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LOWER EXTREMITY REVIEW

January 23 / volume 15 / number 1

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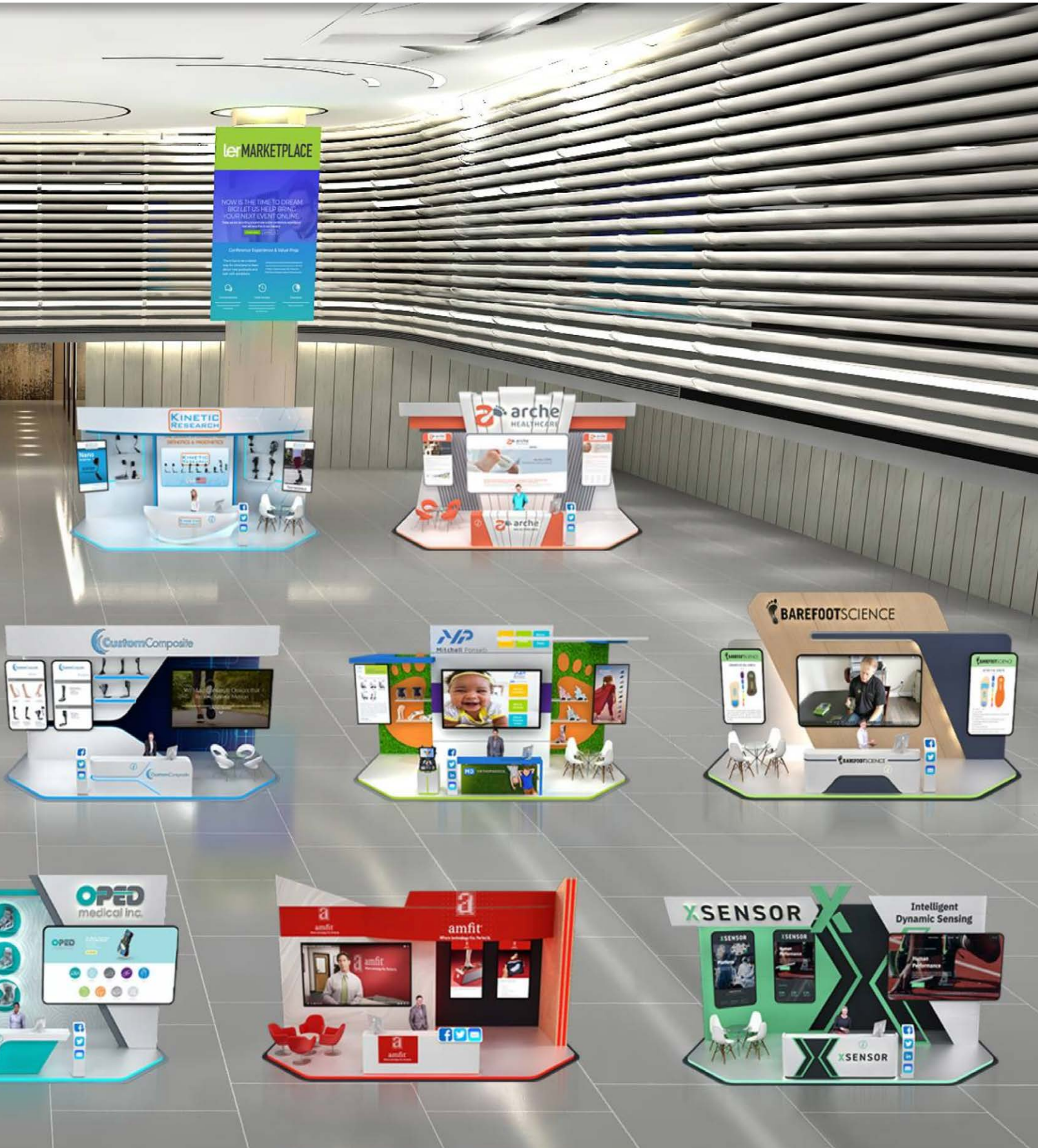

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January 2023

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Designed by @YLMSportScience

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LOWER EXTREMITY REVIEW

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Lower Extremity Review

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. LER is published monthly, except for a combined November/December issue and an additional special issue in December, by Lower Extremity Review, LLC.

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Lower Extremity Review Mission

Showcasing evidence and expertise across multiple medical disciplines to build, preserve, and restore function of the lower extremity from pediatrics to geriatrics.

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- Biomechanics matter
- Movement is essential
- Injury prevention is possible
- Diabetic foot ulcers can be prevented
- Collaborative care leads to better outcomes

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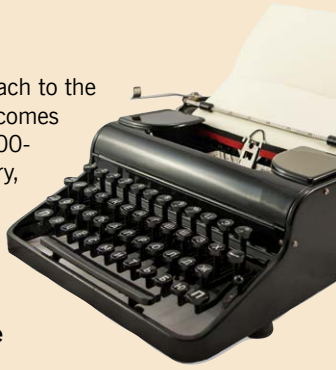
LER encourages a collaborative multidisciplinary clinical approach to the care of the lower extremity with an emphasis on functional outcomes using evidence-based medicine. We welcome manuscripts (1000-2000 words) that cross the clinical spectrum, including podiatry, orthopedics and sports medicine, physical medicine and rehabilitation, biomechanics, obesity, wound management, physical and occupational therapy, athletic training, orthotics and prosthetics, and pedorthics.



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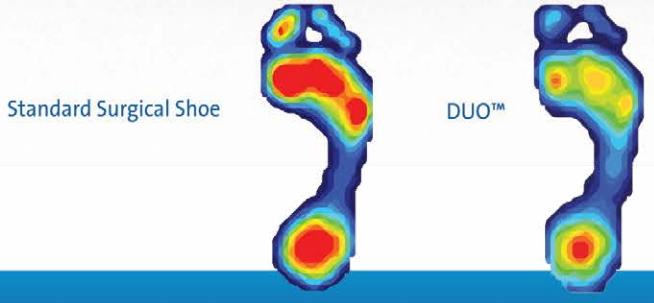

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Publisher's **Memo**

Welcome 2023 – Looking Forward to Working With You!

By Rich Dubin, Publisher

I don't know about you all, but I think – I think – that just maybe that COVID door is closing and the world is waking up to today's new reality. Today's reality may look a lot like pre-COVID, but I can say for sure, we are not going back to that former reality. COVID served as a major disruptor to healthcare, to business, to life in general, and those who can embrace THAT reality will go far in 2023 and beyond.

Of course, there is plenty of crazy and hardship still going on, but there's a lot of life out there itching to start, to go somewhere, and business is starting to climb of out its doomsday basement. Like that quote says, "Don't look back…you're not going in that direction."

Here at LER, we're still pumping away, putting out a monthly magazine, lining up events for lerEXPO, our digital educational platform, and working with advertisers and sponsors on lerMARKETPLACE, our online trade show, and lerEDUCATE, our soon-to-be released platform for continuing professional education —both CMEs and CEUs.

And we're getting out more. But we're being very selective about how we spend our business travel dollars. Not that we were extravagant before, but now with lerEXPO, we can create relationships through a more modern means and we're focused on exploiting those opportunities with global experts who want to be speakers, or advertisers who want to sponsor an event, or everyday readers from across the globe who express interest in certain kinds of educational opportunities — be they print or electronic. It's really almost like internet dating…where you talk online first and get to know each other and decide how you want the relationship to proceed. It's gratifying to talk with people around the world at 10 pm my time because that's when they can talk to me. I know I have their attention and they know they have mine. This is what business looks like today. It's not the 9 to 5 that we grew up with. Some places may try to make it that, but that work-from-home genie has been unleashed and I don't think we're getting it back into the bottle.

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So what can you do? Ride the wave baby! Today's customers aren't pre-COVID. They lived through that same fiasco you and I did and they have gotten more vocal about what they want and how they want it. The successful entrepreneurs of 2023 will be able to translate those demands into valuable goods and services and find a way to get them to their customers in real time. We're looking for those entrepreneurs, to work with you, to write about your products, and to focus on the health needs your customers service. Given the aging population and the growing athleisure world, your customers will be servicing a lot more folks moving forward and we want to help you help them.

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Living With Non-Diabetic Neuropathy: Art Keeps Me Sane

By Deborah Ann

In 1997, at age 50, I started experiencing strange pains in my feet. It varied from lumps in my shoes to a hot poker stabbing my feet. Sometimes it was so intense that I could hardly stand up. I went from doctor to doctor getting treated for one guess to another. After 5 years, a new doctor said it was peripheral neuropathy and put me on gabapentin. It did nothing.

Then I tried all the usual medications, but nothing helped, and the pain got worse. I have a high tolerance to pain but they would prescribe the lowest dose of each new medication and nothing touched the pain. And because of the fear of over prescribing medications, they wouldn't increase the dosage to a level that helped. This was very frustrating because I thought doctors would find an answer to my problem but didn't. I got so I didn't even talk about it. My feet were numb but the slightest touch turned into horrible pain.

The neuropathy continued along this way until it ramped up around 2005. That's when my right foot didn't bother me, but my left foot had this searing, hot sharp pain around the metatarsal between the smaller toes. This pain intensified only in this one location. It was debilitating at its worst and annoying the rest of the time. It would strike day and night and always start as moderate pain, then ramp up to screaming pain before settling back down. It affected everything in my life. I work as an artist and have a lot of meetings to discuss projects. Having an attack during a meeting was unbearable as my whole body reacted with twitches and stiffening up.

Since I couldn't explain my pain in a way that others would understand, I made this sculpture called Pain Without Words. None of my galleries would display it when I had a show because it wasn't pleasant. Then I found the Pain Exhibition (painexhibit.org) and it was accepted there. Since that time, it has taken on a life of its own. I give permission to use the image to advance the understanding of neuropathic pain.

I have wonderful doctors now who are trying to help me. Initially, my new primary care doctor asked me if white noise would help me get to sleep. Then he saw me react to pain and did more research and has combined medications that help some.

About 6 years ago the neuropathy advanced, still with the extreme pain, into ulcers that ate holes in my left foot. My very competent podiatrist recognized what was happening and tried everything to treat them without surgery. Finally, I started having small amputations of tissue to entire toes. When I was almost out of toes and the connecting metatarsals, he recommended a below-the-knee amputation. It will be 4 years this summer since this happened. I thought I would be in less pain, but that didn't happen either. The searing pain episodes I experienced in my foot are still there – my brain refuses to relinquish that memory. Now I have the same terrible pain in my non-existing foot. Phantom pain is real.

Sometimes I despair, wondering if I will ever be out of pain. My art keeps me going. My friends are understanding. ler

Deborah Ann is a fiber and mixed media artist in Yakima, Washington. Find her other (non-pain) artworks at www.deborahann.net.

Editor's Note: We found Deborah Ann's artwork, which appears on the cover, at the online Pain Exhibit. We are grateful to Ms. Ann for allowing LER to use the artwork.

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TREATMENT FOR OSTEOCHONDRAL LESIONS OF THE TALUS

Osteochondral lesions of the talus (OLT) are often associated with ankle pain and dysfunction. They can occur after ankle trauma, such as sprains or fractures, but they usually present as a continued ankle pain after the initial injury has resolved. Chronic ankle ligament instability and subsequent microtrauma may lead to insidious development of an OLT. Medial-sided lesions are more common (67%) than lateral-sided lesions.

For acute lesions that are nondisplaced, nonoperative management is initially performed, with a 4-6 week period of immobilization and protected weight bearing. Symptomatic improvement results in more than 50% of patients by 3 months.

Acute osteochondral talus fractures, which have a bone fragment thickness greater than 3mm with displacement will benefit from early surgical intervention. These injuries should undergo primary repair via internal fixation with bioabsorbable compression screws 3.0mm or smaller using at least 2 points of fixation. Acute lesions that are too small for fixation can be treated with morselization and reimplantation of the cartilage fragments.

If OLTs are persistently symptomatic following an appropriate course of nonoperative treatment, various reparative and restorative surgical options may be considered on the basis of diameter, surface area, depth, and location of the lesion.

A small subset of symptomatic osteochondral lesions of the talus involve subchondral pathology with intact overlying articular cartilage; in these cases, retrograde drilling into the cystic lesion can be employed to induce underlying bony healing. Cancellous bone graft augmentation may be used for subchondral cysts with volume greater than 100 mm^3 or with those with a depth of more than 10mm. Debridement, curettage, and bone marrow stimulation is a reparative technique that may be considered in lesions demonstrating a diameter less than 10mm, with surface area less than 100mm^2, and a depth less than 5mm. This technique is commonly performed arthroscopically using curettes and an arthroscopic shaver to remove surrounding unstable cartilage. A microfracture awl of 1mm or less is used to puncture the subchondral bone with 3-4mm of spacing between to induce punctate bleeding. Initial (<5 year) results are good to excellent in 80% of cases, with some deterioration of improvement over time.

Factors contributing to poor results include surface area greater than 1.5cm^2, overall osteochondral lesion depth over 7.8mm, smoking history, age over 40, and uncontained lesions. Lesions greater than 1.29cm^2, cystic lesions, and lesions that have failed prior treatment are potential candidates for osteochondral autograft transplantation. The autograft is typically harvested from the lateral femoral condyle of the ipsilateral knee with an optimal plug depth and diameter of 12-15mm. Transplantation often involves open technique and may even require malleolar osteotomy for perpendicular access to the defect, as well as visualization of a flush, congruent graft fit. Good to excellent outcomes have been reported in 87.4% of cases with the most common complication being donor site morbidity in up to 15% of cases. Failure rates increased significantly in lesions larger than 225mm^2.

Scaffold-based therapies, such as matrix-associated chondrocyte implantation, can be employed in primary or revision settings in lesions larger than 1 cm^2, including uncontained shoulder lesions with or without cysts. Lesions with greater than 4mm of bone loss following debridement may require bone grafting to augment with the scaffold. This technique requires an initial procedure for chondrocyte harvest and a secondary procedure for transplantation of the scaffold. Outcomes have been good to excellent in up to 93% of cases; however, this technique requires a 2-stage procedure and can be cost-prohibitive.

Particulated juvenile cartilage is a restorative technique that employs cartilage allograft from juvenile donors. The cartilage is placed into the defect and secured with fibrin glue in a single-stage procedure. Studies have shown favorable outcomes in 92% of cases, with lesions between 10 and 15mm in diameter, but increased failure rates and poorer outcomes in lesions larger than 15mm. This may be an alternative option for contained lesions between 10 and 15mm in diameter. Osteochondral allograft plugs are an option for larger contained lesions (>1.5cm in diameter) and in patients with knee osteoarthritis (OA) and concern for donor site morbidity. Furthermore, bulk osteochondral allograft from a size-matched talus can also be used for even larger, unstable/uncontained shoulder lesions. An anterior approach is often employed and fixation is achieved via placement of countersunk headless compression screws. Failure of the aforementioned options associated with persistent pain or progressive

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OA would then lend consideration to ankle arthroplasty versus ankle arthrodesis.

Source: *Powers RT, Dowd TC, Giza E. Surgical Treatment for Osteochondral Lesions of the Talus. Arthroscopy. 2021 Dec;37(12):3393-3396. doi: 10.1016/j.arthro.2021.10.002. Used with permission of Elsevier on behalf of the Arthroscopy Association of North America. All rights reserved.*

CANDIDAEMIA IN PATIENTS WITH DIABETES

Candida glabrata can cause sepsis, especially among patients with compromised immune systems.

Candidaemia is the most common fungal bloodstream infection in hospitalized patients. Diabetes is one of the risk factors for mortality from candidaemia. A group of researchers from Queen Elizabeth University Hospital in Glasgow, Scotland, compared the epidemiology, clinical characteristics, and management of candidaemia in patients with and without diabetes. Their findings were recently published in the Journal of the Royal College of Physicians of Edinburgh.

Over a 10-year period, 200 episodes of Candida bloodstream infection were documented. Patients with diabetes were younger (58.7 vs 65.5 years), less likely to be suffering from cancer (21.8% vs 36%), and had significantly lower 30-day and 90-day crude mortality (17.2% vs 35.6% and 28.4% vs 48.6%, respectively). Candida glabrata was more common in patients with diabetes (39.3% vs 29.7%). Based on European Confederation of Medical Mycology (ECMM) quality indicators, the management of patients with and without diabetes was similar.

This study highlights the importance of epidemiological data in relation to candidaemia in patients with diabetes and the growing threat of invasive C. glabrata infection in this subset of patients.

Source: *Preece G, Bhola S, Davidson A, Collier A, Bal AM. Epidemiology, management and outcome of candidaemia in patients with diabetes. J R Coll Physicians Edinb. 2022 Dec;52(4):292-297. doi: 10.1177/14782715221137451.*

EFFICACY OF POSTOPERATIVE ORAL ANTIBIOTICS IN FOOT AND ANKLE SURGERY

For patients undergoing foot and ankle surgery, preoperative oral antibiotics are standard of care. Yet, there is no consensus on the efficacy of this postsurgical protocol. For this study, researchers from the University of Tennessee Health Science Center in Memphis wanted to know whether postoperative oral antibiotics reduce the rate of surgical site infections (SSIs) in patients, with and without comorbidities, undergoing foot and ankle surgery.

They conducted a retrospective chart review, identifying patients who underwent foot and ankle surgery by 4 fellowship-trained, foot and ankle orthopaedic surgeons between January 1, 2015, and January 1, 2019. Patients were divided into 2 groups: those who received postoperative oral antibiotics (group 1) and those who did not (group 2). Two surgeons routinely prescribed postoperative oral antibiotics, and 2 did not. Demographics, comorbidities, and procedure complexity based on surgical site and Current Procedural Terminology code were recorded from the charts. The primary outcome was postoperative infection (superficial or deep) within 6 months after surgery. Patients with antibiotic use prior to surgery, preoperative infection, or lack of follow-up >6 weeks were excluded. Multivariate logistic regression modeling was used to analyze differences in infection rate and severity.

The results of this study indicate that postoperative oral antibiotics are not associated with differences in infection rates or severity. We do not recommend routine use in foot and ankle surgery.

Source: *Frederick RM, Burnette H, Joyce M, et al. Efficacy of postoperative oral antibiotics in foot and ankle surgery. Foot Ankle Int. 2022 Sep;43(9):1204-1210. doi: 10.1177/10711007221099929.*

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DEFINING SARCOPENIA: CONSENSUS IS SLOWLY GROWING

Writing in the 50th anniversary edition of the journal *Age and Ageing*, researchers Avan Sayer and Alfonso Cruz-Jentoft express optimism that a newly formed Global Leadership Initiative on Sarcopenia will develop international consensus on definition and diagnosis. Their key points:

- Sarcopenia is a disorder involving the loss of skeletal muscle mass and function that commonly occurs with advancing age as well as with a number of long-term conditions.
- Recognition in clinical practice is relatively recent but important because sarcopenia has a range of adverse effects on health, not the least of which include impaired mobility and increased morbidity.
- Original definitions focused on muscle mass but emphasis is now on muscle function as illustrated in a number of international guidelines.
- Progress in the decades ahead is likely to be seen with regard to use of routine health data, prescription of resistance exercise, translation of biology and epidemiology into first-in-man studies for new treatments and focus on sarcopenia in low-and middle-income countries. (ler)

Source: *Sayer AA, Cruz-Jentoft A. Sarcopenia definition, diagnosis and treatment: consensus is growing. Age Ageing. 2022 Oct 6;51(10):afac220. doi: 10.1093/ageing/afac220.*

METER + DIABETES APP = IMPROVED GLUCOSE CONTROL

Using data from the Lifescan server, researchers sought to provide real-world evidence, that their products—the OneTouch Verio Reflect (OTVR) meter which provides ColorSure Dynamic Range Indicator (DCRI) and Blood Sugar Mentor (BSM) features that are complemented

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CALL FOR MANUSCRIPTS

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:

- Biomechanics
- Benefits of movement
- Falls and other injury prevention
- Prevention of diabetic foot ulcers
- Collaborative care

Before you begin to write, query the Editors about your proposed topic (email is fine). Doing so ensures that your manuscript will conform to the mission of the publication and that the topic does not duplicate an article already accepted for publication. Furthermore, a query often allows the Editors and the publication's advisors to make recommendations for improving the utility of the manuscript for readers.

Case reports should be no more than 1500 words (not including references, legends, and author biographies). Photos (≤4) are encouraged. Case reports can include a literature review as is appropriate for the topic. (Please note that for HIPPA compliance, photos should be de-identified before sending.)

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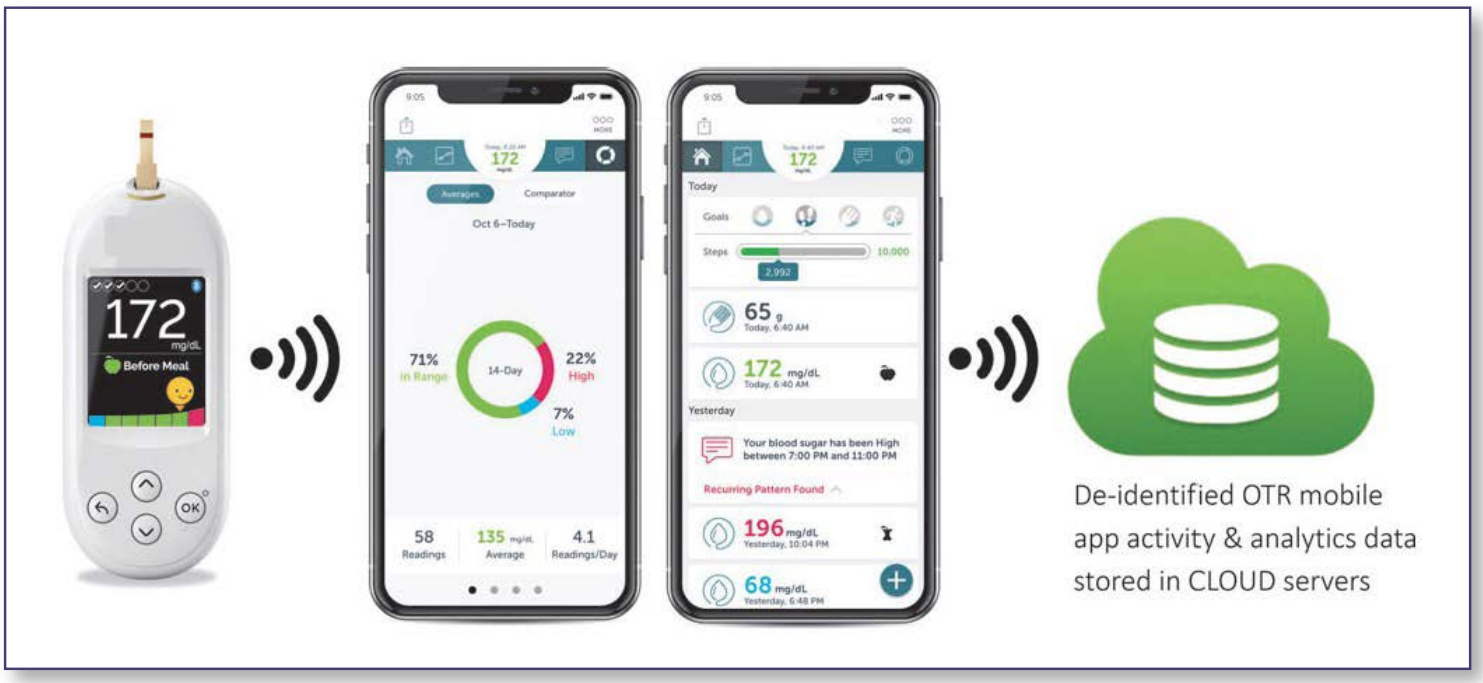

Figure. OTVR meter, OTR app, and CLOUD data collection. CLOUD; OTR, OneTouch Reveal; OTVR, OneTouch Verio Reflect.

by the OneTouch Reveal (OTR) mobile app—support improved blood glucose control.

Anonymized glucose and app analytics were extracted from the LifeScan server for 4154 people with type 1 diabetes (PwT1D) and 13,623 people with type 2 diabetes (PwT2D). Data from their first 14 days using the products were compared with the 14 days before the 90-day time point using paired within-subject differences.

The researchers reported the percentage glucose readings in range (RIR) 70–180mg/dL improved by +8.1% (from 58% to 66.1%) in PwT1D and by +11.2% (from 72.4% to 83.6%) in PwT2D. Hyperglycemic readings (>180mg/dL) reduced by -8.5% (from 37.1% to 28.6%) in PwT1D and by -11.3% (from 26.4% to 15.1%) in PwT2D. Mean glucose reduced on average by -14.5 mg/dL (from 174.8 to 160.2 mg/dL) in PwT1D and -18.2mg/dL (from 157.8 to 139.6mg/dL) in PwT2D. Glycemic improvement was strongly associated with OTR app engagement. Two to three sessions or 11 to 20 min/week in the app improved readings in range in PwT1D by +7.0% or +8.4%, respectively. Similar engagement trends for glycemic improvement were observed in PwT2D. Proportions of subjects achieving a 5% or 10% improvement in RIR were 46.9%/36.6% for PwT1D and 48.7%/37.7% for PwT2D.

The researchers concluded that real-world data from over 17,000 people with diabetes (PWDs) demonstrated significantly improved readings in range and reduced the burden of hyperglycemia in PWDs using the OTVR meter and OTR app. ler

Source: *Grady M, Cameron H, Bhatiker A, Holt E, Schnell O. Real-World Evidence of Improved Glycemic Control in People with Diabetes Using a Bluetooth-Connected Blood Glucose Meter with a Mobile Diabetes Management App. Diabetes Technol Ther. 2022 Oct;24(10):770-778. doi: 10.1089/dia.2022.0134.*

NEWLY DISCOVERED MATERIAL HELPS DIABETIC WOUNDS HEAL QUICKLY

Researchers from the University of Nottingham have discovered a new class of polymer that can provide instructions to both immune and non-immune cells to aid healing in hard-to-treat diabetic wounds. The findings have been published in *Advanced Materials*.

Wound healing is a complex biological process that involves various cell types working together, with a cell type called fibroblasts playing a critical role in forming new tissue required for healing. Diabetes can disrupt these processes in cells making wound healing slow and difficult to treat. This can lead to infection and in far too many cases, the need for amputation.

Experts from the School of Life Sciences and Pharmacy screened 315 different polymer surfaces, examining the different chemical make-up of each until they identified a polymer type that actively drives fibroblasts and immune cells to promote healing. A team from the Faculty of Engineering made small particles that are decorated with this polymer on their surface. These particles could be directly applied to the wound area.

A polymer is a chemical compound made up of molecules bonded together in long, repeating chains. This structure gives polymers unique properties that can be tailored for different uses. Using polymer microparticles the team showed how this new material, when delivered to a wound on an animal model, produces three times more fibroblast activity over a period of up to 96 hours and achieved more than 80% wound closure. This new polymer could be applied as a coating to standard wound dressings to provide a fast and effective treatment.

"This research is a significant step toward being able to create a new, low cost, effective treatment for diabetic wounds. The results we

Continued on page 21

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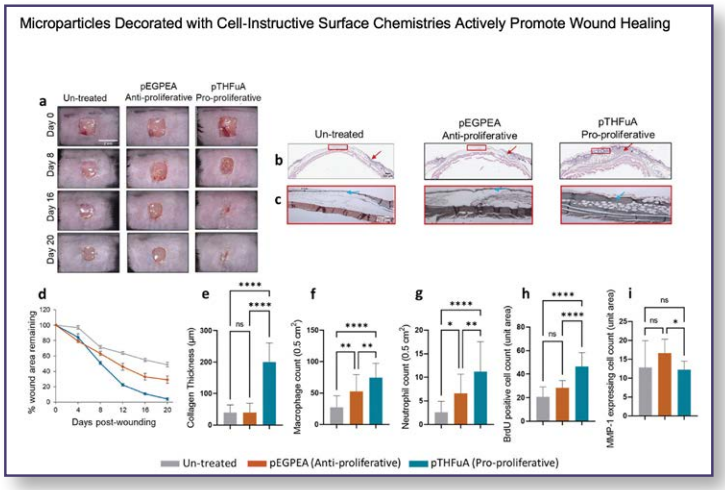

Figure. Histological results retrieved from diabetic mice with full thickness wounds exposed to antiproliferative (pEGPEA) and pro-proliferative (pTHFuA) microparticles. Un-treated wounds served as a negative control. Scale bar = 2 cm. a) Photographs of wounds over time. b) Representative H&E images. Scale bar = 500 μm. c) Representative Massons Trichrome images showing differences in wound healing between treatments. Scale bar = 200 μm. d) Percentage wound area remaining (gray lines = un-treated wound, orange lines = antiproliferative wounds, blue lines = pro-proliferative wounds), e) collagen thickness as determined by Massons trichrome staining. f) Macrophage count. g) Neutrophil count. h) BrdU positive cell count (proliferative cells). i) MMP-1 expressing cell count. Red arrow = most advanced granulation tissue formation. Blue arrow = collagen thickness site. Representation of N = 8 ±SEM for (a)–(d) and N = 8 n = 3–5 ±SD for (e)–(i). Statistical significance was calculated using one-way ANOVA and the Tukey's post hoc analysis where $*p < 0.1$, $**p < 0.01$, $***p < 0.001$, $****p < 0.0001$.

saw were achieved in just one application, which could be transformative for patients whose current treatment often involves repeated treatments delivered by trained health professionals," said Professor Amir Ghaemmaghami, one of the researchers in the study.

Professor Morgan Alexander from the School of Pharmacy at the University of Nottingham added: "We have shown the medical potential of novel polymers in previous work; our bacterial biofilm resistant materials are used on urinary catheters in the NHS, showing how this can prevent infection by changing the bacterial cell behavior at the polymer surface. These polymers also have the potential to be easily applied to dressings, and we are already working with industry partners to develop ways to help wound healing in this way."

Source: *Latif A, Fisher LE, Dundas AA, et al. Microparticles decorated with cell-instructive surface chemistries actively promote wound healing. Adv Mater. 2022 Nov 28:e2208364. doi: 10.1002/adma.202208364.*

Re-imagining The Anatomy of the Pain Scale: QDRIFT – For Communication, Tracking, and Treatment Evaluation

By Jay Segel, DPM; Sally Crawford, MS; and Jason Kraus, BS

Asking patients for a number to describe their pain provides the most minimal of information. These authors are calling for a comprehensive, cross-platform, multidisciplinary solution.

A patient walks into a doctors' office, shares their concerns, and the doctor asks, "How would you rate your pain on a scale of 1-10?" The patient replies, "Well, I could get up, so it isn't a 10, but it hurts now and I couldn't finish my tasks, so it's got to be more than a 5, so I guess it's a 7, but that is pretty arbitrary." No joke, this really happened, and the question is what did we learn? Not much. So clearly a deeper dive and different assessment tools are needed. We believe that a comprehensive, cross-platform, multidisciplinary standardized solution is necessary to evaluate, communicate, and track pain to better understand our patients' experiences. Are they sore? Are they stiff? Are they in overuse or underuse syndromes? Is there an alteration in the processing of their pain in the nervous system proper? A number between 1 and 10 doesn't answer any of these pertinent questions.

We would suggest that understanding pain in a diagnostically meaningful manner relies on breaking it down into its "anatomical" components which we call the QDRIFT:

- **Q** Quality
- **D** Duration
- **R** Region
- **I** Intensity
- **F** Frequency
- **T** Timing

The QDRIFT Pain Evaluation and Management Tool (see page 31) begins with looking at the qualities of pain and exertion stemming from some of the more evidence-based and very standardized scales used through the ages.[1-3] However, QDRIFT takes a more expanded and human approach to the experience of pain and its many details by standardizing and giving verbiage to the sensation the patient wants communicated. We use this tool with each of our patients on every visit, initially for diagnostic purposes, but then to track treatment progress.

Key components of the tool include:

Quality is an essential place to start as the type of pain is often pathognomonic of the primary affected system and diagnosis. The pain described by a person with a dry arterial ulcer is very different than the pain experience one relates who has comminuted heel fracture. Their intensity may be very similar, but the quality leads us down a different diagnostic, treatment, and assessment path. Consider how often a burning or radiating pain will lead to a neurological diagnosis such as peripheral neuropathy or Morton's Neuroma.

Though pain crosses into other body systems, the origin of the pain likely began in one and bled into others. Take for instance

Quality allows patients to describe their own pain.

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Artwork provided by the artist, Deborah Ann (see page 11)

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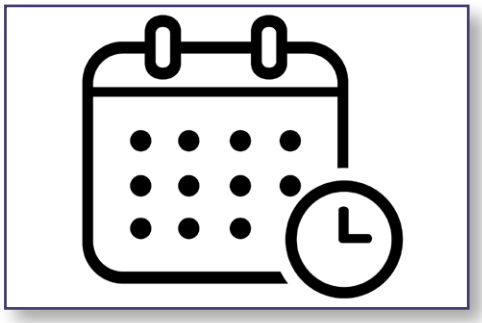


Duration tracks the length of a pain episode or its chronicity.

the aforementioned dry arterial ulcer which certainly indicates a problem stemming from the peripheral vascular blood flow. In many cases, however, the initial sore was caused by direct trauma, such as pressure or picking at the area. That, in turn, may lead to an infective process governed by an overwhelmed or compromised immune system, perhaps winding up with a musculoskeletal consequential event such as amputation. Getting it right from the start is life changing, and maybe even lifesaving.

Duration is an important consideration when evaluating treatment plan efficacy. Comparing the duration of a pain episode as documented in the initial encounter versus the duration of said pain experience as related in the follow up can give both the practitioner and patient better clarity and insights to the efficacy of the treatment plan and suggest next steps in pain management. It is not an unusual response, when asked how they are doing, for a patient to say "I'm about the same," which may make the treating physician rethink their approach. But when queried more specifically about frequency, intensity, and duration, patients relate, "well, the intensity is still the same, but it doesn't come as often and it doesn't last as long," which gives us more to work with and helps the patient better understand that pain management is a process.

Region is a more recent addition to this new way of evaluating pain. It is considered an important consideration as it helps to identify an area – eg, right above the knee or just ahead of

Region provides a better understanding of whether pain is contained (at say just these highlighted spots) or expanding into broader anatomy (say up the calf or above the hip).

the cuboid – and consider that specific anatomy. On follow up, assessing expansion or contraction of our identified problematic region may not be possible without defining "where." There is a relationship between regions, pain, and activities of daily living. The regions also allow us to view "pains" in the context of function, bringing in elements such as stiffness, soreness, or over- and underuse syndromes. Also to be considered is the phenomenon of referred pain,

as may originate in one area but be felt in a different area within or outside the same region or system. This referred pain is often associated with "nerve pain" but is not uncommonly seen in malignancies and musculoskeletal maladies.

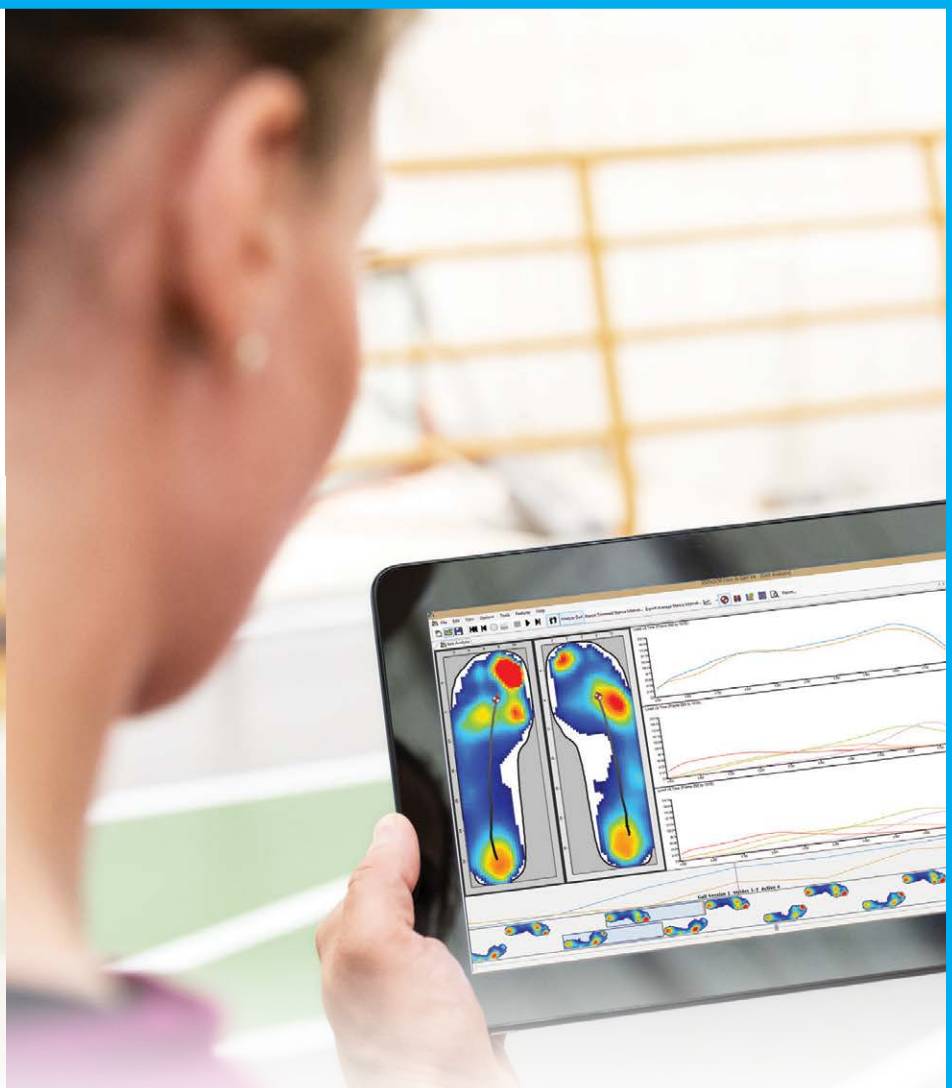
Lower limb arthritis may affect the entire kinetic chain. It can also be joint centric, whereas the region of pain associated with worsening tendinopathy may begin with targeted sensitivity at the origin or insertion and quickly expand through the tendon to the myotendinous junction and beyond. The understanding of the region, given pain ratings translated by a patient, provides great insight to far more.

Intensity is often the most difficult pain attribute to quantify or pin down as it is highly variable based on individual tolerance, timing, and circumstance. Rather than using numbers, other than 0 being equivalent to a finding of "no pain," verbiage is likely a better choice. Pain perhaps begins with awareness. A lack of awareness in an anatomically defined area relative to an adjacent area would equate to our old scale 0 and a general awareness would be a 1. A more specific awareness or sensitivity would translate as a 2 and a 3 would be discomfort. Patients will often use the range of 3-5 to describe a pain between mild and moderate, while 6-7 often indicates the beginning of an interruption of activities of daily living. An 8-9 seems to indicate an avoidance to at least some, if not many, activities of daily living, leaving 10 as intolerable and unworkable. If we can use numbers, why break it out into words of patients experience? The answer is standardization, communication, and precision. Simply put, it is easier for patients to share their experiences of pain than it is to grade it!

Intensity of pain is highly subjective and using words, instead of numbers, to describe it allows patients more room to share their experiences. This young woman survived a boat explosion but lost the right leg to amputation and broke the left—who's to say which is the more intense pain?

Frequency is another hallmark of pain and may be the most maddening of the pain descriptors from the patient perspective. "Doc, the pain just won't leave me alone," or "it's driving me crazy, just when I think it's gone, it comes back." Again, a numbered scale is just not descriptive enough. As we tell our kids, "use your words," we must ask our patients to do the same and be specific. For example, define infrequent pain: once a day, once a week, only when running, just the first few steps in the morning? We need to know these answers for both diagnosis and management. Here's where using the QDRIFT

Continued on page 27



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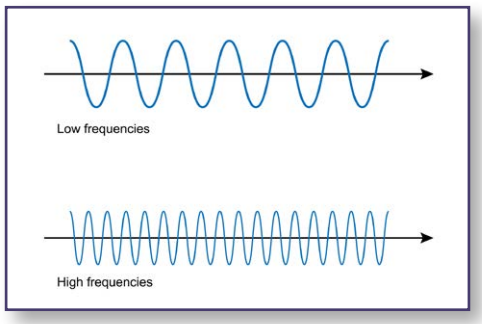
Continued from page 25

Level	Perceived exertion ("label")	Level	Perceived exertion ("label")
0	Nothing at all	5.0	Strong
0.5	Very very weak (just noticeable)	6.0	
1.0	Very weak	7.0	Very strong
2.0	Weak (light)	8.0	
3.0	Moderate	9.0	
4.0	Somewhat strong	10.0	Very very strong (almost max)

Figure 1. Borg's Category Ratio-Scale (CR-10)[1]



Frequency allows both patients and the medical team to track how often pain occurs.

Pain Evaluation and Management Tool at each visit truly pays off. It helps organize and track pain-related items for both the medical team and patient, a clear tool for one-stop evaluation and communication specific to what likely brought any particular patient into your office asking for help.

Timing has three components: "WHEN pain happens", "HOW LONG has the pain been going on" and its relation to an event. These key points let us really dial in perspective. Timing triggers for pain, such as the first few steps in the morning or after lifting a heavy object, are important clues to diagnosis and the origins of said pain. It is also a necessary element used when crafting the treatment plan for pain mitigation. For example, activity pain like a 20-minute walk after a long period of inactivity may require proper stretching and muscle warming, whereas pain due to diagnoses like sprains, fractures, and overuse syndromes, requires rest.

Timing addresses when pain occurs, providing relevant context.

Current Practice

Through these valiant efforts to quantify something that is so subjective as an individuals' pain, it is helpful to have a set of clinical filtered lenses to sharpen this picture. One of the first things we do during the history and physical exam is to look at "Constitution." For example, is the patient oriented to person, place, time, and other such questions? How a person relates his or her experience of pain is often colored by their "pain constitution." Consider the patient who presents with the throbbing pain of an infected toe versus the way a drug seeker or hypochondriac will represent pain. And then there are the stoics, who are usually in your office because a loved one threatened them, they are really scared, or they have a body part in their hand in need of reattachment! In such relaxed or excited states, it still stands true that the way you ask a question is not enough.

Current self-report scales include:

- Numerical rating scales (NRS) use numbers to rate pain (see Figure 1, but note that this is a self-report tool meant to measure the perceived intensity of pain but is not relatable or cohesive with other QDRIFT considerations).[1]
- Visual analog scales (VAS) typically ask a patient to mark a place on a scale that aligns with their level of pain (see Figure 2).[4,5]
- Categorical scales use words as the primary communication tool and may also incorporate numbers, colors, or relative location to communicate pain.

When used for pain, these standardized scales all provide discrete documentation but without enough context or focus on communication.[6] On any scale, or from any clinical perspective, if pain is problematic, then the lack of pain can be catastrophic. Consider the patients who present with peripheral neuropathy which is often associated with loss of protective sensation (LOPS). Wounds are allowed to go undetected until perhaps the patient sees blood on their sock. By then, especially in cases with diabetes and peripheral arterial disease, tissues are undermined, infected, and covered with bioburden, and the need for surgical intervention or a limb salvage procedure may be a short time away but leave you teetering atop a very slippery slope. Catching these patients early and dosing them with effective counseling often makes the difference between loss of limb segment and more walks on the beach.

A Word About Peripheral Neuropathy

Indeed, the world of peripheral neuropathy (PN) is a concerning and mercurial place to reside, filled with missteps and misinformation. PN often begins at our most distal regions with seg-

Continued on page 29

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Continued from page 27

Figure 2. Example of more visual correlation to address the reflection issues of such scales.[4]

mental numbness, burning and/or tingling, yet the patient's physical exam could appear within normal limits. As the condition worsens, the symptoms become more noticeable and extend to the larger, more proximal foot regions. They also take on more curious components such as dysethesias. These are not a lack of sensation, but rather, inaccurate or "abnormal sensations" reported to the brain, such as feet feeling "ice cold" when they are warm to the touch or feeling like there is a "wad of sock" under the distal metatarsal heads as well as countless others. Phantom pain is a similar type of dysethesia, characterized by an unpleasant sensation radiating from an amputated body part.

The larger point to this pathological phenomenon is that messages from this body cannot be trusted and that regular examinations, by both patient and doctor are not just recommended, but strongly advised. One might also include imaging studies and targeted lines of inquiry like a Fall Risk Assessment. These patients often have, or progress to an abnormal and unsteady gait stemming from a lack of foot awareness and positioning referred to as proprioception. Textured orthoses and ankle-foot-orthosis bracing may be a wise choice to protect these neurologically impaired patients.

Why Use QDRIFT?

The QDRIFT tool improves evaluation and management, allowing your patients to help you gain context and facilitate actionable and accurate care. The new data enables you to boost accountability. You enable entry into more precision care, with a more holistic approach.

The narrative your patient hears about QDRIFT will be imperative to make the tool work. Thus, using a standardized form to address each area of QDRIFT may save time and improve care. As a care provider, you are able to address progress and treatment success or failure more directly. With speedier accuracy in your care or treatment actions or recommendations, results may seem more immediate. A patient can not only feel but see their progress in their QDRIFT results over the course of the care plan. QDRIFT is a pain scale that facilitates understanding of goals and expected outcomes.

Why change the current, unstandardized, non-specific, and cookie-cutter style of recording pain, which is usually an afterthought? Because it is deficient in so many areas. QDRIFT is a more comprehensive tool that takes into account all qualifiers that allow for understanding, diagnosing, and assessing treatment and ultimately, improving patient outcomes.

Jay Segel, DPM, has been a private practice podiatrist in Martha's Vineyard, MA, where he has seen patients for nearly 40 years.

Sally Crawford, MS, has been working in biomechanics and precision medicine fields specializing in technology and data driven models of care for 15 years.

Jason Kraus, BS, has been in the medical device industry for more than 40 years and is co-founder of Orthotica Labs, which was established in 2022.

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Continued from page 29

QDRIFT Communication Tool for Evaluation & Management of Pain

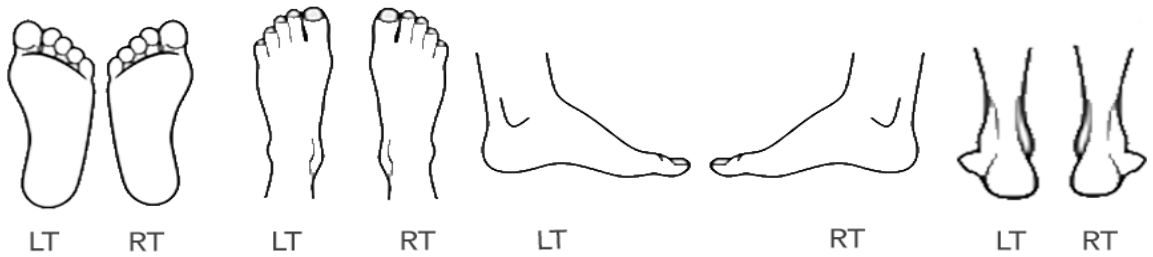
Patient Name: _____ Date of Birth: _____/_____/_____

Check all that apply

Primary Site(s) of Pain—Where is pain located?

Nails Toes Interspace	Ball of Foot Arch	Heel Top Bottom	Lower Leg Ankle

Is this affecting you right now? Yes No



Quality of Pain—How does the pain feel?			
☐ Sharp ☐ Throbbing ☐ Stiff ☐ Burning	☐ Radiating ☐ Dull ☐ Sore ☐ Achy	☐ Itchy ☐ Pain on Palpation ☐ Changing	☐ Phantom Pain ☐ Cramping ☐ Unchanged
Duration—How long does the pain last?			
☐ Constant ☐ Intermittent	☐ Momentary ☐ Increasing	☐ Decreasing	☐ Unchanged
Region—Boundaries of the pain?			
☐ Expanding ☐ Contracting	☐ Limited ☐ Referred	☐ Multifocal	☐ Unchanged
Intensity—How strong is the pain?			
☐ Awareness ☐ Sensitive ☐ Discomfort ☐ Mild	☐ Moderate ☐ Tolerable ☐ Limit Activities	☐ Affecting Activities of Daily Living ☐ Avoid Activities ☐ Debilitating	☐ Cannot bare weight ☐ Unchanged ☐ Better ☐ Worse
Frequency—How often pain occurs?			
☐ Daily ☐ Nightly	☐ Constant ☐ Intermittent	☐ Increasing ☐ Decreasing	☐ Unchanged
Timing—When does the pain occur?			
☐ Morning ☐ After Activity	☐ After Exercise ☐ At night	☐ Acute ☐ Chronic	☐ After Surgery ☐ After Trauma

What makes it better/worse: _____

_____

For Healthcare Team Member: Clinical Lens			
☐ Neuropathic ☐ Stoic ☐ Hypersensitive	☐ On Pain Medication ☐ Self-Medicating ☐ Non-Communicative	☐ Within Normal Limits ☐ Past Addictions ☐ Present Additions	☐ Other:

Patient Signature: _____ Date: _____/_____/_____

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Amanda Meszaros
DPM, FACFAS

James McGuire
DPM PT LPed, FAPWHc

Windy Cole
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Matthew Regulski
DPM, FFPM RCPS (Glasg)

Robert Conenello
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Ian Griffiths

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DPM

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AGENDA

- SURGERY: Medial Column Biomechanics and Surgical Implications
- Huge E&M Changes Are Here! Now!
- SURGERY: Treatment of Navicular Fractures in Athletes
- BIOMECHANICS: Out of the Box
- WOUND CARE: The Role of Artificial Intelligence in Wound Management
- SURGERY: Midfoot Arthrodesis-Clinical Pearls and Cases
- ORTHOBIOLOGICS: Fundamental Concepts and Terms
- SURGERY: Complications in First Ray Surgery
- POD MED: Podiatric Dermatology Pearls you can use on Monday
- WOUND CARE: Management of soft tissue defects of the heel
- Limb Salvage Expert Panel Discussion
- SURGERY: Minimally Invasive Surgical Techniques of the First Ray
- SURGERY: Principles & Practice of Pediatric Flatfoot
- Endocrinology Expert Panel Discussion
- SURGERY: Endoscopic Calcaneoplasty (What? Why? How?)
- SURGERY: Application Of Anatomage In Surgical Amputation Medicine
- BIOMECHANICS: Should we consider color when prescribing foot orthoses?

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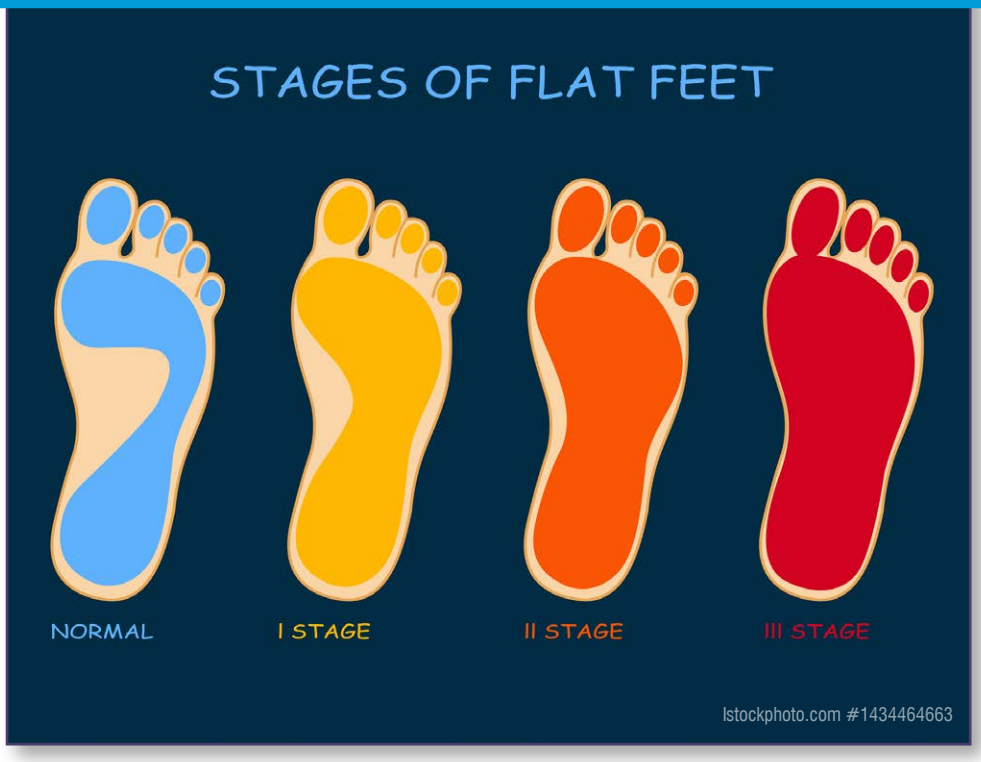
15 Rules for Foot Orthosis Prescription for Pes Planus Patients

By Ji-Yong Jung, Chang-Min Yang, Jung-Ja Kim



Researchers have developed a decision tree algorithm that they propose can be used to accurately and easily prescribe customized foot orthoses to patients with pes planus.

Pes planus, one of the most common foot deformities, includes the loss of the medial arch, misalignment of the rearfoot, and abduction of the forefoot, which negatively affects posture and gait. Foot orthosis, which is effective in normalizing the arch and providing stability during walking, is prescribed for the purpose of treatment and correction. Currently, machine learning technology for classifying and diagnosing foot types is being developed, but it has not yet been applied to the prescription of foot orthosis for the treatment and management of pes planus.

The aim of this study is to propose a model that can prescribe a customized foot orthosis to patients with pes planus by learning from and analyzing various clinical data based on a decision tree algorithm called classification and regressing tree (CART).

Methods

CART is a representative algorithm for generating decision trees. This study used clinical data from 1,548 patients diagnosed with pes planus at the Department of Rehabilitation Medicine of Chungnam National University Hospital in Daejeon, Republic of Korea. Pes planus was diagnosed based on the results measured by a professional clinician with a goniometer (universal goniometer and gravity goniometer) and an inclinometer.

Twenty independent variables related to the diagnosis of pes planus in patients were considered. All variables were preprocessed through importance analysis. Through data preprocessing, the study was conducted with a total of 418 data. Then, the following 9 variables affecting the prescription of foot orthosis were selected out of the original 20: age, hip internal rotation (HIR), transmalleolar angle on the left side (TMA-L), inversion angle of the subtalar joint on the left side (IASTJ-L), eversion angle of the subtalar joint on the left side (EASTJ-L), eversion angle of the subtalar joint on the right side (EASTJ-R), forefoot to rearfoot angle on the right side (FFRF-R), resting calcaneal stand position angle on the left side (RCSPA-L), RCSP angle on the right side (RCSPA-R).

Two types of foot orthoses—gait plate (GP) and arch support orthosis with heel cups ASOHC—were used as a dependent variable in this study. A GP is a special type of orthosis that is prescribed to limit in-toeing gait due to increased internal hip rotation and femoral anteversion with pes planus. ASOHC, designed to support the medial longitudinal arch and heel, is recommended to reduce rearfoot pronation, the collapse of the longitudinal arch, and foot instability. Two types of foot orthoses were customized for each patient's foot. Plaster casting was used to capture the shape of the patient's foot. Then, based on patient-specific measurements, a GP or ASOHC prescribed by an expert clinician was manufactured.

This article has been excerpted from "Decision Tree-Based Foot Orthosis Prescription for Patients with Pes Planus," which was published in the International Journal of Environmental Research and Public Health. 2022;19(19):12484. doi: 10.3390/ijerph191912484. Editing has occurred, including the renumbering of tables, and references have been removed for brevity. Use is per CC BY.

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Table 1. The 15 rules for the prescription of foot orthoses.

		Rules
GP	1	RCSPA-L ≤ −7.5°, Age ≤ 12 years
	2	RCSPA-L ≤ −7.5°, Age ≤ 12 years, RCSPA-L ≤ −5.5°, FFRF-R ≤ 1.5°
	3	RCSPA-L ≤ −7.5°, HIR = abnormal, RCSPA-R ≤ −6.5°, EASTJ-L ≤ 10.5°
	4	RCSPA-L ≤ −7.5°, HIR = abnormal, RCSPA-R ≤ −6.5°, EASTJ-R ≤ 15.5°
	5	RCSPA-L ≤ −7.5°, HIR = abnormal, RSCPA-R ≤ −6.5°, EASTJ-R ≤ 15.5°, EASTJ-L ≤ 14.5°
	6	RCSPA-L ≤ −7.5°, Age ≤ 12 years, RCSPA-L ≤ −5.5°, TMA-L ≤ −1.0°, IASTJ-L ≤ 46.5°, EASTJ-L ≤ 14.5°
	7	RCSPA-L ≤ −7.5°, Age ≤ 12 years, RCSPA-L ≤ −5.5°, TMA-L ≤ −1.0°, IASTJ-L ≤ 46.5°, EASTJ-L ≤ 14.5°, EASTJ-R ≤ 11.0°, RCSPA-R ≤ −4.5°
ASOHC	1	RCSPA-L ≤ −7.5°, HIR = Normal
	2	RCSPA-L ≤ −7.5°, Age ≤ 12 years, RCSPA-L ≤ −5.5°, TMA-L ≤ −1.0°
	3	RCSPA-L ≤ −7.5°, Age ≤ 12 years, RCSPA-L ≤ −5.5°, FFRF-R ≤ 1.5°
	4	RCSPA-L ≤ −7.5°, HIR = abnormal, RCSPA-R ≤ −6.5°, EASTJ-L ≤ 10.5°
	5	RCSPA-L ≤ −7.5°, HIR = abnormal, RCSPA-R ≤ −6.5°, EASTJ-R ≤ 15.5°, EASTJ-L ≤ 14.5°
	6	RCSPA-L ≤ −7.5°, Age ≤ 12 years, RCSPA-L ≤ −5.5°, TMA-L ≤ −1.0°, IASTJ-L ≤ 46.5°
	7	RCSPA-L ≤ −7.5°, Age ≤ 12 years, RCSPA-L ≤ −5.5°, TMA-L ≤ −1.0°, IASTJ-L ≤ 46.5°, EASTJ-L ≤ 14.5°, EASTJ-R ≤ 11.0°
	8	RCSPA-L ≤ −7.5°, Age ≤ 12 years, RCSPA-L ≤ −5.5°, TMA-L ≤ −1.0°, IASTJ-L ≤ 46.5°, EASTJ-L ≤ 14.5°, EASTJ-R ≤ 11.0°, RCSPA-R ≤ −4.5°

HIR, hip internal rotation; TMA-L, transmalleolar angle on left side; IASTJ-L, inversion angle of subtalar joint on left side; EASTJ-L, eversion angle of subtalar joint on left side; EASTJ-R, eversion angle of subtalar joint on right side; FFRF-R, forefoot to rearfoot angle on right side; RCSPA-L, resting calcaneal stand position angle on left side; RCSPA-R, RCSP angle on right side.

Results

The CART decision tree method used in this study is among the most effective and practical algorithms for classification and prediction. This method can be applied to foot orthosis prescription due to its ease of classification by making easy-to-understand rules in an if-then format. Hence, the visualized tree-based model can be effectively utilized for decision making by physicians about prescribing foot orthoses.

The 15 rules—7 for GP and 8 for ASOHC—for prescribing the 2 types of foot orthoses are shown in Table 1.

The accuracy of the foot orthosis prescription for patients with pes planus, based on the CART algorithm used, is 80.16%. The results of GP prescription showed 89.66% precision, 73.24% sensitivity, and 80.62% f1 score. In the results of ASOHC prescription, the precision, sensitivity, and f1 score were 72.06%, 89.09%, and 79.67%, respectively.

Discussion

Pes planus, commonly known as flat foot, is a structural deformity defined as a condition accompanied by a decrease in the medial longitudinal arch height, rearfoot valgus, and lateral deviation of the forefoot. In previous studies, it has been reported that pes planus is often associated with rotational abnormalities of the lower extremities and increased internal rotation of the hip. It is estimated that the prevalence of pes planus is approximately 20% to 37% of the population. This deformation negatively affects the shock absorption from the ground, resulting in foot fatigue, pain, abnormal gait, and postural imbalances. Foot orthosis is most frequently cited as a conservative (non-surgical) intervention for the treatment and management of pes planus. A customized foot orthosis has been prescribed based on the diagnosis results of clinicians to control rearfoot alignment, correct posture, provide comfort, and reduce abnormal movement.

In this study, the authors confirmed the classification accuracy of the CART model for foot orthosis prescription using evaluation metrics. The CART model that was developed prescribes 2 types of foot orthoses in consideration of the various biomechanical characteristics of patients with pes planus: GP and ASOHC. Based on the evaluation results on feature importance, it was confirmed that RCSPA, EASTJ, HIR, TMA, FFRF, and IASTJ were important parameters in prescribing foot orthosis. Age has also been found to be an important factor in prescribing foot orthosis. This result is consistent with previous studies suggesting that excessive joint mobility affecting arch height reduction, rearfoot valgus, and forefoot abduction can manifest differently with age.

Conclusions

Although detailed factors for a patient may affect the accuracy of prescription, the CART model for prescribing a foot orthosis in consideration of the importance and measurement value for biomechanical variables can be utilized to assist expert clinicians. The CART algorithm-based method that was presented in this study resulted in the generation of 15 rules based on the importance of the 9 variables related to foot orthosis prescription identified.

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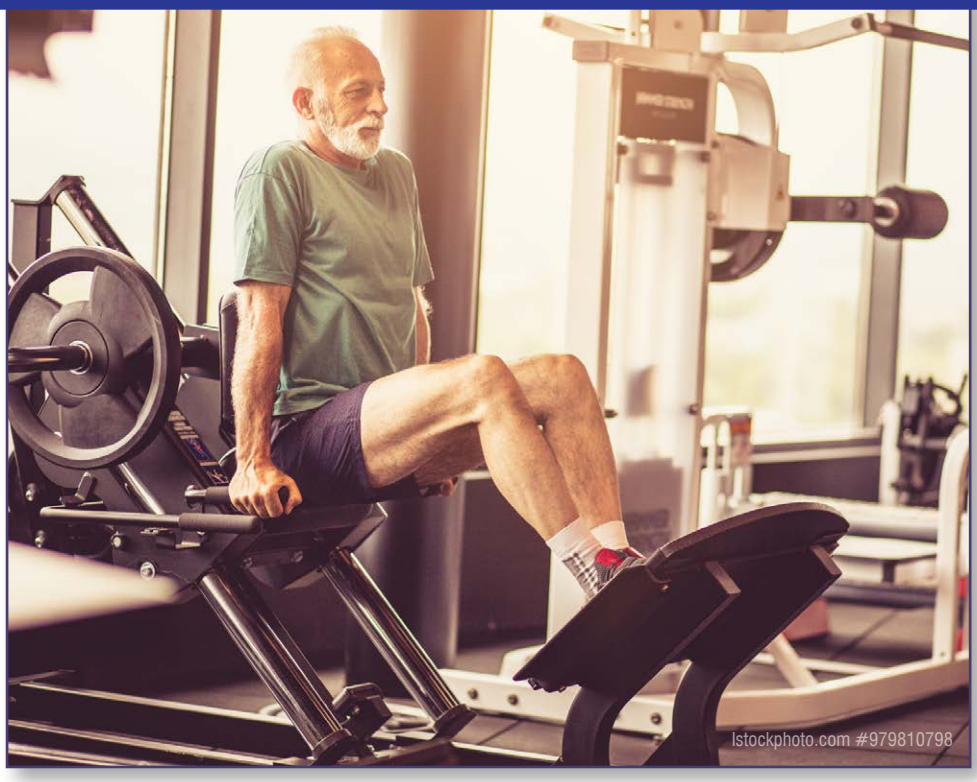
The Effects of Exercise on the Geometry and Bone Mineral Density of Femoral Neck Strength

By Dermot O'Rourke, Belinda R. Beck, Amy T. Harding, Steven L. Watson, Peter Pivonka, Saulo Martelli



Physical exercise induces spatially heterogeneous adaptation in bone. However, it remains unclear where the changes in bone mineral density (BMD) and geometry have the greatest impact on femoral neck strength.

Osteoporotic hip fractures are a considerable cause of morbidity and mortality and occur in specific local regions where strain exceeds tissue strength. Focal bone loss in osteoporosis has been found to play a key role in determining fracture risk and fracture location. Meanwhile, the mechanical loading associated with exercise can cause higher than normal strain in certain locations, which elicits a spatially heterogeneous adaptative response in the bone to improve resistance to future strain. However, the relative contributions of spatially heterogeneous adaptations in bone mineral density (BMD) and geometry on femoral neck strength are not well understood. Additionally, there are contrasting opinions on where spatially heterogeneous adaptation in the proximal femur has the greatest impact on its strength.

Toward that end, the aim of this study was to determine the principal BMD-and-geometry changes induced by exercise that have the greatest effect on femoral neck strength. A secondary aim was to compare BMD-and-geometry changes caused by an established exercise protocol to controls based on those BMD-and-geometry changes most associated with changes in strength.

Methods

Pre- and post-exercise intervention DXA scans (an imaging test that measures bone density) were obtained of the non-dominant proximal femur from male participants with osteoporosis and osteopenia (67±7 years) in Australia's LIFTMOR-M (Lifting Intervention for Training Muscle and Osteoporosis Rehabilitation for Men) 8-month semi-randomized controlled targeted exercise intervention trial, which was designed to reduce the risk of osteoporotic fracture in older men with low bone mass. The participants were from 3 groups: a high-intensity progressive resistance and impact training group (HiRIT, n=34), a machine-based isometric axial compression group (IAC, n=33), and a control group of sex- and age-matched participants from the same community (67±6 years) (n=25). The HiRIT program consisted of multi-joint, compound movement, high-intensity progressive resistance training, and high-impact jumping exercises. The IAC program incorporated self-initiated near-maximal 5-second isometric contractions performed for the chest press, leg press, core pull, and vertical lift exercises using the bioDensity™ system. The trial protocol has been published describing the exercise interventions and control group activities.

Meshes with element-by-element correspondence were generated by morphing a template mesh to each bone to calculate changes in BMD and geometry. Finite element (FE) models predicted femoral neck strength changes under single-leg stance and sideways fall load (Fig. 1). Partial least squares regression (PLSR) models

This article has been excerpted from "Geometry and Bone Mineral Density Determinants of Femoral Neck Strength Changes Following Exercise," which appeared in Biomechanics and Modeling in Mechanobiology in October 2022. https://doi.org/10.1007/s10237-022-01642-w. Editing has occurred, including the renumbering of tables, and references have been removed for brevity. Use is per CC BY 4.0.

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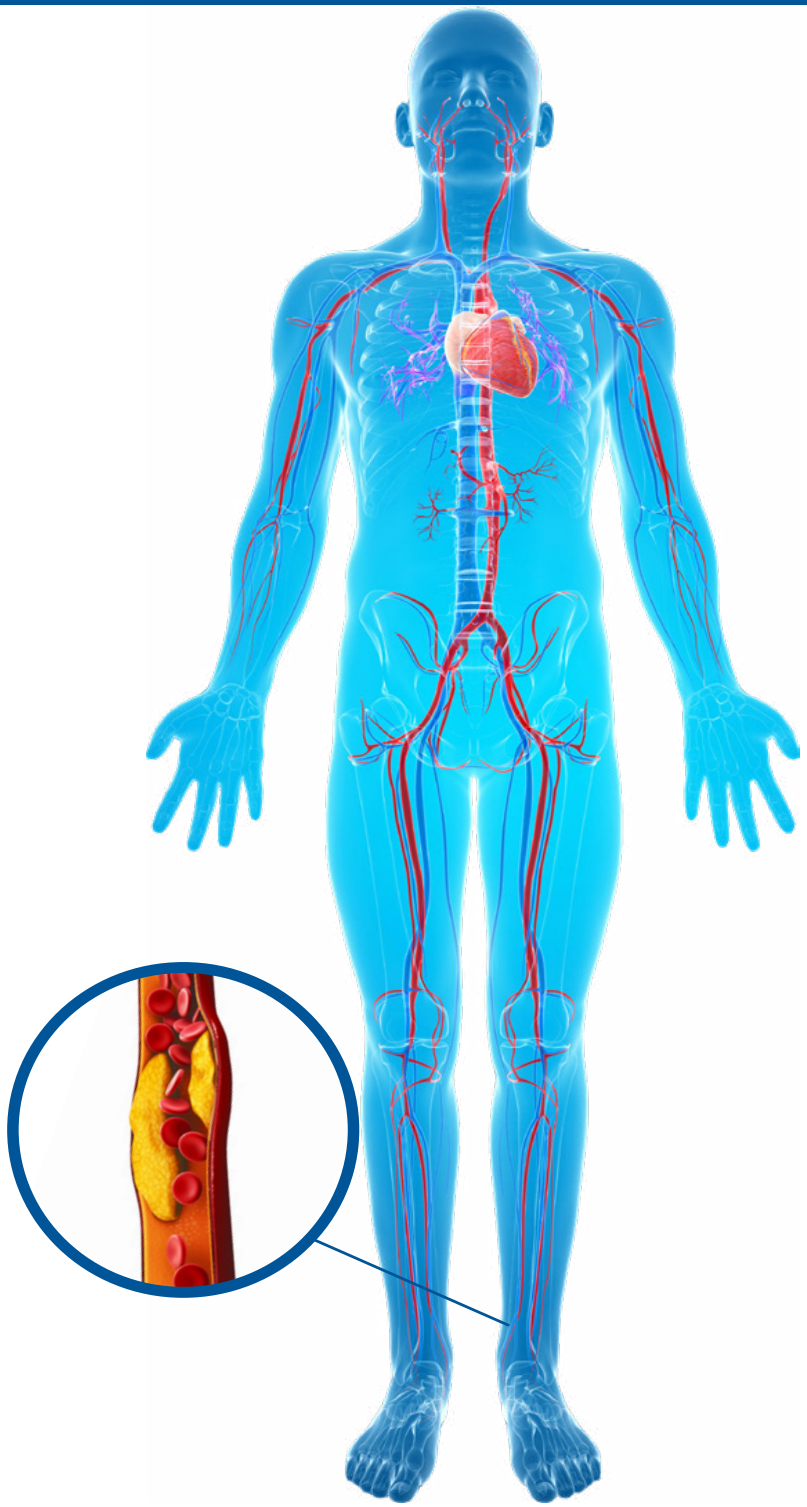

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Continued from page 39

Table 1 Mean ± standard deviation for total hip volumetric BMD, single-leg stance strength (SLS), and sideways fall strength (SF) changes in the high-intensity progressive resistance and impact (HiRIT) group, the isometric axial compression (IAC) exercise group, and control group

	Control ($n=25$)			HiRIT ($n=34$)			IAC ($n=33$)		
	Baseline	Follow-up	% change	Baseline	Follow-up	% change	Baseline	Follow-up	% change
vBMD (g/cm^3)	0.29 ± 0.04	0.29 ± 0.04	−0.1 ± 2.4	0.27 ± 0.03	0.28 ± 0.04	0.93 ± 2.6	0.272 ± 0.025	0.274 ± 0.025	0.87 ± 3.3
SLS (N)	4021 ± 499	4093 ± 520	1.9 ± 6.2	3801 ± 632	3837 ± 651	1.2 ± 8.6	3770 ± 574	3850 ± 531	2.5 ± 5.8
SF (N)	1699 ± 340	1704 ± 332	0.6 ± 6.2	1501 ± 291	1533 ± 301	2.3 ± 7.2	1523 ± 266	1564 ± 273	2.9 ± 7.4

were developed with (1) combined geometry and BMD, (2) geometry only, and (3) BMD only to determine the principal modes that explained the greatest variation in neck strength changes.

Results

The BMD-only PLSR model explained over 90% of the strength variation in single-leg stance and sideways fall across all participants with 3 PLS components ($R^2>0.92$, root mean square error (RMSE)<0.06 N). The geometry-only models explained over 90% of the strength variation in single-leg stance and sideways fall with 8 PLS components ($R^2>0.93$, RMSE<0.06 N). The combined BMD-and-geometry models were closer to the BMD-only models, explaining 90% of the bone strength variation in both single-leg stance and sideways fall with 5 PLS components each ($R^2>0.93$, RMSE<0.06 N).

The first 3 modes of variation of the BMD-only models displayed similar patterns of BMD changes for both single-leg stance and sideways fall. The largest BMD changes (±0.1 g/cm^3) were found in the cortex distal to the femoral neck for the first mode of variation. The second mode displayed focal changes (±0.06 g/cm^3) in the distal cortex, superior and inferior neck cortex, and the medial femoral head. The third mode showed the largest BMD changes (±0.05 g/cm^3) in the distal cortex and superior femoral head, while BMD changes in the superior neck were slightly larger for the sideways fall load case as compared to the single-leg stance load case. Similarly, the first 2 modes of variation of the geometry-only models for single-leg stance and sideways fall displayed the largest changes in the proximal femoral shaft and femoral head and the femoral neck. However, the variable importance in projection (VIP) scores indicated that the most important BMD changes for femoral neck strength differed between sideways fall and single-leg stance. During sideways fall, the most important regions were those of the superior femoral head and lateral trochanteric region, while during single-leg stance the most important BMD changes were those of the superior neck and the distal cortex. The VIP scores for geometry changes confirmed the importance of the femoral neck during single-leg stance and the trochanteric and head regions during a sideways fall.

Comparing vBMD and strength changes, there were no statistically significant differences between groups for vBMD changes ($F=1.05$, $P=0.36$) nor in strength changes either for single-leg stance ($F=0.26$, $P=0.77$) and sideways fall ($F=0.83$, $P=0.77$) as determined by 1-way ANOVA (Table 1). However, differences were observed between the control group and both the HiRIT and IAC groups using the PLS modes in the geometry-only, and the geometry-and-BMD models. Specifically, a Bonferroni post hoc test indicated that both the HiRIT and IAC groups had significantly higher PLS component 2 scores in single-leg stance and PLS component 1 scores in sideways fall. No difference in PLS component scores was found between the HiRIT and IAC groups.

> Mechanical loading associated with exercise can cause higher than normal strain in certain locations, which elicits a spatially heterogeneous adaptative response in the bone to improve resistance to future strain…

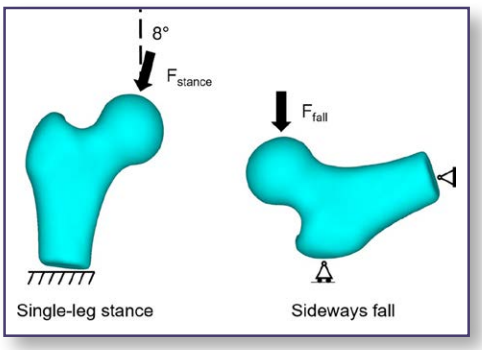

Figure 1. Single-leg stance and sideways fall loading conditions simulated to calculate the change in femoral neck strength.

Discussion

The current study determined the principal BMD-and-geometry changes induced by exercise that explained most of the variation in femoral neck strength. Changes to BMD in the superior neck, inferior neck, and greater trochanter primarily explained the variation in neck strength changes seen in the group of middle-aged and older men with osteopenia and osteoporosis in single-leg stance and sideways fall loading. Local changes in femoral neck and head geometry could differentiate the exercise groups from the control group, but not in predicted strength changes. Exercise interventions may target BMD changes in the superior neck, inferior neck, and greater trochanter for improved femoral neck strength in single-leg stance and sideways fall.

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Stingray Injuries of the Lower Extremity Treated at United States Emergency Departments

By Mathias B. Forrester, BS

Background: Stingray injuries may occur as a result of stepping on stingrays or while handling stingrays when fishing. Over 1,000 stingray injuries are estimated to occur in the United States (US) annually. The objective of this study was to characterize stingray injuries of the lower extremity treated at emergency departments (EDs).

Methods: An analysis was performed of stingray injuries of the lower extremity using data from the National Electronic Injury Surveillance System of the US Consumer Product Safety Commission during 2000-2021.

Results: An estimated 59,119 stingray injuries of the lower extremity treated at US hospital EDs during 2000-2021 were identified. The patient age was 1.5% 0-5 years, 11.3% 6-12 years, 12.8% 13-19 years, and 74.5% 20 years or older; 58.6% of the patients were male and 41.4% female. The most frequently reported activities associated with the injury were swimming (91.4%), fishing (4.5%), and surfing (2.4%). The distribution of injuries by 3-month period was 41.3% in June-August, 27.1% in September-November, 5.7% in December-February, and 26.0% in March-May. The affected body part was 89.8% foot, 3.7% toe, 3.6% ankle, 1.9% lower leg, 0.6% knee, and 0.4% upper leg. The patient was treated or examined in the ED and then released in 99.3% of the time.

Conclusions: Stingray injuries of the lower extremity most frequently occurred while swimming. The injuries were seasonal, most often occurring in the summer. The body part most often injured was the foot. The majority of patients were treated or examined and released from the ED.

Stingrays are cartilaginous fish related to sharks with round, flattened bodies and whip-like tails. Stingrays are common to shallow intertidal areas of tropical and subtropical oceans around the world, although some rays inhabit cooler waters and freshwater.[1-5] While there are approximately 150 species of ray worldwide, one to two dozen stingray species are found along the United States (US) coasts.[4,5]

Stingrays have one–three venomous barbed (serrated) blades (spines) on the dorsal aspect of their tails.[2,3,5] Stingray venom contains cystatins, peroxiredoxin, and galectin;[6] the toxicity varies by species.[5] Stingrays typically are not aggressive and usually only attack when provoked.[1] Stingray injuries may occur as a result of stepping on stingrays, usually affecting the lower extremities, or while handling stingrays when fishing, usually involving the upper extremities.[1-4,7] Stingrays sting more people annually than any other fish, and it is estimated that over one thousand stingray injuries occur in the US annually.[2,8]

Contact with a stingray blade may cause localized trauma (puncture wound or laceration), bleeding, intense pain, edema, and discoloration and may result in blistering, tissue necrosis, and secondary infection.[1-5,7,9,10] Systemic effects may include nausea, vomiting, diarrhea, headache, fever, chills, seizures, generalized edema, muscle cramping, tremors, weakness, limb paralysis, hypotension, bradycardia, convulsions, and syncope.[1,2,4,5,7,9] Although uncommon, deaths have been reported from stingray injuries,[1-4] notably that of wildlife expert Steve Irwin in 2006.[11]

The objective of this investigation was to describe stingray injuries of the lower extremity treated at US hospital emergency departments (EDs).

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Table 1. Time period and patient demographics of stingray injuries of the lower extremity treated in United States emergency departments, National Electronic Injury Surveillance System, 2000-2021

Variable	No.		Est.		
	No.	%	No.	%	95% CI
Treatment 3-month period					
December-February	48	5.4	3,349	5.7	2,145-4,553
March-May	232	26.1	15,347	26.0	11,631-19,063
June-August	372	41.8	24,396	41.3	19,024-29,769
September-November	238	26.7	16,026	27.1	12,182-19,871
Treatment day of week					
Saturday-Sunday	398	44.7	26,375	44.6	20,654-32,096
Monday-Friday	492	55.3	32,744	55.4	25,924-39,563
Patient age (years)					
0-5	13	1.5	896	1.5	-
6-12	99	11.1	6,653	11.3	4,690-8,616
13-19	115	12.9	7,543	12.8	5,388-9,698
20-29	121	13.6	8,073	13.7	5,806-10,340
30-39	165	18.5	10,876	18.4	8,033-13,720
40-49	181	20.3	12,049	20.4	8,972-15,126
50+	196	22.0	13,029	22.0	9,760-16,299
Patient sex					
Male	521	58.5	34,670	58.6	27,525-41,815
Female	369	41.5	24,449	41.4	19,067-29,831
Total	**890**		**59,119**		**48,017-70,220**

No. = Number.

Est. = Weighted estimate (sum of the Weight numeric field in the National Electronic Injury Surveillance System database). The numbers in the Weight field are not whole numbers but include decimals. As a result of rounding to whole numbers when performing analyses, the sum of the estimates for a given variable might not equal the total. The Consumer Product Safety Commission considers an estimate unstable and potentially unreliable when the number of records used is <20 or the estimate is <1,200.

95% CI = 95% confidence interval. Not calculated if the estimate is <1,200.

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Table 2. Circumstances of stingray injuries of the lower extremity injuries treated in United States emergency departments, National Electronic Injury Surveillance System, 2000-2021

Variable	No.		Est.		
	No.	%	No.	%	95% CI
Location of incident					
Place of recreation or sports	694	78.0	46,262	78.3	37,205-55,319
Other public property	184	20.7	12,113	20.5	9,024-15,203
Home	2	0.2	166	0.3	-
Street or highway	1	0.1	68	0.1	-
Not recorded	9	1.0	509	0.9	-
Activity					
Swimming	808	90.8	54,060	91.4	43,755-64,365
Fishing	43	4.8	2,663	4.5	1,630-3,696
Surfing	25	2.8	1,434	2.4	727-2,140
Other/unknown	14	1.6	961	1.6	-
Total	**890**		**59,119**		**48,017-70,220**

Please see full footnote on Table 1.

Methods

This study used data downloaded from the National Electronic Injury Surveillance System (NEISS) website at https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx. The NEISS has been described in detail previously.[12] Briefly, the NEISS collects data on consumer product-related injuries from the EDs of a stratified random sample of 100 US hospital EDs. NEISS coders view the medical charts at participating hospitals and, for patients with injuries that meet NEISS inclusion criteria, collect and code information such as treatment date; patient age, sex, and race; injury diagnosis and body part injured; discharge disposition; consumer product(s) involved in the injury; location where the incident occurred; and a brief narrative describing the incident.[13-15] Since the data are publicly available and de-identified, the study is exempt from institutional review board approval.

Cases were stingray injuries of the lower extremity included in the NEISS database during 2000-2021. In order to identify cases, the Narrative text field (a brief summary of the circumstances of the injury) of all records was searched for any mention of both of the letter groups "sting" and "ray." For the resulting subset of records, the narrative field was reviewed to determine whether the injury appeared to be due to a stingray. Cases were included in the study only if the Body_Part numeric field contained codes for a lower extremity body part (upper leg, knee, lower leg, ankle, foot, toe). An additional numeric field (Body_Part_2) collects information if a second body part was injured (or the same body part experienced a different type of injury). However, this field was added in 2019, so data in the Body_Part_2 field were excluded from the analysis. The two cases with a lower extremity coded in the Body_Part_2 field also had a lower extremity coded in the Body_Part field.

The variables examined were the time of treatment (year, three month period, and day of week), patient age and sex, location where the injury incident occurred, activity during which the injury occurred, type of injury, body part affected, and patient disposition. The activity during which the injury occurred was identified by review of the Narrative text field and Product_1, Product_2, and Product_3 numeric fields and grouped into the following categories: swimming, fishing, surfing, and other/unknown.

Analyses were performed using Office Professional 2007 Access and Excel (Microsoft

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Corporation, Redmond, Washington, US). The distribution of cases and national injury estimates were determined for the variables. National injury estimates were calculated by summing the values in the Weight numeric field in the publicly available NEISS database, and 95% confidence intervals (CIs) were calculated for the estimates. The CPSC considers an estimate unstable and potentially unreliable when the number of records used is <20 or the estimate is <1,200.[13] For those variable subgroups where the estimate was <1,200, 95% CIs were not calculated.

Results

There were a total of 890 stingray injuries of the lower extremity treated at a sample of US hospital EDs during 2000-2021, resulting in an estimated 59,119 (95% CI 48,017-70,220) such injuries (88.4% of the 66,894 total estimated stingray injuries of any body part). The estimated annual number of stingray injuries of the lower extremity was 15,558 in 2000, declining to 164 in 2021. The mean annual estimated number of injuries was 8,112 during 2000-2005, 1,152 during 2006-2011, 325 during 2012-2016, and 370 during 2017-2021.

Table 1 presents stingray injuries of the lower extremity by time period and patient demographics. The highest proportion of injuries were treated in June-August and the lowest proportion in December-February. Almost 45% of the injuries were treated on the weekend. The majority (74.5%) of patients were adults, and most patients were male.

The majority of the injuries occurred at a place of recreation or sports or other public property, and most occurred while the patient was swimming (Table 2). Of the estimated 57,105 total stingray injuries of any body part that occurred while swimming, 54,060 (94.7%) involved the lower extremity. Of the estimated 7,191 total stingray injuries of any body part that occurred while fishing, 2,663 (37.0%) involved the lower extremity. All of the estimated 1,434 total stingray injuries that occurred while surfing involved the lower extremity.

Table 3 shows the distribution of stingray injuries of the lower extremity by type of injury and patient disposition. The majority of injuries were a puncture, and most of the injuries involved the foot. The majority of patients were treated or examined in the hospital ED and released.

Discussion

This study examined stingray injuries of the lower extremity treated in US hospital EDs. Over one thousand stingray injuries are estimated to occur in the US annually.[2,8] This study found that 88% of all estimated stingray injuries treated at hospital EDs involved the lower extremity. Thus, examination of the characteristics of stingray injuries focusing on the lower extremity may be particularly useful.

The estimated number of stingray injuries of the lower extremity declined during the 22-year period of the study. This may be due to a

decline in the total number of stingray injuries that occur or a decreasing proportion of stingray injuries being treated at hospital EDs. Two studies that examined stingray injuries reported to state poison centers found that the majority of patients were managed outside of a healthcare facility.[9,10] Moreover, people may be able to find information on how to treat a stingray injury on the internet. Thus, during the latter part of the study period, people may have increasingly sought treatment of stingray injuries outside of hospital EDs.

Changes in the NEISS itself also may account for the decline in the estimated number of stingray injuries. There may have been changes in the NEISS inclusion or exclusion criteria that resulted in fewer stingray injuries being included in the database. In addition, the specific hospitals that participate in NEISS change over time due to sample redesigns where another stratified random sample of hospitals is performed as well as changes in hospital size and the opening and closure of hospitals.[13-15] All hospitals are not equally likely to treat stingray injuries. Since stingrays are predominantly found in the ocean, hospitals closer to the coast may be more likely to treat stingray injuries. Furthermore, stingray injuries may be more likely to occur in coastal areas with larger human populations or where people are more likely to fish or take part in other aquatic activities (e.g., popular fishing spots or public beaches). The study of stingray injuries report to Texas poison centers found that 60% of the injuries were reported from counties along the coast and 33% of the injuries were reported from only two counties.[10] Therefore, changes in the hospitals participating in NEISS over time might affect the number of stingray injuries included in the database.

Stingray injuries of the lower extremity were seasonal, with the highest proportion treated in the summer (June-August) and the lowest proportion in the winter (December-February). The two poison center studies found over half of the stingray injuries were reported during June-August.[9,10] People may be more likely to engage in ocean activities, and thus more likely to encounter stingrays, in the summer. Almost 45% of the stingray injuries of the lower extremity were treated on the weekend, a time when people are more likely to have free time to engage in ocean activities.

The majority of patients were adults, and most patients were male. This is consistent with the poison center studies.[9,10]

The majority of stingray injuries of the lower extremity occurred while the patient was swimming with smaller proportions occurring when the patient was fishing or surfing. Moreover, 95% of all stingray injuries that occurred while the patient was swimming resulted in lower extremity injuries while only 37% of all stingray injuries that occurred while the patient was fishing resulted in lower extremity injuries. When swimming, a person might be more likely to be injured when they accidentally step on a stingray. In contrast, when fishing, a person might be more likely to receive injuries to other parts of the body, particularly, the upper extremity, as they try to handle a stingray.

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Table 3. Type of injury and disposition of stingray injuries of the lower extremity injuries treated in United States emergency departments, National Electronic Injury Surveillance System, 2000-2021

Variable	No.		Est.		
	No.	%	No.	%	95% CI
Type of injury					
Puncture	806	90.6	53,793	91.0	43,530-64,055
Laceration	22	2.5	1,537	2.6	802-2,272
Foreign body	17	1.9	1,121	1.9	-
Contusion or abrasion	2	0.2	135	0.2	-
Burn or scald	1	0.1	98	0.2	-
Nerve damage	1	0.1	68	0.1	-
Other/not stated	41	4.6	2,368	4.0	1,411-3,325
Body part affected					
Foot	796	89.4	53,070	89.8	42,922-63,218
Toe	35	3.9	2,213	3.7	1,296-3,130
Ankle	33	3.7	2,129	3.6	1,235-3,024
Lower leg	18	2.0	1,119	1.9	-
Knee	5	0.6	348	0.6	-
Upper leg	3	0.3	239	0.4	-
Disposition					
Treated or examined and released	879	98.8	58,703	99.3	47,666-69,739
Treated and admitted for hospitalization	9	1.0	394	0.7	-
Held for observation	1	0.1	6	0.0	-
Left without being seen/against medical advice	1	0.1	16	0.0	-
Total	**890**		**59,119**		**48,017-70,220**

Please see full footnote on Table 1.

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The majority of the stingray injuries involved the foot. This might be expected considering that people are most likely to encounter a stingray by stepping on the fish. The most frequently reported diagnosis was a puncture, and approximately 99% of the patients were treated or examined and released from the ED. Punctures and other reported injuries such as lacerations and foreign bodies might be considered relatively minor and usually not require hospitalization.

This study is subject to various limitations. The NEISS collects data on consumer product-related injuries in the US, although the definition of "consumer product-related" does include all injuries where a consumer product, sport, or recreational activity is associated with the reason for the visit or related to a condition treated.[14] Therefore, only those stingray injuries related to consumer products (including sport and recreational activities) would be included in the study, a subset of total stingray injuries. However, advantages of the NEISS database are that its data are publicly available and includes hospitals from all regions of the US. Another study limitation was that cases were identified by searching for the letter combinations "sting," and "ray" in the Narrative field, and the selection of records to be included in the study was performed by a single person. Errors in the selection of records may have resulted in records being included or excluded erroneously. Furthermore, only those stingray injuries of the lower extremity treated at hospital EDs were included in the study. The number of such injuries not seen at EDs (i.e., managed at home or by a private physician) is unknown.

In conclusion, stingray injuries of the lower extremity most frequently occurred while the patient was swimming. The injuries were seasonal, most often occurring during the summer. The majority of patients were adults, and most were male. The foot was the part most often injured. The majority of patients were treated or examined and released from the hospital ED. ler

Mathias B. Forrester, BS, is an independent researcher in Austin, Texas. Now retired, he previously performed public health research for various university and government programs for 34 years.

The majority of the injuries occurred at a place of recreation or sports or other public property, and most occurred while the patient was swimming

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BOOK EXCERPT

Practical Biomechanics: Treating Asymmetry

By Richard Blake, DPM

One of the most perplexing issues I deal with in biomechanics is trying to take asymmetrical functioning bodies and make them more symmetrical when I think it will help the patient's symptoms and function. However, asymmetry is part of who we are as people, so some thought has to be put into deciding exactly what needs to be changed because differences in biomechanics can cause chronic problems.

If you work with patients who are over 50 years old, you will spend incredible amounts of time trying to balance their foot function, balance their muscle strength and flexibilities, balance their short legs, etc. These imbalances tend to catch up with us in some fashion. A small asymmetry at the foot can become a big problem over the years. Yet, why are 95% of all orthotics I see prescribed symmetrical – including over-the-counter ones? They sure do not make our feet function that way.

Let us say that I correct for 5 degrees of pronation, for example, in a patient where one foot is 10 degrees everted in resting heel position and the other foot is 7 degrees everted in resting position (each degree at the foot is equivalent to 1/16th of an inch change in the average-sized patient). After the 5-degree change, one foot will now be 5 degrees everted and the other 2 degrees everted. The difference remains, although I agree we have moved the patient into a better position. When you simply take small differences in foot function (one more pronated than the other) combined with a short leg (80% of the population has a 1/16th inch or more discrepancy), along with the asymmetry produced by right-handedness vs. left-handedness, and then add an injury with some permanent weakness or stiffness, these differences easily become big issues. Why do you think 80% of all adults over 60 have back pain to some degree? It can't all be blamed on prolonged sitting and poor mattresses. I know it has something to do with what we can treat as podiatrists. I have found it good practice to aim for stability, aim for symptom relief, aim for symmetry, and try to do it as naturally as possible. We have to try to motivate our patients to work harder for their health (not an easy task).

Complete Symmetry?

One of the main questions then is, do we want to make people completely symmetrical? It takes a little time to learn what motions and positions cause an individual's problems. Sometimes the problems are permanently fixed, but the movement in medicine in general is to back off on full correction when the patient gets better. This does not apply to chronic conditions improved by orthotic devices or lifts for a short leg when that treatment brings complete or significant relief. These can also be congenital conditions like ligamentous laxity for which individuals will need stabilization their whole lives. Seeking symmetry is a goal that sometimes is needed to help someone completely resolve their problems. And sometimes, it is okay to accept asymmetry as long as the correction you have given has brought good symptom relief. However, I believe the patient should be part of the process and understand when lack of complete correction occurs. Years later, with some other problem, the patient – who may not even live in your area anymore – will remember that there could be more work to be done.

By measuring the relaxed calcaneal stance position we can get a feel for which foot is more pronated and treat with more correction.

One classic example concerns treating the biomechanics of windswept feet. These are feet that pronate on one side and supinate on the other, as if the wind was blowing hard from the right or left and was about to sweep them off their feet in the frontal or coronal plane. The prescription must be asymmetrical to control the abnormal pronation on one side and abnormal supination on the other. Other common examples are patients with the residual mechanics of a partially corrected clubfoot on one side, or the sudden change from one side developing stage 2 or 3 posterior tibial tendon dysfunction or post-operatively the changes from almost any lower extremity surgery. This list is long.

Richard Blake, DPM, MS, is adjunct faculty at the California School of Podiatric Medicine. He has practiced podiatry at the Sports and Orthopedic Institute of St. Francis Memorial Hospital in San Francisco, CA. His book, Practical Biomechanics for the Podiatrist, Book 1, is available from Amazon.com and Barnesandnoble.com, as well as from the publisher at bookbaby.com.

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MEDIUM		9-11	8.5-10	
LARGE		11.5-13.5	10.5-13	
X-LARGE		14+	13.5+	

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KneeCap™ Therapeutic Compression Wrap looks like a baseball cap, but is made of stretchy Neoprene and contains a reusable cold pack. That means it is able to compress, cool, and comfort knees, elbows, or heels while allowing people to stay mobile. Designed by Kathi Fairbend, MS, RPT, in collaboration with a Johns Hopkins–trained physician, these wraps are infinitely adjustable and offer cooling, compression, and comfort while allowing people to remain on the go rather than sitting around while icing. The unique design includes Ver2Flex technology, meaning the wrap can be worn with the brim pointed up toward the ceiling or down toward the floor, to target nerves, muscles, and tendons above or below the painful joint. The brim itself is made of a special material chosen to conform to a person's anatomy.

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DEVELOPMENT OF A LOW-COST 'SMART' ROLLATOR FOR CLINICAL REHABILITATION

Researchers from the University of Malaga in collaboration with the Polytechnic University of Catalonia, both located in Spain, have created an 'intelligent' rollator that evaluates patient movements to improve rehabilitation. With this system based on a standard model called Walk-IT, healthcare professionals receive better information about the progress of patients under treatment, allowing them to attend to a greater number of users with more accurate assessments.

The researchers started from a rollator commonly used in rehabilitation clinics and added modules that measure different parameters needed to monitor patients, such as cadence, step velocity or time, and stride length. In addition, the system can directly measure rollator position, speed, and applied forces. In addition to a control system, the researchers attached load gauges to the handles to measure the support exerted on each handle during walking. Encoders are also included on the rear wheels of the rollator to measure user speed and estimate stride length. A laser sensor detects feet movement, gait phases, or whether there are any nearby obstacles.

The open-source 'intelligent' rollator evaluates patient movements to improve rehabilitation.

The experts have confirmed that the data obtained from 11 patients undergoing treatment match and even improve the accuracy of those collected by therapists using the traditional observation method. The only drawback encountered is that visibility of the patient's legs is required for an adequate observation by the laser, since when wearing long skirts, for example, the data are not captured appropriately.

Both the hardware and the software are licensed open-source, which reduces the cost considerably and allows its widespread implementation. The system is available for consultation and download at github.com/TaISLab/WalKit.

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WEGYM's Rally X3 Pro smart resistance bands are made of PA+TPU material with a drop-resistant design. Fabricated from high-quality latex material, the product life offers up to 30,000 extensions, and the 10–110 lb. resistance level range makes it suitable for beginners to the proficient. With LCD display and precise workout sensors, stats can be viewed in real time. The WEGYM app provides intelligent tracking and customized courses to enhance the user's fitness routine. Users can view their resistance level, number of stretches, and calories burned and receive recommendations for future workouts. Built for heavy use, the X3 Pro also features lightweight, high-strength aluminum aviation carabiners. The wrist and ankle straps are durable and comfortable to keep skin from getting irritated. Professional-grade Velcro provides stable adhesion. Quality sliding clamps intensify the level of tension without the need to switch out bands.

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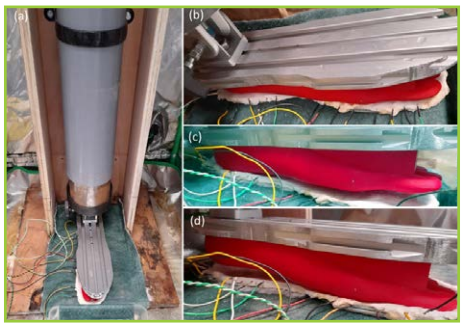
USING FUNGUS TO MEASURE GAIT

Biomaterials, such as mycelium bound composites, present a promising alternative to conventional smart insoles. They exhibit sensing and responsive capabilities without requiring additional space and external inputs to operate, using their own bioelectric activity. Fungal sensors offer increased biodegradability; they are self-sustainable as they can self-grow, self-repair, and self-assemble; they are abundant; and they offer low-technology cultivation. Moreover, they are inexpensive and easily scalable to produce customized insole sizes. Now, researchers at the Unconventional Computing Laboratory at the University of West England have assessed the electrical response of bespoke insoles made from capillary matting colonized with oyster fungi to compressive stress.

A test rig was developed using a prosthetic foot to apply compressive loading to insoles to replicate the weight of a human when walking and standing. Three modes of compressive loading were explored: toe bias, heel bias, and uniformly distributed. Electrical activity (spiking) was recorded in mycelium bound composites fabricated into insoles.



Bespoke insole test rig: (a) setup inside growth tent; (b) weight uniformly distributed via pivot joint on prosthetic foot; (c) heel bias; and (d) toes bias.

The experiments showed that the number and periodicity of electrical spikes changed when the mycelium was subjected to compressive loading. According to the researchers, this showed that it might be possible to discern the loading from the electrical response of the fungi to stimuli. The results advance the development of intelligent sensing insoles, which are a building block toward more generic reactive fungal wearables. Fungal based insoles offer augmented functionality (sensory) and aesthetic (personal fashion), they said.

MOVEMENT AND COMPRESSIONS (MAC) SYSTEM

The Movement and Compressions (MAC) System is a novel, data-driven, mobility measurement device designed for hospital and home use. It provides therapeutic compressions to the lower leg and displays real-time patient mobility data, empowering bedside caregivers with critical metrics to support the execution of in-hospital mobility and adherence to deep vein thrombosis (DVT) prophylaxis. This solution provides transparency and access to patient mobility data while seamlessly fitting into the complicated hospital workflow. Additionally, MAC embraces the continuum of care by providing at-risk patients discharged to the home setting access to the same mobility and compression data to actively engage and participate in their recovery.

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ILLINOIS TECH PROFESSOR FUNDED TO DEVELOP TREATMENT FOR DFUS

Papavasiliou

Illinois Institute of Technology (Illinois Tech) professor of biomedical engineering Georgia Papavasiliou, PhD, and her team are developing a novel ointment to treat chronically infected diabetic wounds that fail to heal, such as diabetic foot ulcers (DFUs).

They have received a second round of funding from the Pilot and Feasibility Program at University of Chicago's Diabetes Research and Training Center to advance their work. The team's approach examines the problems with current ointment manufacturing processes and forges a new path for controlled and sustained delivery of multiple therapeutics from a single ointment.

As most diabetic wounds develop a bacterial biofilm that makes bacteria stick together as well as to surfaces, including the wound bed, Papavasiliou has been collaborating with Associate Professor Seok Hoon Hong, PhD, from the Department of Chemical and Biological Engineering, to identify compounds that will both disperse an existing biofilm and suppress its regrowth.

Papavasiliou and S.C. Johnson Professor of Chemical Engineering Fouad Teymour, PhD, have developed a polymerization process to produce biocompatible ointments that contain multiple types of hydrogel nanoparticles. Each nanoparticle type can be precisely constructed to encase each drug and release it for the desired duration needed to perform its therapeutic mechanism of action. The nanoparticles are produced within the ointment phase, and the entire product can be delivered directly to wounded tissue to release the drugs on a set schedule for up to 40 days.

The team is currently testing a version of the ointment that contains 3 drugs with different functions, aiming to eradicate biofilms and, at the same time, promote blood vessel growth to stop the cycle of reinfection.

FINDING, KEEPING THE PERFECT FIT FOR A PROSTHETIC LEG

University of Washington (UW) Professor Joan Sanders, PhD, and her team are creating a new type of prosthetic leg: one that automatically adjusts its fit throughout the day. Her group, housed within the Department of Bioengineering, designs, builds and tests prostheses for people with transtibial amputations. Their latest prototype alters its fit without the need for adjustments to padding or user action. It detects in real time how well the prosthetic socket and residual limb are fitting and responds by automatically changing the size of the socket. Test results with volunteers are so promising that the researchers hope to eliminate the need to add or remove padding throughout the day.

Sanders holds a prototype of the auto-adjusting prosthesis that her team developed. Image courtesy of Kiyomi Taguchi/UW.

The prototype resembles a typical transtibial prosthetic limb, but it contains several key features to make auto adjustment possible:

- A gel interface material—shaped like a sock that users typically wear over their residual limb—that contains a small amount of iron.
- Three ultrathin sensors embedded within the wall of the socket detect the distance to the iron in the gel and send that data to the socket's microcontroller.
- The microcontroller calculates whether adjustments are needed. If so, it transmits instructions to 3 motorized "panels" within the socket wall—2 in the front, 1 in the back. The panels can move in to make the socket smaller, or out to make it bigger.
- The adjustments that the panels make, which can also be controlled manually via an app on the user's smartphone, are usually tiny—less than a millimeter.

Through user trials with volunteers, Sanders' team is collecting more detailed data on the device's performance and is working to make the prototype's motors smaller and lighter.

PAIN RELIEF PATCH

Kailo is a skin patch that targets pain using nanotechnology. The patch contains millions of nanocapacitors, each of which is capable of carrying a small electrical signal. When the patch is applied to the skin it creates contact points that allow these nanocapacitors to interfere with the body's electrical system, stopping pain at the source. A clinical trial has shown that Kailo significantly reduced pain compared to a placebo. To find the optimal place for the Kailo patch, move the patch over the body until it blocks pain signals. The pain relief patch should start working instantly—or within a few seconds of application. The patch can be worn for 5 to 10 minutes per day, relieving short- and long-term pain. It can also be worn constantly, even while working out. The device is sweatproof and waterproof, and can last for years.

Kailo Labs
gokailo.com

OUTWAY PERFORMANCE SOCKS

Outway state-of-the-art performance socks are designed for the pursuit of personal bests. Bike, run, workout, hike, and more in comfort and style. These socks come with premium yarns,

original designs, and the right technical features to help users take on any challenge while looking and feeling their very best. Designed to work with their shoes and feet, these socks allow users to focus, breathe, and move. Stay-up compression and a hand-sewn seamless toe keeps the socks from falling down and bunching up. Strategic venting and sweat-wicking yarns allow feet to breathe and maintain the ideal temperature. An engineered heel and midfoot arch support prevents socks from moving around within the shoe so users need not worry about abrasions and blisters as they move around throughout the day. The company currently offers over 80 original sock designs in ankle, mid, crew, and over calf compression.

Outway
outway.com

RESEARCHER AWARDED $1.2M FOR STUDIES ON DFUS AND FALL PREVENTION

Rosenblatt works with a study participant in the Center for Lower Extremity Ambulatory Research.

The National Institute of Diabetes and Digestive and Kidney Diseases awarded Rosalind Franklin University (RFU) of Medicine and Science scientists Noah Rosenblatt, PhD, and Ryan Crews, PhD, a 3-year, $848,596 grant to evaluate the impact of removable cast walker (RCW) designs on diabetic foot ulcer (DFU) healing. RCWs are commonly prescribed to treat DFUs, but low adherence to the treatment predicts poor DFU healing, which could ultimately lead to an amputation.

"Our long-term goal is to optimize offloading adherence and subsequent DFU healing outcomes by considering not only how much the device offloads the DFU, but also how much the device's design impacts the patient experience," said Rosenblatt.

Rosenblatt was also awarded a 2-year, $349,999 grant from the Department of Defense's Orthotic and Prosthetic Outcome Research Program for a study of the physical and mental health of service members and veterans who use prostheses.

"As warfighters injured during recent conflicts continue to age, they will be faced with new physical and mental challenges that impact mobility, including increased fall risk," he said. "We must support advances in rehabilitation across their lifespan."

Rosenblatt's team hopes to provide preliminary evidence that the socket trim line in people with transfemoral amputations can impact fall risk, and to ultimately promote enduring improvements in the physical and mental health of prosthetic users by reducing the prevalence and the burden of falls.

ATHLETE'S FOOT PRODUCT LINE

Kerasal's Athlete's Foot product line features a unique formula with 5-in-1 benefits to not only help treat and heal most athlete's foot, but also improve skin appearance and support a healthy footcare routine. This product line provides safe and effective treatment and was designed to be incorporated into a daily footcare routine for optimal results. Each product is easy to use with calming and soothing benefits. The Invisible Powder Spray and Silky Clear Gel cure most athlete's foot while treating symptoms, preventing recurrence, and relieving skin from itching, burning, and scaling, and deodorizing. The Gel also has anti-fungal properties. The Rapid Symptom Relief Medicated Soak is specially designed as a symptom relief solution to help with the burning sensation associated with athlete's foot. The medicated footcare formula delivers rapid itch relief while reducing rashes and blistering to soothe the affected area.

Kerasal
877/674-3475
kerasal.com

MASSAGE ROLLER

Compex' deep tissue Ion™ massage roller targets sore and achy muscles and is easy to travel with and transport from home to the gym. It is designed for consumers who need help loosening their myofascial tissue, which in turn increases blood flow, reduces next day soreness, releases knots and tension, prevents injury, improves range of motion, and relaxes and loosens muscles. The Ion is a heavy-duty roller that has 4 vibration speeds to tailor intensity. It provides relief from sore or stiff muscles by working deep layers of tissue and is best used for loosening tight and sore tissue over a full muscle. The roller is made of highly durable industrial-grade material with a rigid/textured finish for solid grip. It maintains its shape even under extreme weight loads. Charge with USB cable.

Compex
877/266-7398
compex.com

Why Running at Night Seems Harder

Reference: Eiken et al. EJAP 2022

Designed by ©YLMSportScience

15 subjects were tested for 10 min on a treadmill in four different conditions:

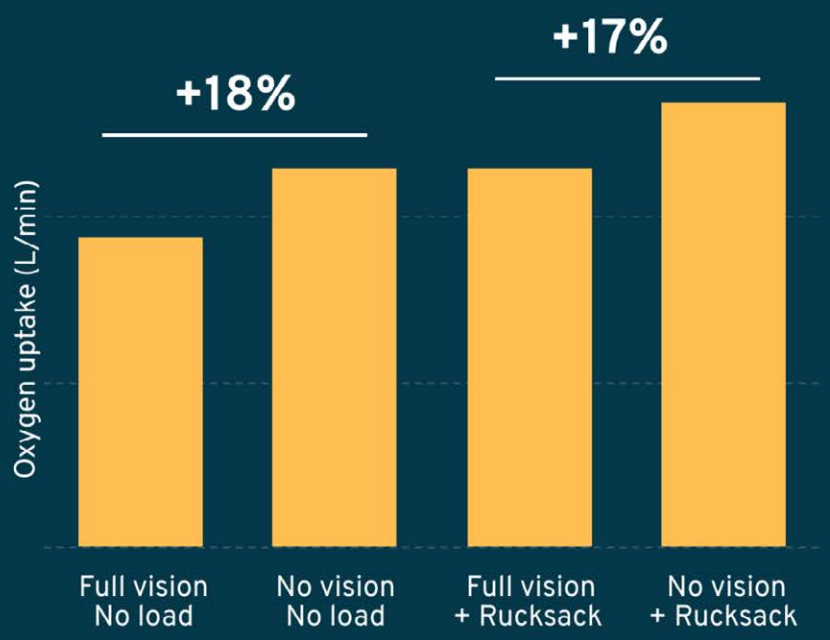
Full vision X No carried load

No vision X No carried load

Full vision X 25.5-kg rucksack

No vision X 25.5-kg rucksack

WHAT THEY FOUND



The participants adjusted their strides when blindfolded:

- Their steps got 11% shorter and 6% wider,
- They also lifted their feet 18% higher

Images provided by PresenterMedia

It seems reasonable to assume that similar mechanisms – but in smaller extent – are at work when you're running in the dark. From this perspective, night running might really be physiologically harder due to stride , not just a perception

Source: Eiken O, Mekjavic IB, Babi J, Danielsson U, Hallberg M, Kounalakis SN. Effects of vision on energy expenditure and kinematics during level walking. Eur J Appl Physiol. 2022 May;122(5):1231-1237. doi: 10.1007/s00421-022-04914-6.

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