promote patient adherence to offloading and activity restrictions by providing real-time prompts to patients and caregivers, thus reducing healing time.
- Serve as educational devices that provide patients with insights into their disease management behaviors, thus reinforcing patient education.
- Increase patient engagement with prevention and treatment regimens through “gamification.”
- Facilitate communication between provider and patient (eg, about treatment plan, patient compliance, or need for office visit).
- Facilitate home care and decrease the need for hospitalization.

A variety of sensors specific to DFU detection are both under development and on the market.

## NEW TECHNOLOGY FOR DFU PREVENTION

**SmartMat.** Before diabetic foot ulcers develop, inflammation is present and can be detected

“Sensors embedded in offloading devices such as shoe insoles are now able to provide real-time feedback and alerts to patients about their adherence to offloading; these can help us to tackle one of the most challenging barriers to DFU treatment.”

**Bijan Najafi, PhD**

by measuring foot temperatures. The daily remote temperature monitoring foot mat (Figure 2; SmartMat™; Podimetrics, Somerville, MA, USA) uses infrared thermometry to measure plantar foot temperatures and transmits the data automatically to the Podimetrics care team, who triage any concerning findings and help patients receive appropriate, preventive treatments under the direction of their clinician. (See “Unilateral remote daily temperature monitoring to predict diabetic foot ulcers shows promise,” Lower Extremity Review, September 2019, pg 13-14.)

Features of SmartMat:

- Takes only 20 seconds to use and can

help patients easily measure daily foot temperatures at home.

- Able to detect a DFU an average of 37 days before it presents which allows for early intervention.
- Equips providers with remote monitoring capability which allows them to more closely monitor patients, detect potential and actual DFUs earlier, and promptly initiate a care plan.

[**Editor’s Note:** The promise of this device for high-risk populations such as Veterans has resulted in early adoption of this device by the US Veteran’s Administration (VA). In December 2019 the VA announced that the Podimetrics SmartMat™ is in use at 15 VA medical centers and will be available to all veterans across the country through local Prevention of Amputations for Veterans Everywhere clinic providers.]

## NEW TECHNOLOGY FOR DFU PREVENTION AND TREATMENT

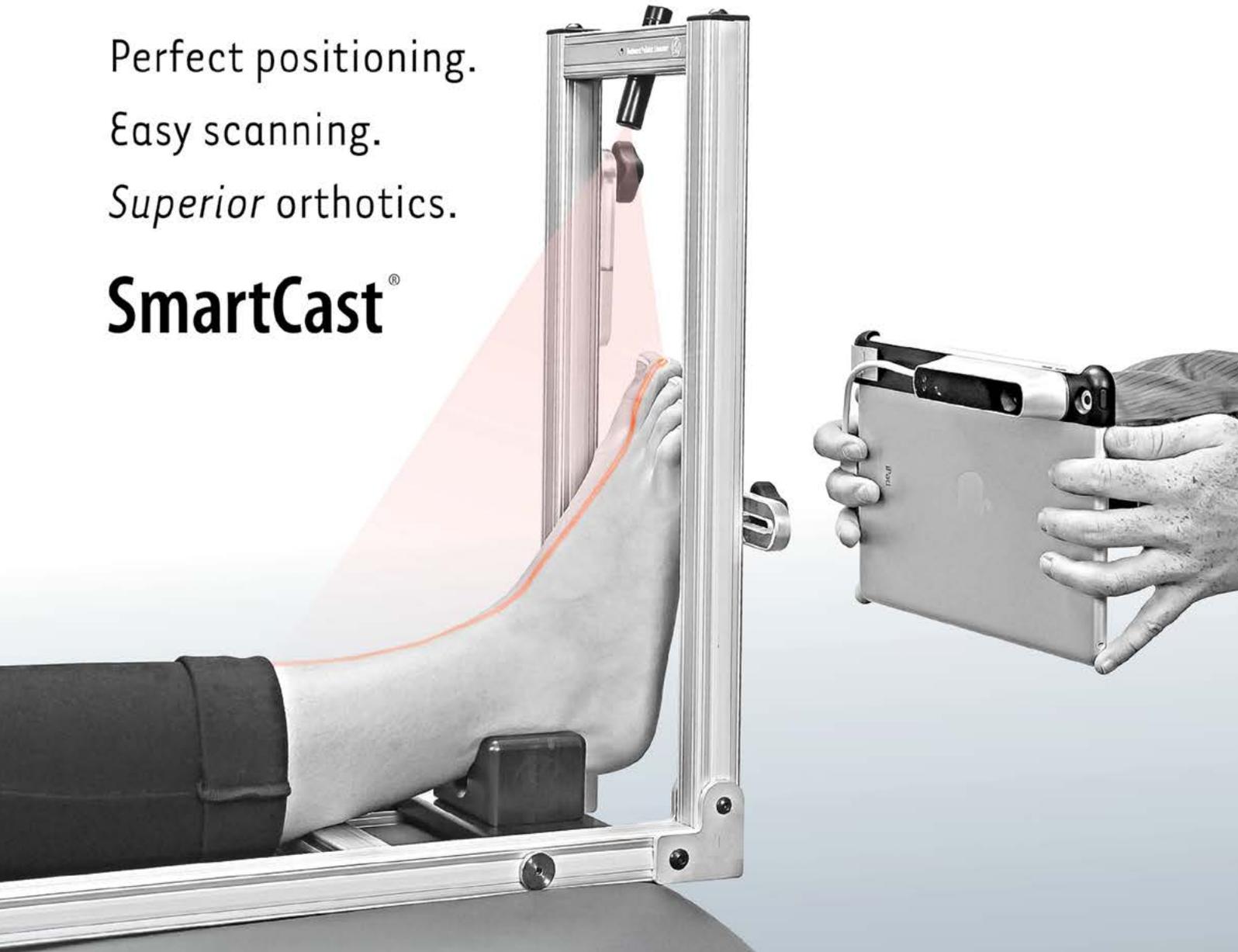
**MIMOSA.** Another emerging technology, developed by Canadian physician researcher Karen Cross, PhD, MD, and her team at St. Michael’s Hospital in Toronto, is a state-of-the-art mobile health platform that uses optical imaging and



**Figure 2.** The SmartMat is a remote temperature monitoring foot mat certified as a “high-traction” product by the National Floor Safety Institute and legally marketed in the USA as a class I medical Device. Photo is courtesy of the manufacturer, Podimetrics, Somerville, Massachusetts.

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# “To see consumer electronics merging with medical devices like never before is really a great leap forward.”

**David Armstrong, DPM, MD, PhD, Professor of Surgery and Director, Southwestern Academic Limb Salvage Alliance at Keck School of Medicine, University of Southern California, Session moderator and Co-Founder of the DFCon—Diabetic Foot Global Conference.**

artificial intelligence (AI) to non-invasively assess tissue health.

MIMOSA (which stands for **M**ultispectral **M**obile **t**iSsue **A**ssessment device) uses near-infrared imaging to detect key indicators of tissue health such as the oxygen saturation of foot tissue and areas of poor circulation. This small and portable camera-device integrates with a smartphone and can image the skin with near infrared light. The resulting image (Figure 3) can be used in both the prevention and treatment of DFUs.

Cross' impetus for creating MIMOSA is personal: a close relative lost a limb to diabetes. She underscored the potential impact this device can have, “Three million Canadians are living with diabetes—even more globally—and our device has the potential to help every single one of them.”

Features of MIMOSA:

- It is easy to use.
- The device does not touch the skin and will not interfere with wound healing.
- It can be used on a foot with active wounds to assess healing and can be used to monitor the non-affected foot during treatment to prevent development of a new wound.

## WEARABLE SENSORS TO HELP WITH OFFLOADING

Patients with an active DFU or those with a history of a DFU are often prescribed footwear or casts to reduce pressure on the affected area of the foot. Poor adherence to the offloading provided by these devices is a major reason for failure in wound management. During the first

2 weeks of healing walking just 1000 steps per day decreases the rate of healing by 5.2% a day.

**Motus Smart Boot.** Alberto Piaggese, MD, from the University of Pisa, Italy, described the Motus Smart Boot (Figure 4), an offloading device equipped with sensors that monitor patient adherence to clinician recommendations on movement and provides continuous, remote monitoring of patients recovering from DFUs. This device is the result of a collaboration between Optima Molliter (Civitanova, Italy), a leading orthopedic medical footwear manufacturer, and Sensoria Health (Redmond, Washington) a leader in embedded sensors and mobile applications for remote monitoring.

The Motus Smart Boot is the first technology specific to DFU prevention and treatment that uses Microsoft Azure Cloud technologies. By applying AI algorithms to the sensor data, alert messages can be transmitted via text messages to patients, caregivers, and clinicians.

Features of the Smart Boot:

- Can be used for both prevention and treatment of plantar DFUs.
- Provides positive reinforcement and can alert patients to their non-compliance including time standing, walking, and wearing the device.
- Can be made non-removable, if desired.
- Efficacy is on par with total contact casting, the previous gold standard for DFU treatment.

In addition to privacy protections, the Smart Boot integrates with HL7 interoperability standard-compliant hospital EMR systems.

Starting in 2020, Medicare will reimburse clinicians who use the Motus Smart Boot

system to improve outcomes and reduce the risk of amputation. The coverage is approximately \$122/member per month (See “Reimbursement for Remote Monitoring,” page 38).

Microsoft's Van Hoof presented a back-of-the-envelope estimation of reimbursement for the Smartboot: “A primary care physician with an average number of Medicare patients could



**Figure 3.** MIMOSA, a Multispectral MOBILE tiSsue Assessment device that uses near-infrared imaging to detect key indicators of tissue health (eg, oxygen saturation, blood circulation), provides a read-out that can be used to monitor and manage the development of diabetic foot ulcers. Photo is courtesy of the manufacturer, MIMOSA Diagnostics, Toronto, Ontario, Canada.

Continued from page 38

generate \$200,000 per year if 20% of all eligible Medicare patients consented to remote monitoring.”

## ON THE HORIZON

**Chiara Daraio, PhD**, of the California Institute of Technology is pioneering development of plant-based sensors that are stretchable and can be embedded in fabrics. Developed from pectin, a sugar molecule found in the cells of apples and other fruits, these devices capitalize on plants’ extraordinary sensitivity to temperature which results in a sensor that can measure and map temperature in real time. Given the importance of temperature monitoring in early detection and prevention of DFUs, plant-based sensors may someday be used in wearable devices to prevent DFUs.

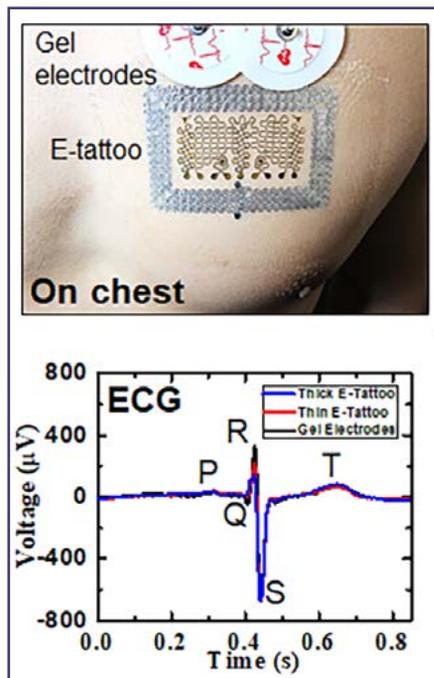
**Nanshu Lu, PhD**, and a team of researchers at University of Texas are



working on epidural electronics, also known as “e-tattoos”. These thin, light weight, graphene-based wearables are made of polyvinylidene fluoride, a polymer that’s capable of generating its own electric charge. E-tattoos are under pre-clinical trial for use in electrocardiograms (Figure 5). Another possible application of this technology is using e-tattoos to promote wound healing; by sending a microcurrent through the wound the e-tattoo could be used to kill bacteria, enhance protein synthesis and cell reproduction. This application has not yet been tested in humans, but lab work is underway and shows promise. 



**Figure 4.** Motus Smart Boot is an offloading device with interchangeable insoles (Optima Milliter boot) equipped with the Sensoria Core patient mobile app which provides continuous remote patient monitoring capabilities. Photo is courtesy of the manufacturers, Optima Molliter and Sensoria Health.



**Figure 5.** Studies are in the works to see if e-tattoos may be used to promote wound healing in diabetic foot ulcers. Photo is courtesy of Nanshu Lu, PhD.

## REIMBURSEMENT FOR REMOTE MONITORING

- Remote monitoring has the potential to extend patient care beyond hospital walls, to reduce hospital admissions, and to improve management of chronic diseases such as DFUs.

- Lack of reimbursement by insurance programs and health ministries has been a key barrier to availability and use of remote monitoring to prevent DFUs.

- As of January 1, 2020, the Centers for Medicare and Medicaid (CMS) will cover remote monitoring for devices including the MOTUS Smart Boot.

- Four CPT codes are available for remote patient monitoring (RPM):

- ✓ CPT code 99453: Remote monitoring of physiologic parameter(s) (eg, weight, blood pressure, pulse oximetry, respiratory flow rate), initial; set-up and patient education on use of equipment. (This covers onboarding a new patient onto an RPM service.)

- ✓ CPT Code 99454: Device(s) supply with daily recording(s) or programmed alert(s) transmission, each 30 days. (This covers initial supply and daily recording or programmed alert transmission for a 30-day period for remote devices measuring the same physiologic factors as code 99453.)

- ✓ CPT Code 99457: Remote physiologic monitoring treatment management services, 20 minutes of clinical staff/physician/other qualified healthcare professional time in a calendar month requiring interactive communication with the patient/caregiver during the month. (This covers remote monitoring and management of physiologic conditions, including 20 minutes per month of staff time requiring interactive communication with the patient or caregiver. This cannot be billed concurrently with 99091.)

- ✓ CPT Code 99458: Remote physiologic monitoring treatment management services, 20 minutes of clinical staff/physician/other qualified healthcare professional time in a calendar month requiring interactive communication with the patient/caregiver during the month. (This can be used for an additional 20 minutes of staff time requiring interactive communication with the patient/caregiver.)

- Hopefully, these trends will spread to insurance companies and other public insurers so that use of remote monitoring will become more common.



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# Lymphedema of the Lower Extremities

Often overlooked, lymphedema of the lower extremities is becoming more common as aging, obesity, and cancer therapies all take their toll. Detection is key to getting appropriate treatment.

BY STANLEY G. ROCKSON, MD

Lymphedema of the lower limbs is a common, complex, and highly treatable disease that begs recognition by healthcare providers. This debilitating disorder has profound psychological, social, functional, and health implications for the affected individual and it has been far too frequently neglected or overlooked within the healthcare environment. If we acknowledge that the predisposing factors to lymphedema include, most commonly, cancer, chronic vein disease, obesity, and infection, it is readily comprehensible that lymphedema is a disease that is very common and that its prevalence is likely to increase significantly over the next decade.

Before considering the clinical attributes of lower limb lymphedema, it is appropriate to define terms. Lymphedema is a pathology that presents whenever the lymphatic vascular system is intrinsically abnormal in its development or function. This form of the disease, called primary lymphedema, can appear throughout life, although 25% of the cases appear at birth or shortly thereafter. Primary lymphedema,



**Figure 1.** Lymphedema of the right leg. All clinical photos in this article are courtesy of the author.

ascrivable to inborn errors of structure or function, represents the smallest segment (<1%) of the lymphedema community. While relatively uncommon, primary lymphedema is a very important problem, both because of the genetic implications, which warrant direct evaluation, and because of the profound impact of lifelong disease that often arises in infancy or young adulthood.

Much more prevalent than the primary lymphedemas are those that arise when a previously healthy lymphatic circulation is secondarily damaged by disease, infections,

trauma, or medical interventions. In most of these circumstances, the damage is structural, but chronic venous disease and other systemic medical conditions can lead to relative lymphatic failure when, with time and the persistent requirement for greatly enhanced lymphatic flow, the capacity of the system is overwhelmed, and the pathology of lymphedema supervenes.

## Consequence of Cancer

Lymphedema as a consequence of cancer and cancer treatment represents the most common form of lower limb lymphedema that is seen

Dr. Stanley G. Rockson is the Founding Chair of the Scientific & Medical Advisory Council for the Lymphatic Education & Research Network (LE&RN). LE&RN is an internationally recognized non-profit organization founded in 1998 to fight lymphatic diseases (LD) and lymphedema (LE) through education, research, and advocacy. Among its many programs and initiatives to make LE and LD a global priority, in 2016 LE&RN wrote the bill that was unanimously passed in the US Senate establishing March 6th as World Lymphedema Day. Please visit LE&RN's website: [LymphaticNetwork.org](http://LymphaticNetwork.org)



Lymphatic Education & Research Network

Continued on page 42

## Patients with lower extremity lymphedema are more likely to present with swelling, heaviness, tightness, and skin alterations than those who experience problems with upper limb lymphedema.

today in the United States and the developed world. For many cancers of the skin and of the genitourinary system, among others, staging and treatment require the surgical excision of large numbers of lymph nodes. This iatrogenic lymphatic injury, often accompanied by radiation damage to lymph node-bearing regions, can lead to the relative failure of the system to maintain fluid balance in the tissues, and lymphedema ensues. The incidence of cancer-associated lower limb lymphedema varies by the specific tumor type but, in general, 20-50% of survivors of the relevant cancers will subsequently manifest the problem of lymphedema.

Given the predominant role of cancer-associated lower extremity lymphedema, it is instructive to examine this subtype to best understand the problem in general.

Secondary lymphedema of the legs is most often ascribed to surgical excision of inguino-femoral lymph nodes. Radiotherapy to the respective node-bearing areas can be causal by itself, but most often plays an adjunctive role to the surgical trauma. The disease will present as progressive swelling of one leg or both, most typically within the first 12 months after the treatment for cancer. Once it develops, it is often progressive and rarely, if ever, reverts to normal.

Published incidence estimates vary substantially, depending on the type of cancer, the stage of the cancer, the specific treatment protocol, and the sensitivity of the measurement tool used to detect edema. The highest relative incidence has been observed for vulvar cancer and the lowest after treatment for prostate cancer. Lymphedema incidence increases most predictably when there is adjunctive radiotherapy, where the highest rates are seen.

In most cases of secondary limb lymph-

edema, the swelling of the limb does not appear immediately at the time of lymphatic trauma. In the context of cancer, the reported timing of lymphedema onset varies substantially. In one published case series, 75% of the lymphedema cases appeared within the first post-treatment year, 19% in the following year, and 6% between 2 and 5 years after diagnosis. Most commonly, in practice, it can be anticipated that the timing of the onset will be within one year of the causal treatment intervention. The patient's initial complaint is usually painless swelling of one or both of the lower limbs. The patient may

also describe the sensation of heaviness in the limb, especially at the end of the day and in hot weather. For affected female patients, symptoms can vary throughout the menstrual cycle.

### Detection/Evaluation

Unfortunately, lymphedema is often not detected or evaluated at its earliest and most treatable stage. The first stage of lymphedema may be quite transient, but it is characterized, as is any edematous condition, by the presence of pitting, which describes the ability of the examiner to temporarily displace the excess tissue fluid



**Figure 2.** Prominent lichenification and papillomatosis in chronic leg lymphedema.



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## Lipedema is characterized by a significant pain component and often occasions easy bruising, which is not a feature of lymphedema.

through pressure applied by the examining finger, thereby creating a fleeting, visible indentation in the surface of the skin. However, the natural history of lymphedema, and one of its unique attributes within the category of edematous disorders, is the tendency to inexorably progress to a non-pitting condition. Ultimately, it is this relatively non-pitting edema that is considered to be a distinguishing hallmark of lymphedema (Figure 1).

In lymphedema, the distribution of the edema is asymmetrical. A positive Stemmer sign (the examiner's inability to tent the skin at the base of the second toe) is a useful, but not invariable, clinical finding that, when present, is considered to be pathognomic for lymphedema. The edema can spread either proximally or distally along the lower limbs in the early stages, but after the first year, while the magnitude of the edema can continue to increase, the extent of involvement along the axis of the limb uncommonly changes after the first year.

The failure to address lymphedema with appropriate treatment increases the likelihood that the disease will progress in severity. The end organ damage in uncontrolled lymphedema is sustained by the skin and its supporting structures. In such cases, with the passage of time, the lymphedematous leg accumulates increasing pathological changes in the skin. These lymphedematous changes can be quite dramatic, with accentuated skin creases, progressive loss of skin elasticity, hyperkeratosis, lichenification, and papillomatosis (Figure 2). Symptomatically, nearly all patients describe the presence of limb heaviness, fullness, or chronic dull pain. Additional subjective features of lower limb lymphedema include tightness of the shoes or

frank inability to wear footwear; loss of hair on the affected limb; burning or itching of the legs, feet, or toes; and sleep disturbances. It is interesting to note that the published medical literature supports the observation that patients with lower extremity lymphedema are more likely to present with swelling, heaviness, tightness, and skin alterations than those who experience problems with upper limb lymphedema.

In severe cases, skin breakdown does occur, as does lymphorrhea (exudation of tissue fluid through the skin surface). These latter conditions predispose the patient to an increased

risk of soft-tissue infection. Indeed, even in the absence of lymphorrhea or skin breakdown, recurrent infection, cellulitis, and lymphangitis are exceedingly common in lower limb lymphedema; more than one-half of these patients experience at least one episode of cellulitis, and perhaps one-third of the patients experience repeated episodes of infection. Repeated infection can further damage the lymphatic structures and thereby reduce lymphatic function, creating a vicious cycle of infection and sequential worsening of limb health.



Figure 3. Lipedema.

## Clinical Diagnosis/Differential Diagnosis

The clinical diagnosis of lower limb lymphedema rests upon observations that can be made in the examining room. The documentation and quantitation of edema is based upon measures of limb circumference and/or volume. When only one leg is swollen, concurrent measurement of the uninvolved leg can be used to assess the extent of swelling in the affected limb. However, the disease often affects both lower limbs. In addition, in some patients, pre-existing asymmetry in the two lower limbs may hamper the ability to accurately compare the limbs for the assessment of edema presence and magnitude. Circumferential measurements of the limbs can be unreliable, but if performed methodically along the axis of the leg, the data can be used to accurately calculate limb volume using established geometric formulas. Water displacement volumetry, although not commonly used, directly measures limb volume. This method is cumbersome but accurate. Surveillance of at-risk patient groups is increasingly performed with bioimpedance spectroscopy, a non-invasive technique that can detect subtle degrees of asymmetry in extracellular fluid volume before edema becomes clinically manifest.

As in all medical presentations, there is a differential diagnosis for lower limb lymphedema. Chief among these is the recognition of edema due to venous pathologies. As already mentioned, the presence of chronic venous edema can lead to functional, secondary lymphatic failure. Therefore, combined lymphaticovenous edema can commonly be encountered. A rigorous search for evidence of venous hypertension (Figure 3), including such findings as superficial varicosities, dependent rubor, hemosiderin deposits, and lipodermatosclerosis can assist the clinician in identifying components of the presentation that are amenable to correction or amelioration. While reversal of venous hypertension will not eradicate concomitant manifestations of established secondary lymphedema, such strategies can certainly mitigate the extent of disease, limit

disease progression, and render the lymphedema more responsive to the appropriate physical interventions.

Lipedema is another pathology that can be mistaken for lower limb lymphedema. Lipedema is relatively common but still poorly understood. A problem almost exclusively of women, it typically arises either at puberty, in association with pregnancy, or during menopausal change. Lipedema is a disease of the subcutaneous fat in the lower extremities. Its pathogenesis is likely initiated by lymphatic microvascular pathology (perhaps promoted by hormonal and genetic factors), yet, in contrast to lymphedema, pitting edema will not be present unless lymphedema supervenes in the late stages of the disease. Also in contrast to lymphedema, the involvement of the limbs is quite symmetrical. Foot involvement in lymphedema is variable, but in lipedema, the feet are typically uninvolved (Figure 4). Lipedema is characterized by a significant pain component and often occasions easy bruising, which is not a feature of lymphedema.

## Treatment Goals

The treatment goals in lower limb lymphedema are straightforward: to prevent disease progression, to achieve meaningful reduction of edema volume and to thereafter maintain the reduction of limb size, to ease the symptom-



**Figure 4.** Physical findings of venous hypertension.

atic burden of lymphedema, to improve limb function, and to prevent skin infection. The indicated treatment strategy will depend upon the symptoms and the severity of the condition. While pharmacological and surgical interventions can play a role in lymphedema management, the mainstay of treatment intervention is comprised of conservative physical approaches. These treatment strategies, known collectively as chronic decongestive therapy, include:

- manual lymphatic massage (otherwise known as manual lymphatic drainage, or MLD)
- multilayer bandaging and other complex decongestive physiotherapeutic maneuvers
- appropriate application of compression garments
- limb exercises and limb elevation
- pneumatic biocompression, and
- low-level laser therapy

These therapeutic modalities all have acute and chronic implications for their use. In general, decongestive therapy with multilayer bandaging is initiated by highly trained lymphedema therapists and utilized in an intensive course of 4-6 weeks of these interventions, designed to minimize the existing edema volume. Thereafter, the patient is taught to undertake self-management with skin care, exercise, and the daily (and sometimes nightly) application of properly fitted compression garments. Home use of pneumatic biocompression and other devices can be optionally included in the treatment regimen.

It should be underscored that compression garments do not, by themselves, reduce limb volume; rather, they are designed to prevent edema re-accumulation. Hence, garments do not play a role, and should not be prescribed, in the initial care of an untreated patient (unless the goal is to stabilize a newly diagnosed, mild or subclinical edema).

The surgical management of lower limb lymphedema may optionally include debulking interventions, such as suction-assisted lipectomy, or microsurgical procedures designed to restore lymphatic vascular function. Historical-

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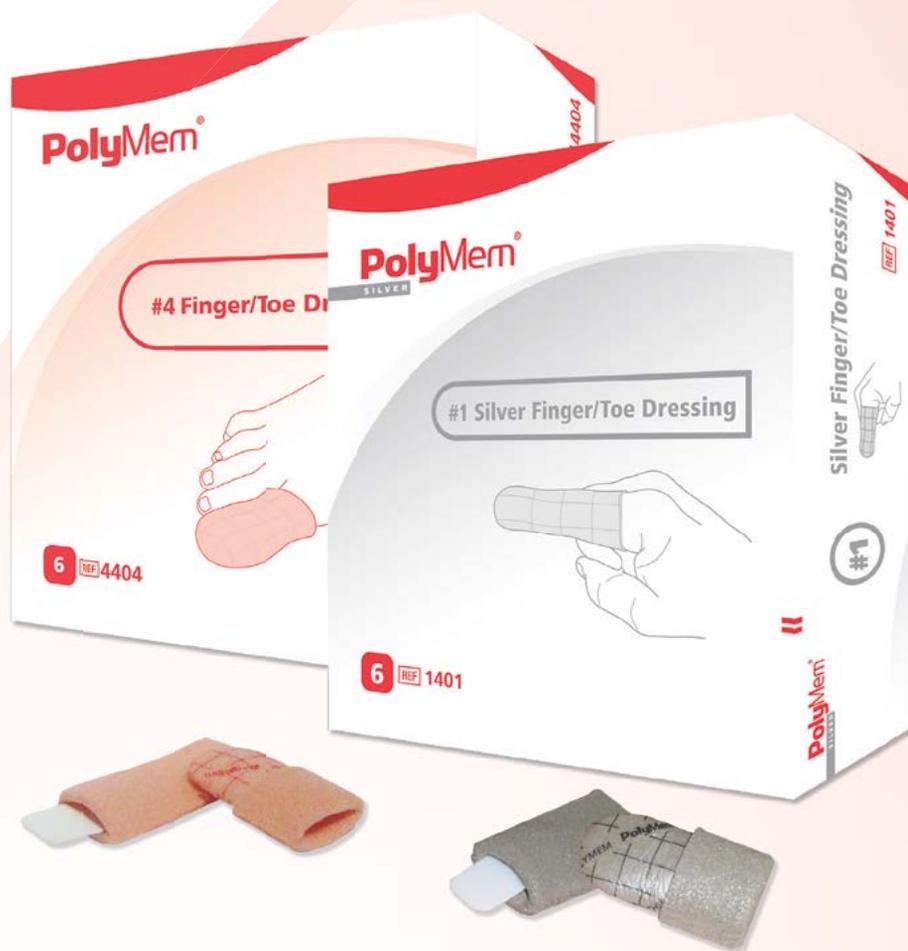
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ly, pharmacological therapy has not played a major role in the management of lymphedema, but this may change in the future as newer insights guide anti-inflammatory and other therapeutic strategies to minimize the pathology of lymphedema. In addition, consideration of chronic antibiotic suppression may be appropriate for selected patients that manifest recurrent, severe episodes of soft tissue infection.

### Failure to Address Impacts Quality of Life

In most cases, the diagnosis of lower limb lymphedema should be quite straightforward, and treatment interventions, particularly if undertaken early in the course of the disease, effectively stabilize the affected limb and produce significant improvement in limb size and function. Nevertheless, patients with swollen limbs continue to suffer from the persistent limited motivation of healthcare professionals to recognize and treat the problem. The

Compression garments do not, by themselves, reduce limb volume; rather, they are designed to prevent edema re-accumulation.

published medical literature documents that, in cancer-associated lymphedema, patients encounter delays in diagnosis, barriers in the access to treatment, and conflicting advice on the management of their lymphedema. In general, treatment of lower limb lymphedema, when it is recognized and evaluated, receives treatment at a relatively advanced stage. The lay public awareness of lymphedema of the leg lags behind its recognition of breast cancer-associated lymphedema of the upper limb. In cancer treatment centers, healthcare profes-

sionals increasingly provide advice and services for breast cancer survivors, yet comparable interventions for the prevention and early detection of lower limb lymphedema are generally much less readily available.

Among cancer patients, the advent of lymphedema is reported to be one of central issues in survivorship. In these patients, as in those with lymphedema of any cause, its presence has a profound impact on clothing and footwear choices, quality of life, financial status, and physical and social engagement. Lymphedema has an objectively documented impact on emotional well-being. The impact of lymphedema in the upper limb is comparable in nature, yet in those with leg involvement, reports of fatigue are much more prevalent and the intensity and level of distress in lower limb lymphedema is exaggerated.

Nearly all of the provoking factors for lower limb lymphedema are commonly encountered in the general public, which serves to explain the high population prevalence of

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chronic lower limb edema. Furthermore, the incidence of cancer and the prevalence of obesity continue to rise, thereby predicting a parallel increase in the incidence and the public health burden of lower limb lymphedema. There is an obvious imperative to provide appropriate guidelines not only for patients but also for healthcare professionals. One of the barriers to the development of evidence-based guidelines on risks, diagnosis, and management is the historical lack of methodically conducted research on these topics. Undoubtedly, there is still much to be learned and studied yet, certainly, the current body of knowledge is sufficient to create concern over a disease whose impact and population burden are likely to be underestimated. For cancer patients in particular, focused educational efforts can help to identify the potential triggers for the onset of overt lymphedema and thereby provide effective strategies for risk reduction and disease modification. Patients can be informed to facilitate appropriate decisions regarding

treatments and elective lifestyle behaviors. For those who experience the onset of overt disease, reassurance can be derived from the knowledge that treatment of limb lymphedema has the capacity to ameliorate function and restore quality of life. 

*Stanley G. Rockson, MD, is the Allan and Tina Neill Professor of Lymphatic Research and Medicine at the Stanford University School of Medicine. He is also co-founder of the Lymphatic Research and Education Network (LE&RN), an internationally recognized non-profit organization founded in 1998 to fight lymphatic diseases and lymphedema through education, research, and advocacy.*

#### Suggested Reading

1. Gianesini S, Obi A, Onida S, et al. Global guidelines trends and controversies in lower limb venous and lymphatic disease: Narrative literature revision and experts' opinions following the vWINTER international meeting in Phlebology, Lymphol-

ogy & Aesthetics, 23-25 January 2019. *Phlebol.* 2019;34(1 Suppl):4-66. doi: 10.1177/0268355519870690.

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3. Rockson SG, Tian W, Jiang X, et al. Pilot studies demonstrate the potential benefits of antiinflammatory therapy in human lymphedema. *JCI Insight.* 2018;3(20). pii: 123775. doi: 10.1172/jci.insight.123775.
4. Rockson SG, Keeley V, Kilbreath S, Szuba A, Towers A. Cancer-associated secondary lymphoedema. *Nat Rev Dis Primers.* 2019;5(1):22. doi: 10.1038/s41572-019-0072-5.

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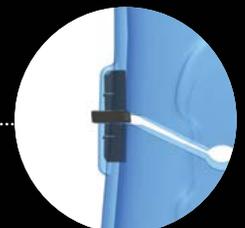
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# Patient Presentations Improve Communications, Increase Efficiency

A legal encounter with a patient led this podiatrist to rethink how and what he communicates with patients.

BY DONALD PELTO, DPM

Many of us are increasingly pushed to provide a greater amount of care along with reducing costs or increasing the value of each patient office visit. There are many thoughts about how to increase the per-visit value, but the key is to provide more value in the form of products or services. One way to do this is to build on the ideas of scripting patient visits and patient protocols.

As a young doctor, many of my older mentors recommended developing a script for the most common patient interactions. Few doctors actually take the time to write down what they say, much less practice these scripts. However, when shadowing more experienced doctors, it was clear they always repeated the same explanation for common conditions such as how orthotics would help, how to deal with plantar fasciitis pain, and the logistics of bunion surgery. These doctors naturally used these scripts and many of the “pearls” I learned as a young doctor came from listening and writing down how these explanations were done.

However, there was still some complexity that came from a variety of treatment options that are available for each condition. Many diagnoses, such as plantar fasciitis, can have 20 to 30 treatment options and as a young doctor



I didn't know what to offer first, what was the most important. Many times patients became confused about all the different options as I “educated them” about treatment options. Other more experienced doctors recommended using treatment protocols.

Treatment protocols delineate how each individual condition would be treated on the first and subsequent visits. This includes different categories such as office visit billing codes, in-office dispensing, durable medical equipment, and time frames between visits. I spent many hours developing all of these protocols before I even started in private practice only to find that

often I didn't follow them, and the patients were still confused even when I did.

Early in my career I brought up the idea about doing a presentation to patients to go over treatment options, but I was always discouraged from doing so because “it took too much time” and the doctors were “too busy” and “it wasn't practical.” I found that, like most busy doctors, I offered my patients what was most convenient to me in terms of reimbursements, what I'd seen work well, and, most importantly, what I had time to explain based on the time constraints of private practice.

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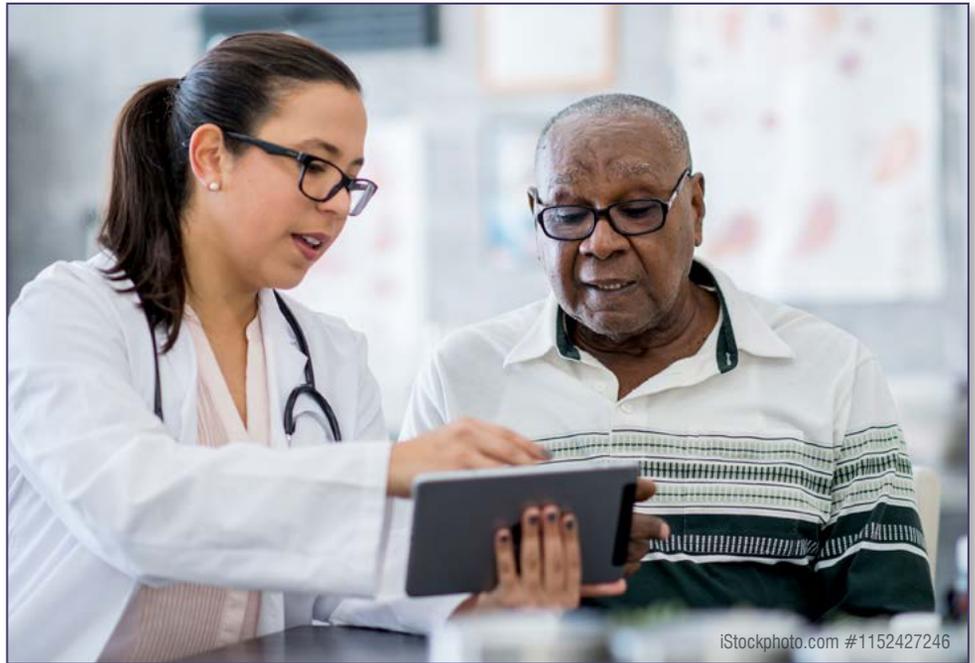
Many diagnoses, such as plantar fasciitis, can have 20 to 30 treatment options and as a young doctor I didn't know what to offer first, what was the most important.

*Continued on page 52*

Then, I was sued for a poor surgical outcome. One of the allegations was an improper pre-surgical discussion and informed consent prior to surgery. After that episode, I was motivated to have a thorough pre-surgical consent and thus was formed my first patient presentation. Using a PowerPoint presentation, I went over all the aspects that I typically went over prior to surgery. Using this format, I found I was more thorough and never missed any part of the presentation even when I was rushed for time. The presentation itself slowed me down and made me more thorough. I started doing these presentations for every surgical patient and many were appreciative of the thoroughness of the discussion. Furthermore, the informed consent was easier to obtain from patients since I had already gone over the procedure, alternatives, and possible complications.

## Improving Communications

After a few months of doing these presentations and really enjoying them, I realized that certain diagnoses were difficult and frustrating to explain due to the complexity of the condition and treatment options combined with time constraints. Patients would come in with plantar fasciitis and I would groan just thinking about explaining the condition again, or if I had been seeing someone for a number of weeks without improvement, patients were confused as to the next steps for treatment.



This helped to develop this idea I call “Patient Presentations.” This idea is more than a PowerPoint presentation; rather, it’s a mixture of scripting, treatment protocols, and patient educational materials plus a way to reduce complexity for the doctor and the patient in terms of treatment options. Let’s look at how this could be used in your practice.

Our next patient is coming in for plantar fasciitis, a condition we’ve already seen 20 times this week. We all think we are great at treating this condition. We typically talk to the patient about plantar fasciitis and they nod their heads

saying they understand...but do they really? How many times do they leave thinking, “I have this condition because I am fat!” While we never said that, that’s what the patient will say they heard.

Consider this alternative. We go in to visit the patient, Mrs. Smith, and listen to her concerns with a growing sense she indeed has plantar fasciitis. We perform a physical examination and watch her walk. Next we review the x-rays with her, and she asks if the spur is the cause of her heel pain. But before going any further, we open a presentation on plantar fasciitis on the computer screen right in front of her. This presentation will go over the cause of the condition and provide an organized approach toward treating the condition. As we sit together, Mrs. Smith has the chance to ask questions and we can reinforce certain points we want to make sure she gets. We can let her know that she doesn’t need to take notes or remember everything because she will be given a paper copy to review or share with a family member after, or she can receive a copy by email. When the presentation is over, we can go over a checklist of treatment options and together with Mrs. Smith determine what the next steps are.

This is the idea of “Patient Presentations.” It is a way to help explain diagnoses, slow down the doctor to be more thorough, and make

## The Plantar Fasciitis Checklist

<p><b>Imaging</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> X-ray</li> <li><input type="checkbox"/> Diagnostic Ultrasound</li> <li><input type="checkbox"/> MRI</li> </ul> <p><b>Traditional Treatments</b></p> <p>Reduce Inflammation</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Shockwave Therapy (EPAT)</li> <li><input type="checkbox"/> Cortisone Injection (8 weeks)</li> <li><input type="checkbox"/> NSAIDs and Prednisone</li> <li><input type="checkbox"/> Icing &amp; Contrast Baths</li> </ul> <p>Reduce Tightness</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Physical Therapy</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Home Therapy</li> <li><input type="checkbox"/> Stretching</li> <li><input type="checkbox"/> Night Splint</li> </ul> <p>Stabilize Foot - Reduce Pressure</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Custom Orthotics</li> <li><input type="checkbox"/> Supportive Shoes</li> <li><input type="checkbox"/> Taping</li> <li><input type="checkbox"/> Walking Boot</li> <li><input type="checkbox"/> Ankle Brace</li> </ul> <p><b>Advanced Treatments</b></p> <ul style="list-style-type: none"> <li><input type="checkbox"/> Amnio Injection</li> <li><input type="checkbox"/> PRP Injection</li> <li><input type="checkbox"/> Surgery</li> <li><input type="checkbox"/> Second Opinion</li> </ul>
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**Figure.** Checklists at the end of Patient Presentations provide a reminder of durable equipment that might be offered in conjunction with the diagnosis.

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Using this format, I found I was more thorough and never missed any part of the presentation even when I was rushed for time. The presentation itself slowed me down and made me more thorough.

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certain all the treatment options are included in the discussion. What I have found in the past 6 months of using these presentations for practically all conditions are the following:

### For Me, the Doctor

**Greater enjoyment in treatment of complex conditions.** Using these have made explaining treatment options much more enjoyable and I have been more comprehensive. Patients are more involved and engaged.

**Slow down.** Doing a patient presentation or simply reviewing a treatment slide slows me

down and helps me not to forget any treatment option due to other distractions or time constraints.

**Simplicity.** It is easier to treat patients as I know what I am going to say. These are similar to the patient protocols but can be continually tweaked and the presentations can be adapted and improved as needed.

### For the Patient and Family Members

**Increased understanding.** Because the presentation is visual, patients and family members

come away with a greater understanding of their condition, plus, they can review the presentation again in their own home. The program I use, Patient Education Genius (patienteducationgenius.com), can be uploaded with your information for your patients.

**Homework helpers.** In addition to the presentation, videos of the recommended exercises and other educational materials can be made available for patients to use at home and study at their leisure. This improves their retention of exercise instructions and, at least for me, has increased compliance with follow-up visits.

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## For the Practice

**Increased billing.** In our office, we both sell and dispense durable equipment. Many times in the past, these were not offered because we were too busy or forgot. When the items are included in the presentations and patients can see how they are used by others, patient acceptance of durable medical equipment and products is greatly increased. For example, with a plantar fasciitis patient, the checklist slide at the end of the presentation jogs my memory to offer a night splint or walking boot as an option, if they are not getting better.

**Referrals and reputation.** On each of the educational pages that are made for patients, the software program we use includes an area where a chat bot asks for an online recommendation. We have found it improves our social media rankings tremendously on Google.

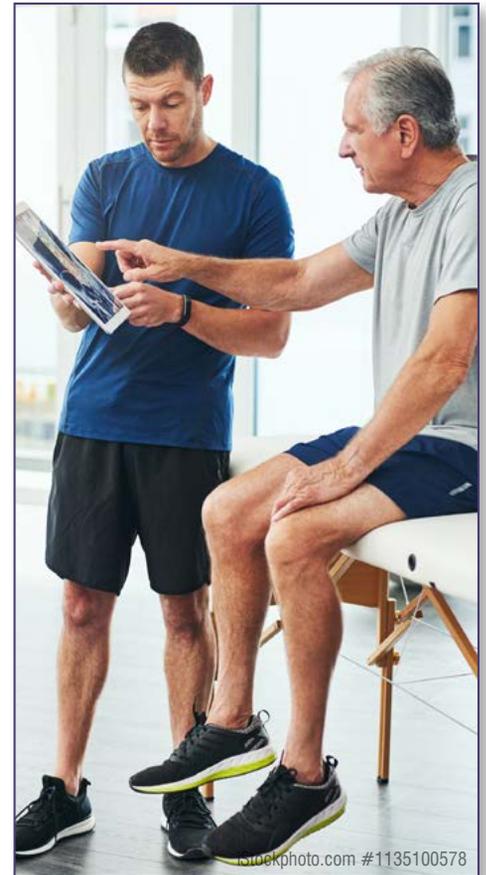
## For the Healthcare System

**Wow.** Patients are wowed and many times say, “I have never had any doctor be so prepared

for my visit.” The preparation starts before and takes some additional upfront work on your part, but I have found that patients do appreciate it and hopefully will stick with treatment longer, improving outcomes all the way around. 

*Donald Pelto, DPM, has been a podiatrist for more than 10 years with Central Massachusetts Podiatry in Worcester. A selection of Dr. Pelto's Patient Presentations can be found at the link below. To discuss these or others he has available to share, reach him at don@centralmasspodiatry.com.*

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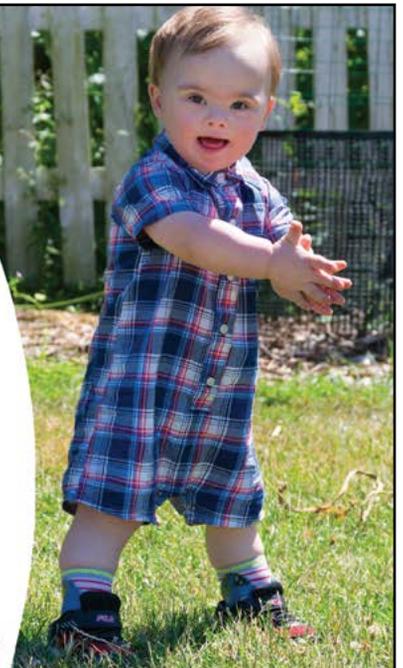
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Noteworthy products, association news, and market updates

## ORPYX SI SENSOR INSOLES



Orpyx SI sensory insoles help prevent diabetic foot ulcers (DFUs) and limb loss through advanced pressure, temperature, and movement sensor technology and analytics. A randomized controlled trial showed an 86% reduction in DFU recurrence compared to control when the Orpyx SI technology was worn 4.5+ hours per day. Plantar pressure is considered an early indicator of DFU formation. Orpyx SI sensory insoles are designed specifically to help mitigate this risk by providing patients with real-time feedback, enabling them to take immediate action. In addition, the sensory insoles monitor variances in plantar foot temperature, which is considered a late-stage indicator for DFU formation. This provides an additional warning parameter to help healthcare providers treat DFUs.

**Orpyx**  
403/460-0216  
orpyx.com

## BATTERY-POWERED HEADGEAR COULD SHORT-CIRCUIT OA JOINT PAIN

Hyochol "Brian" Ahn, PhD, ANP-BC, an associate professor with Cizik School of Nursing at The University of Texas Health Science

Center at Houston (UTHealth), believes knee pain can be stopped by administering tiny electrical charges to the brain's primary motor cortex. The brain is an electrochemical organ that processes pain, according to Ahn, and his team is trying to desensitize the areas tied to knee pain. This treatment has the potential to improve the self-management of pain, decrease health expenditures, and improve quality of life for patients.

Study participants, who range in age from 50 to 85 with symptomatic knee osteoarthritis, wear a battery-powered cap that relays a weak current between a positive and negative electrode. There are 15 20-minute sessions over 3 weeks. To see if the brain stimulation works, participants are asked to complete a questionnaire for which they rate their pain on a scale



Knee pain sufferer Deborah Brown is helping UTHealth's Ahn and his colleague Lindsey Park evaluate an innovative pain relief treatment  
Photograph by Maricruz Kwon/UTHealth

of 1 to 100 before and after the treatment. Researchers will also review medical images of the participants' brains for possible changes. To establish the validity of the experiment, Ahn is creating a control group comprised of volunteers who do not receive enough brain stimulation to make a difference.

The clinical trial, Self-Administered Transcranial Direct Current Stimulation for Pain in Older Adults with Knee Osteoarthritis: A Phase II Randomized Sham-Controlled Trial (NCT04016272), runs through July 31, 2022.

## ARMOR 8 LACE UP ANKLE BRACE



Newly available from Elite Orthopaedics is the Armor 8 Lace Up Ankle Brace, which is designed to provide stability and protection. The figure-8 non-stretch wrap is engineered to stabilize the ankle and help control abnormal eversion and inversion. The brace uses a unique soft, pliable armor to limit inversion, eversion, flexion, and extension movements. The compact design fits easily into most athletic or street shoes. The ankle brace is available in 5 sizes, based on ankle circumference: X-small (9"-10"), small (10"-11"), medium (11"-12"), large (12"-13"), and X-large (13"-14"). The suggested HCPCS code is L1902.

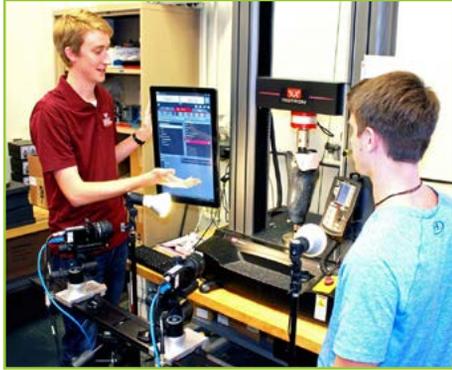
**Elite Orthopaedics**  
800/284-1688  
elite-ortho.com

## VIRGINIA TECH RESEARCHERS DEVELOPING SMART PROSTHETIC SOCKET TO IMPROVE COMFORT, PERFORMANCE

A Virginia Tech research team, led by Associate Professor Michael Philen, PhD, of the Kevin T. Crofton Department of Aerospace and Ocean

## INDUSTRY SNAPSHOT

Engineering, and Professor Michael Madigan, PhD, of the Grado Department of Industrial and Systems Engineering, has received a \$400,000 National Science Foundation grant to study residual limb volume loss and develop smart prosthetic sockets to improve comfort and performance in prostheses. The team is collaborating with Brian Kaluf, CP, FAAOP, of Ability Prosthetics and Orthotics, Charlotte, NC.



Aerospace engineering PhD candidate Carson Squibb and mechanical engineering junior Trevor LeMaster, who has a transfemoral amputation, use digital image correlation on a carbon fiber composite prosthetic socket to track limb deformations during simulated loading. Photograph courtesy of Virginia Tech

Over the course of the 3-year grant, the researchers will be developing new techniques to accurately measure residual limb volume change and deformation throughout the day, as well as the changes in the fit of the prosthetic socket itself. Philen's work in the Aerospace Structures and Materials Laboratory includes a technology known as fluidic flexible matrix composites. These composites have been demonstrated in aerospace structures, morphing structures, robotics, and wave energy conversion systems. When integrated into a prosthesis, fluidic flexible matrix composites can accommodate to residual limb volume loss and help maintain a comfortable fit for the user. Madigan's Biomechanics Group brings expertise studying the dynamics of human movement, including gait, balance, and slip, trip, and fall prevention.

Digital image correlation and a clear diagnostic socket will be used to track strains

(ie, deformation) on the residual limb during daily activities. Digital image correlation is an established technique for acquiring 3D strains and displacements on the surface of materials; applying this technique to socket fit will provide new insights into the relationship between strain and comfort. Additionally, the researchers are developing a high-precision laser scanning system to measure the shape and volume of the limb before and after completing the physical activities. Once they have a better understanding of residual limb deformation during active use, the researchers will work on developing a smart prosthetic socket employing fluidic flexible matrix composite technology. Wafers made of this composite integrated into the smart socket can achieve an increase in volume when pressurized, exhibit changes in stiffness, and be fabricated into a variety of shapes and configurations that can be tailored for the user.

## NEW LOWSHOCK GEL HEEL WEDGES



PediFix has added LowShock Gel Heel Wedges to its product line. These newly designed heel wedges are constructed from shock absorbing Pedi-GEL, an exclusive gel material that offers shock absorption and long-term use advantages that older wedges do not. According to the company, medial and lateral wedges provide biomechanical benefits and have been used for decades, but they're typically made of felts,

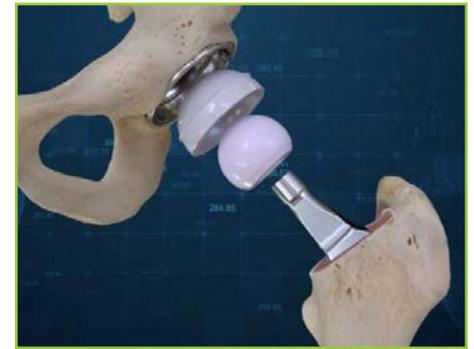
foams, or rubbers that soon flatten, quickly reducing their effectiveness. These new heel wedges can be used in conjunction with, or instead of, orthotics to limit pronation. They are available in small, medium, large, and X-large.

### PediFix

800/424-5561

pedifix.com

## CONFORMIS HIP SYSTEM FEATURES IFIT IMAGE-TO-IMPLANT TECHNOLOGY



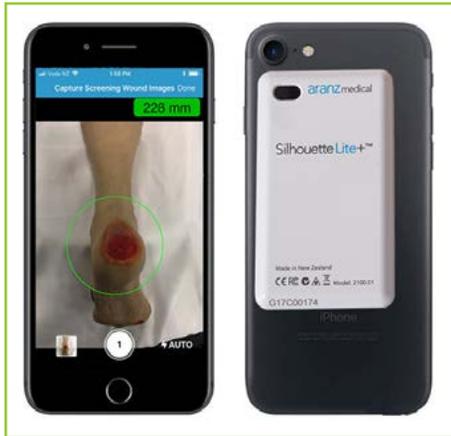
The proprietary iFit Image-to-Implant technology platform from Conformis is used to develop and manufacture joint replacement implants customized to fit each patient's unique anatomy. The company recently announced US Food & Drug Administration clearance of its 3D-designed Conformis Hip System. The new system incorporates design improvements based on surgeon feedback after completion of over 400 surgeries. After each patient's CT scan is converted into a 3D computer model, the patient's measurements are transformed into a comprehensive, individualized, pre-operative surgical plan that is delivered to the surgeon along with the custom implant. The surgeon is also provided with a set of disposable patient-specific 3D-printed jigs, to aid in implant positioning.

### Conformis

855/904-0343

conformis.com

## SILHOUETTELite+ BY ARANZ MEDICAL



SilhouetteLite+ is a smart phone-based imaging product designed to enable accurate measurements, images, and data capture of soft tissue and skin lesions, such as diabetic foot ulcers. The SilhouetteLite+ system, in conjunction with the suite of Silhouette products, allows for wound documentation at the point of care or via telehealth solutions. It is easy to use and offers non-contact 2D planimetry modeling with support taking 2D measurements of the wound's length, width, perimeter, and area. According to the company, the data collected is securely synchronized in ARANZ Medical's proprietary, cloud database, SilhouetteCentral, for ease of analysis and reporting. The system consists of an app and a sensor that attaches to the back of an iPhone or iPad.

**ARANZ Medical**  
866/467-0934  
aranzmedical.com

## DARCO MEDSURG DUO SHOE

The MedSurg DUO shoe is built to provide patients with hassle-free durability and comfort, while providing pressure relief to the post-op or wound site. According to the company, the DUO shoe is constructed of 2 different densities of EVA to provide up to 40% more plantar pressure reduction than standard post-op shoes



as well as superior shock absorption, all in a semi-rigid product. The sole is 27% lighter weight compared to standard post-op shoes. The soft, padded ankle strap adds comfort that patients will appreciate. By incorporating a dual buckle, the strap and pad can be switched to the left side or right side. Available in 5 sizes, from X-small to X-large.

**DARCO International**  
800/999-8866  
darcointernational.com/duo

## CMS ADDS NEW L-CODE FOR 2020; UPDATES THERAPEUTIC SHOE MODIFICATION CODES

The Centers for Medicare & Medicaid Services (CMS) have announced the following updates, which are effective for dates of service on or after January 1, 2020:

- **New L-Code:** A new lower extremity-related Healthcare Common Procedure Coding System (HCPCS) code has been added. The new code is L2006: Knee ankle foot device, any material, single or double upright, swing and/or stance phase microprocessor control with adjustability, includes all components (eg, sensors, batteries, charger), any type activation. To access the complete list of 2020 codes, additions, deletions, and changes, visit [cms.gov/Medicare/Coding/HCPCSReleaseCodeSets/Alpha-Numeric-HCPCS](https://www.cms.gov/Medicare/Coding/HCPCSReleaseCodeSets/Alpha-Numeric-HCPCS).
- **Fee Schedule Change, Therapeutic Shoe Modifications:** Fee schedule amounts

have been adjusted for shoe modification codes A5503 through A5507 to reflect more current allowed service data. Section 1833(o)(2)(C) of the Social Security Act required that the payment amounts for shoe modification codes A5503 through A5507 be established in a manner that prevented a net increase in expenditures when substituting these items for therapeutic shoe insert codes (A5512 or A5513). Base fees for A5512 and A5513 were weighted based on the approximated total allowed services for each code for items furnished during the second quarter of 2004 to establish the fee schedule amounts for the shoe modification codes. For 2020, CMS weights the base fees for A5512 and A5513 based on the approximated total allowed services for each code for items furnished during 2018. To access the 2020 fee schedule, visit: <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/DMEPOSFeeSched/DMEPOS-Fee-Schedule>.

## DDR: X-RAY THAT MOVES



Konica Minolta Healthcare Americas has unveiled the compact and efficient KDR AU Advanced U-Arm, which has the image-acquisition capability of Dynamic Digital Radiography (DDR). DDR, or X-ray that Moves, provides a cine loop of rapidly acquired, diagnostic-quality

ity images depicting full views of articular mobility. When applied in musculoskeletal applications, clinicians can assess changes in relationship of bones, ligaments, and other anatomical structures through full range of motion to evaluate knees, spines, shoulders, and wrists. In addition to producing dynamic sequences, the KDR AU also provides standard medical images for all anatomies. Using the KDR AU Advanced U-Arm helps practitioners expedite the diagnostic process and improve outcomes while offering an improved patient experience.

**Konica Minolta Healthcare Americas**  
800/934-1034  
[konicaminolta.com/medicalusa](http://konicaminolta.com/medicalusa)

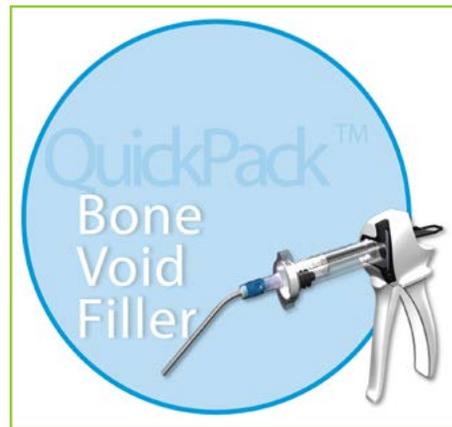
## HANGER PROMOTES REGINA WEGER TO SPS



### PRESIDENT

Regina Weger has been promoted to president of SPS, Alpharetta, GA; the company is a subsidiary of Hanger, Austin, TX. Weger has been with SPS for over 20 years, starting in the customer service function. She most recently served as vice president and general manager. Prior to that she was vice president of SPS sales and marketing. In this new role, Weger will report directly to Hanger President and Chief Executive Officer Vinit Asar.

## SYNTHETIC BONE GRAFT SUBSTITUTE



OrthoPediatrics announced the launch of QuickPack, a fully synthetic bone graft substitute featuring high viscosity, calcium phosphate cement that closely mimics the mineral phase of natural bone. The product is supplied in a user-friendly, self-contained, closed loop double-syringe delivery system, eliminating the need for open air mixing in a bowl and messy or inadequate transfer of material for injection. This solution complements the surgeon's toolbox when performing bone reconstructive and trauma surgery by temporarily filling the defect and allowing new bone to form during the healing process. Through a new partnership with Graftys, the product developer and manufacturer, OrthoPediatrics will offer QuickPack through a private label agreement within the US.

**OrthoPediatrics Corp.**  
877/268-6339  
[orthopediatrics.com](http://orthopediatrics.com)

## OTTOBOCK APPROVED FOR €100 MILLION IN FINANCING FOR PRODUCT DEVELOPMENT

The European Investment Bank (EIB) is providing financing of up to €100 million to Ottobock SE & Co. KGaA, Duderstadt, Germany. The company will use the funds over the next three years to fund new product development

and product improvements with a focus on prosthetics, orthoses, and human mobility. The loan is backed by a guarantee from the European Fund for Strategic Investments (EFSI).

## CASCADE ORTHOPEDIC SUPPLY ANNOUNCES INVESTMENT BY OTTOBOCK NORTH AMERICA

Cascade Orthopedic Supply, Chico, CA, announced an investment made in the company by Ottobock North America, Austin TX; details of the transaction were not disclosed. The investment aims to strengthen the collaboration of the two companies to further improve access to product for all orthotic and prosthetic (O&P) customers and drive efficiencies in supply chain operations that will spur growth for the industry.

## MASTER OF SCIENCE IN P&O PROGRAM APPROVED FOR KENNESAW STATE

The Board of Regents of the University System of Georgia has approved a Master of Science in Prosthetics and Orthotics (P&O) at Kennesaw State University. It will be housed in the Department of Exercise Science and Sport Management in the WellStar College of Health and Human Services. The program was first approved at the Georgia Institute of Technology by the Board of Regents in 2002 and will transfer to Kennesaw State to leverage the university's established strengths in clinical care, health sciences, and engineering. The program will be available to students beginning in the fall of 2020.

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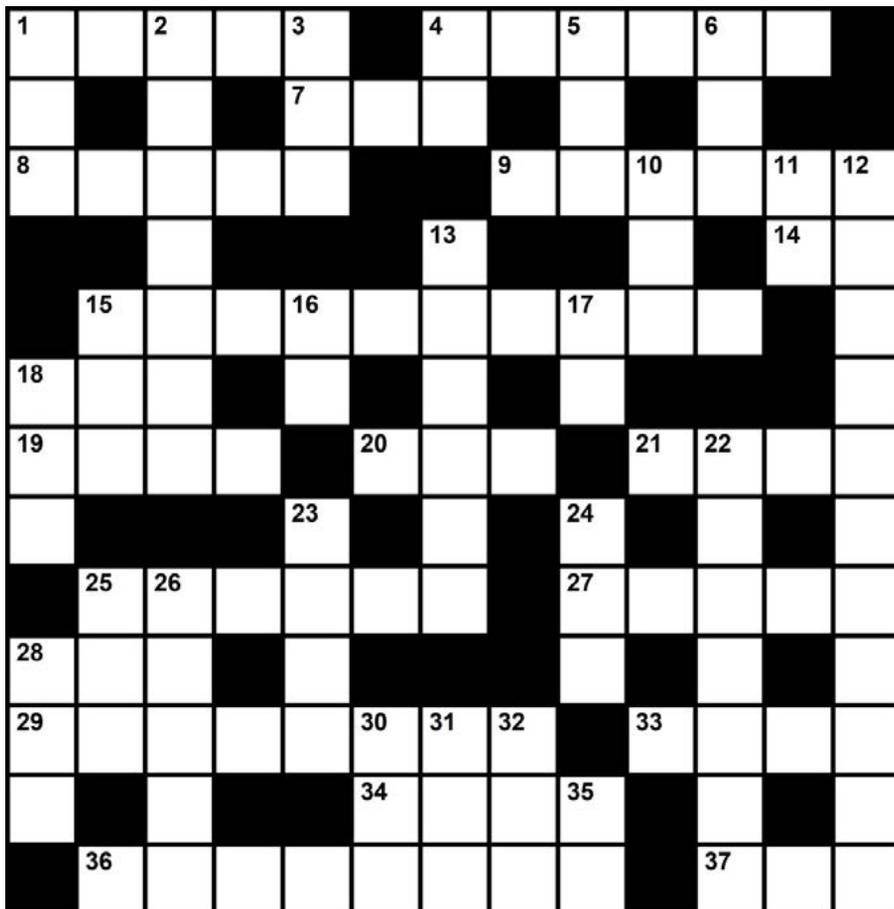
This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the Academy for Continued Healthcare Learning and LE&RN. ACHL is accredited by the ACCME to provide continuing medical education for physicians.

The Academy for Continued Healthcare Learning designates this live activity for a maximum of **7.00 AMA PRA Category 1 Credits™**. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

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## How Well Did You Read This Issue?

Test your knowledge of information from this issue of *Lower Extremity Review* and the world in general with our crossword puzzle feature. The answer box can be found online at [lermagazine.com](http://lermagazine.com).



### ACROSS

- 1 Colorless fluid containing white blood cells
- 4 This disease and its treatments are a major cause of lymphedema in lower limbs
- 7 Center for massage and relaxation
- 8 Small, fluid-filled sac
- 9 Relating to a membrane or sac of abnormal character containing fluid
- 14 Osteopath, abbrev.
- 15 Inflammation of tissue below skin
- 18 Ventilate
- 19 It's indicated in a prescription
- 20 Lower-extremity amputation, abbr.
- 21 Bone \_\_\_\_\_, especially painful in knees and feet
- 25 Deep-\_\_\_\_\_ thrombosis
- 27 Skin, anatomically
- 28 Postop day, abbrev.
- 29 How lymphedema presents in the legs
- 33 \_\_\_\_\_ lap surgical technique
- 34 Close by
- 36 Abnormally swollen or knotty
- 37 Col.'s superior, abbr.

### DOWN

- 1 Where bloodwork is done
- 2 Indicators of disease
- 3 Type of tax advantaged account for health purposes, abbr.
- 4 - \_\_\_\_\_ -125, antigen test for malignancy
- 5 Senate vote
- 6 Take nourishment
- 10 Biol. or chem., abbr.
- 11 A patient has to present one to receive treatment
- 12 Type of bandage used in treating lymphedema
- 13 The U in DFUs
- 15 Computer exec, abbr.
- 16 Weight measurement
- 17 Trademark, abbreviation
- 18 Disorder of distractibility, abbr.
- 22 Characterization of the first stage of lymphedema
- 23 Painful, pus-filled sore
- 24 IV amounts
- 25 Solemn promise
- 26 Fluid accumulation resulting in swelling
- 28 Pressure measurement, abbr.
- 30 Company letters
- 31 \_\_\_\_\_sporin, OTC anti-infective
- 32 Beano therapeutic target
- 35 Start of a memo, abbrev.

### CROSSWORD BY MYLES MELLOR

With over 12,000 crosswords published internationally, Myles Mellor is one of the top crossword writers in the world. His work includes crosswords, diamond crosswords, syndicated puzzles, cryptograms, diagramless crosswords, word search, sudokus, anagrams, and word games published on mobile devices and e-readers. [www.themecrosswords.com](http://www.themecrosswords.com)

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