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LOWER EXTREMITY REVIEW

April 26 / volume 18 / number 4

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LOWER EXTREMITY REVIEW

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

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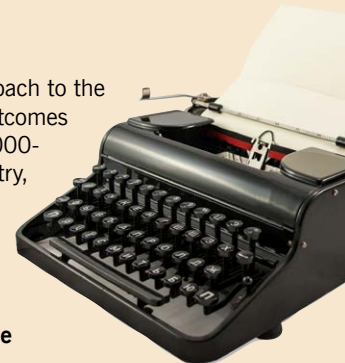
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LER encourages a collaborative multidisciplinary clinical approach to the care of the lower extremity with an emphasis on functional outcomes using evidence-based medicine. We welcome manuscripts (1000-2000 words) that cross the clinical spectrum, 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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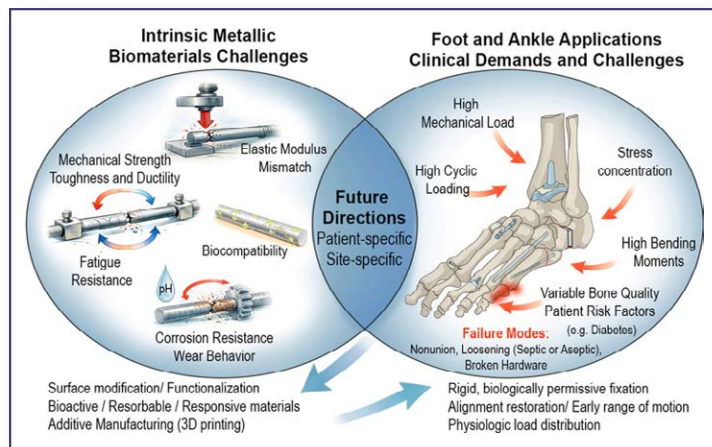
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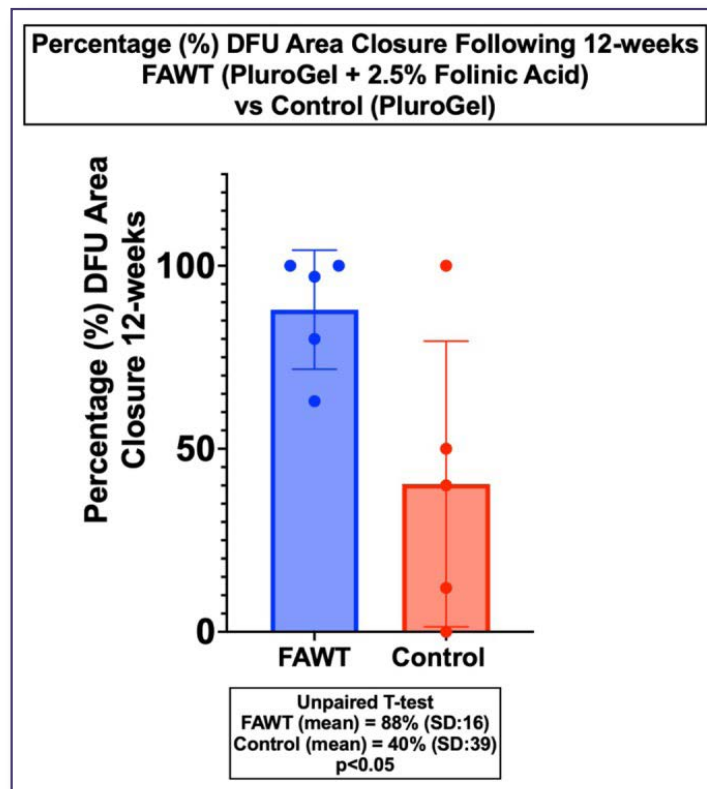
FOOT AND ANKLE BIOMATERIALS: A COMPREHENSIVE REVIEW



Metallic biomaterials enable successful reconstruction of skeletal tissues by supporting repair, load-bearing function, and anatomical alignment in foot and ankle surgery. The unique anatomic and biomechanics in this region, and challenging pathologies such as flatfoot and Charcot neuroarthropathy, present challenges. Intervention requires targeted biomaterial solutions. Metallic biomaterials currently represent the most predominant and clinically validated fixation systems in foot and ankle surgical reconstructions. This review summarizes and discusses their applications, outcomes, limitations, unmet needs, and future directions based on literature from 2020–2024. 3D-printed titanium implants for patient-specific reconstructions, surface-engineered alloys with infection mitigation properties for at-risk patient populations, and the exploration of bioresorbable/biointegrative magnesium, as well as non-metallic alternative materials (eg polymeric) were examined. Persistent unmet needs identified include hardware challenges in osteoporotic bone and neuropathic patients, ion leeching, cyclic fatigue, economic burden, imaging artifact interference, and lack of long-term data or clinical trials on innovative implant designs and manufacturing approaches. Lastly, scanning electron microscopy (SEM) imaging of titanium, nitinol, and stainless steel is provided to offer an analysis on biomaterial-specific microstructural features that play a role in influencing tissue integration, corrosion behavior, and mechanical performance in reconstructive surgeries. This review provides guidance for selecting metallic biomaterials for biomechanical and pathological demands of foot and ankle surgery, supporting evidence-based selection of hardware, improved fixation strategies, and reduced complication rates. It adds insights informing the development and of next-generation devices based on patient- and site-specific requirements, such as 3D-printed constructs and surface-engineered implants, designed to enhance fusion, reconstruction, and limb salvage. ⁽¹⁾

Source: Elvin P, Sanchez A, Reyes AA, et al. Foot and ankle biomaterials: a comprehensive review of current applications, challenges, and future directions. J Orthop Translat. 2026 24;57:101051. doi: 10.1016/j.jot.2026.101051.


FOLINIC ACID IMPROVES HEALING OF DIABETIC FOOT ULCERS




A novel folinic acid (FA) wound treatment (FAWT) significantly ($P < 0.05$) improved healing of chronic diabetic foot ulcers (DFUs). In a double-blind randomized controlled trial, 10 subjects with chronic DFUs were treated daily with either control therapy ($n = 5$; PluroGel) or FAWT ($n = 5$; PluroGel containing 2.5% FA). After 12 weeks, the FAWT group demonstrated significantly greater DFU area reduction compared with controls (88% [SD 16] vs 40% [SD 39], respectively).

Mechanistically, FAWT was associated with decreased activation of NF κ B/p65 and p38 MAPK, suggesting reduced pro-inflammatory signaling. Genomic DNA methylation analysis of keratinocytes revealed significantly decreased FAWT-induced methylation at regulatory sites of multiple microRNAs associated with inflammatory regulation. Reduced methylation suggests increased expression of these microRNAs, which may inhibit translation of proteins involved in MAPK signaling pathways.

These pathways mediate signaling from pro-inflammatory receptors such as RAGE, TLRs, and IL-1R and regulate downstream gene expression.

Inhibition of MAPK signaling following FAWT may therefore reduce NFκB/p65 and p38-mediated pro-inflammatory gene expression, consistent with the observed decreases in HMGB1 and IL-1β protein levels. Collectively, these findings suggest that FAWT promotes coordinated expression of anti-inflammatory microRNAs, suppresses MAPK signaling, and facilitates the transition of DFUs from a chronic inflammatory state to wound repair, enabling keratinocyte proliferation, migration, and re-epithelialization. 

Source: Hoke GD, Stone A, Bauer MA, Carter WC, Newsom MR, Boykin JV Jr. Folic acid improves healing of diabetic foot ulcers. *wound repair regen.* 2026;34(2):e70141. doi: 10.1111/wrr.70141.

0.05), with a large group × time effect observed for the primary outcome CAIT (partial $\eta^2 = 0.414$). The combined group (OEP + NMES) demonstrated the most significant improvement in CAIT and UST scores ($P < 0.05$) and outperformed the other 2 groups in dynamic balance in the posteromedial and posterolateral directions. The combined intervention of OEP and NMES significantly improves ankle stability, both static and dynamic balance abilities, and alleviates pain in older adults with CAI. This combined approach offers a safe and effective rehabilitation strategy for older adults. 

Source: Zhang Y, Shin MC, Tao Y, Yang K, Liu S. Effect of otago exercise program combined with neuromuscular electrical stimulation on chronic ankle instability in older adults: a pilot randomized controlled trial. *J Clin Med.* 2026 4;15(5):1968. doi: 10.3390/jcm15051968.

EFFECT OF OTAGO EXERCISE PROGRAM WITH NEUROMUSCULAR ELECTRICAL STIMULATION ON CAI

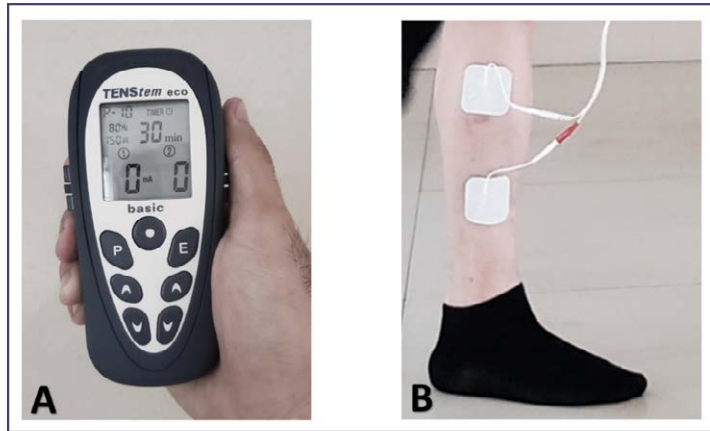


Figure. (A) Neuromuscular Electrical Stimulation device; Product Name: TENStem eco BASIC (JIAJIAN Corp., Wuxi, Jiangsu, China); (B) electrodes attached to the skin.

Chronic ankle instability (CAI) is a common functional disorder in older adults, affecting their balance and quality of life. Effective ways to enhance ankle stability and function remains a key for healthy aging. This study aims to explore the effects of the Otago Exercise Program (OEP) combined with Neuromuscular Electrical Stimulation (NMES) on ankle stability, the pain index, and balance ability in older adults aged 60 and above with CAI. This study is a single-blind pilot randomized controlled trial with 34 completing the trial. Participants were randomly assigned to the OEP group, the combined group (OEP + NMES), and the control group. The intervention was 8 weeks. Evaluation was the Cumberland Ankle Instability Tool (CAIT), Visual Analog Scale (VAS), Eyes-closed Single-Leg Stance Test (UST), and the Modified Star Excursion Balance Test (mSEBT), with assessments conducted before the intervention, at week 4, and at week 8. After the intervention, all 3 groups showed significant improvements in CAIT, VAS, UST, and mSEBT scores ($P <$

BILATERAL ACHILLES TENDON INJURY IN A 14-YEAR-OLD ADOLESCENT: CASE REPORT



Figure. Bilateral Achilles tendon section. (A) Left tendon and (B) right tendon.

Achilles tendon (AT) wounds are defined as partial or complete disruptions of the tendon that create direct communication with the external environment (Lamah L Diallo M Tekpa JBD). The incidence of bilateral AT lacerations in children remains unknown. These researchers report a case of simultaneous bilateral AT laceration in a 14-year-old adolescent following a domestic accident.

Case report: A 14-year-old male adolescent with no prior medical history was admitted to the emergency department for open ankle trauma following a domestic accident. While walking backward, his heels

Continued on page 12

struck a sheet of metal lying on the ground. He presented with complete functional impairment, linear wounds with a depression over both ATs. Clinical examination revealed a positive bilateral Thompson test. The diagnosis of a total, bilateral AT laceration was confirmed. Surgical debridement and tendon repair were performed, followed by immobilization of the ankles in equinus position for 3 weeks, then at 90° for another 3 weeks. Postoperative recovery was uneventful, with normal walking and return to activities by 8 months after surgery. While various series of AT wounds have been described in the literature, no cases of simultaneous bilateral AT wounds have been previously reported. To the researchers' knowledge, this is the first reported case of a simultaneous, complete bilateral AT laceration in a child. This case report describes a complete transection of the AT resulting from a domestic accident. The case underscores the potential hazards associated with household injuries. [ler](#)

Source: Kouassi-Dria AKS, Bonny Obro R, Ouattara JJ, Midekor Gonebo KA, Aké YL, Moh N. Bilateral Achilles tendon injury in a 14-year-old adolescent: case report. *Int J Surg Case Rep.* 2026 8;138(2):133-135. doi: 10.1097/RC9.0000000000000035.

IMPACT OF SPINAL CORD STIMULATION IN DIABETIC PERIPHERAL NEUROPATHY

Diabetic peripheral neuropathy (DPN) is a common and debilitating complication of diabetes that leads to chronic pain, sensory loss, and functional decline. While spinal cord stimulation (SCS) is FDA-approved for painful diabetic neuropathy, its potential to modify disease pathology rather than merely suppress symptoms remains poorly understood. This narrative review bridges this knowledge gap by elucidating the role of SCS in mitigating structural and functional changes in the spinal cord and the peripheral nervous system in DPN. A systematic PubMed search for studies published between January 1990 and May 2025 on the structural, functional, vascular, or biochemical effects of SCS in diabetic neuropathy yielded 361 records, of which 22 met the inclusion criteria. Data were extracted thematically across 5 domains: peripheral nerve structure, spinal plasticity, supraspinal modulation, neuroinflammation, and vascular/metabolic effects. SCS consistently improved both functional and structural biomarkers of neuropathy. In clinical studies, SCS enhanced nerve conduction velocity, increased intraepidermal nerve fiber density, and promoted corneal nerve regeneration within 6-12 months. Preclinical data demonstrated suppression of microglial activation, downregulation of pro-inflammatory mediators, and restoration of neurotrophic signaling. SCS also improved spinal and peripheral microcirculation and reversed metabolic and vascular dysregulation associated with hyperglycemia. Collectively, these effects suggest that SCS has multimodal benefits that can restore neural integrity, recalibrate neuroimmune pathways, and mitigate disease progression in DPN. These findings position SCS as a potential disease-modifying therapy for DPN and underscore the need for prospective mechanistic trials integrating structural and functional biomarkers to refine patient selection and optimize neuromodulation outcomes. [ler](#)

Source: Almosawi M, Shanti R, Hill N, et al. Structural and functional im-

pact of spinal cord stimulation in diabetic peripheral neuropathy. *Cureus.* 2026 16;18(2):e103728. doi: 10.7759/cureus.103728

ACHILLES TENDON PROPERTIES OF JUMPING LEG IN UNIVERSITY BASKETBALL ATHLETES



The Achilles tendon (AT) plays a crucial role in force transmission and movement efficiency, and greater tendon stiffness may enhance elastic energy storage and improve performance in explosive movements. Shear-wave elastography (SWE) enables reliable, non-invasive assessment of tendon stiffness, yet its associations with other ultrasound (US)-derived properties and functional outcomes remain insufficiently defined in athletes. Limited normative data exists for university-level basketball players, despite the relevance of tendon adaptations and asymmetries in this population. This study aimed to examine AT stiffness, thickness, echo intensity (EI), and fibrillar pattern in male and female university basketball athletes, and to explore their associations with ROM, injury history, and performance measures.

Thirty-one university basketball athletes participated in this cross-sectional study. US imaging and SWE measured AT stiffness, thickness, and EI in both the dominant jumping leg (DJL) and the non-dominant jumping leg (NDJL). Functional assessments included a single-leg vertical jump, heel raise (HR) test, and ankle dorsiflexion ROM.


Female players had lower AT thickness compared to males and showed a trend toward lower stiffness. No significant differences in stiffness, thickness, or EI were observed between the dominant and non-dominant jumping legs. Male players with a prior lower-body injury exhibited lower AT stiffness. A strong negative correlation between AT thickness and EI emerged in both sexes.

Considering sex and injury history when interpreting tendon properties is crucial, and future studies are needed to better understand how tendon characteristics evolve and inform training and injury prevention strategies. [ler](#)

Source: Soontjens O, Busner J, Fortin M. Achilles tendon ultrasound-derived properties of the dominant and non-dominant jumping leg of

DIABETIC SOCKS: A SYSTEMATIC REVIEW OF COMMERCIAL PRODUCTS




In recent years, various diabetic socks have been developed and introduced to help prevent diabetes related foot ulcers (DFUs). However, the question of which type of sock is most suitable for individuals with diabetes has not been adequately addressed. This review systematically explores the current evidence regarding the performance and structural properties of diabetic socks, along with a narrative analysis of commercial socks. Four databases, including Web of Science, PubMed/Medline, CINAHL (EBSCO), and Google Scholar, were examined, resulting in the selection of 9 articles. Methodological quality of the clinical trials was assessed using the Downs and Black tool. Additionally, 17 commercially available socks were selected for analysis. Among the selected articles, 4 were clinical trials, 2 mixed-design studies, and 3 laboratory-based investigations. The clinical studies exhibited poor quality and were unable to demonstrate significant outcomes. Laboratory-based studies indicated that functional finishes on yarns could prevent microbial growth and that the blend of fibers and the structure of the socks significantly affect the overall performance. Commercially available socks reporting new types of fibers lack clinical evidence to support their claims, complicating the understanding of their performance in people with diabetes. Current evidence regarding the structure and function of diabetic socks is limited, with clinical trials characterized by poor methodological quality. Technical suggestions for diabetic sock design are based on limited evidence from laboratory-based studies, highlighting gaps in the literature. This review highlights the need for further investigation to establish the evidence base for diabetic socks in supporting diabetic foot care. 

Source: Venkatraman PD, Orlando G, Culmer PR, et al. Diabetic socks: a systematic review of the literature and commercially available products. *Diabetes Metab Res Rev*. 2026 ;42(2):e70138. doi: 10.1002/dmrr.70138.

CHANGES IN LOWER EXTREMITY TENDON THICKNESS AFTER STROKE REHABILITATION



Peripheral musculoskeletal structures may undergo changes after stroke, but tendon-specific adaptations with functional recovery are not well defined. This study examined lower extremity tendon thickness in patients with post-stroke hemiplegia before and after an inpatient rehabilitation program and explored associations between tendon thickness and clinical improvement. 45 patients with post-stroke hemiplegia completed a 4-week rehabilitation program. Quadriceps, patellar, Achilles tendon and plantar fascia thicknesses were measured bilaterally at baseline and post-treatment using ultrasonography. Fifteen healthy volunteers served as controls. Continuous variables are presented as mean \pm SD when approximately normally distributed and as median (IQR) otherwise; p-values were adjusted for multiplicity in secondary analyses as specified. Paretic-side quadriceps tendon thickness increased from 5.94 ± 0.96 to 6.48 ± 0.95 mm ($P < 0.001$), with 21/45 (46.7%) exceeding minimal detectable change with a 95% confidence interval (MDC95). Baseline paretic-side quadriceps thickness was lower than controls ($P_{adj} = 0.048$) but did not differ post-treatment ($P_{adj} > 0.99$). Patellar and Achilles tendons and plantar fascia also showed consistent bilateral increases (all $P < 0.001$). Balance and functional outcomes improved over the period (BBS Δ : 6 [4-9]; FAC improved by ≥ 1 level in 27/45 [60.0%]; Barthel improved with median paired Δ : 0 [0-5]; all $P < 0.001$). Changes in quadriceps tendon thickness showed positive associations with changes in BBS (both sides) and Barthel (non-paretic side). Lower-extremity tendon morphology in post-stroke hemiplegia appeared dynamic over the rehabilitation period, with quadriceps tendon thickness paralleling improvements in balance and functional independence. Longer-term studies are needed to clarify. 

Source: Alisik T, Demir E. Ultrasonographic changes in lower extremity tendon thickness after stroke rehabilitation and their associations with balance and functional outcomes. *Front Neurol*. 2026 17;17:1773636. doi: 10.3389/fneur.2026.1773636.

Snake Bites to the Lower Extremity Reported to U.S. Emergency Departments

BY MATHIAS B. FORRESTER, BS

Abstract

Background: Thousands of snake bites occur in the U.S. each year. Venomous snake bites can produce serious adverse effects, and even bites from nonvenomous snakes may cause adverse effects. Snake bites are often treated at hospital emergency departments (EDs). The objective of this study was to describe snake bites to the lower extremity treated at US hospital EDs.

Methods: The data source for this study was the National Electronic Injury Surveillance System (NEISS), a database of consumer product- and activity-related injuries collected from a representative sample of approximately 100 U.S. hospital EDs. National estimates are calculated from database records according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample. Cases were snake bites to the lower extremity treated during 2000–2024. The distribution of snake bites to the lower extremity was determined for selected variables.

Results: Based on the NEISS database, there were an estimated 14,837 snake bites to the lower extremity treated at US hospital EDs during 2000–2024, representing 53.8% of the 27,561 total snake bites. The bitten body part was 37.7% lower leg, 28.4% foot, 18% ankle, 11.6% toe, 2.2% upper leg, and 2.1% knee. By 3-month period, 3.3% of the snake bites to the lower extremity were treated during November-January, 11.2% during February-April, 48.9% during May-July, and 36.5% during August-October. The circumstances of the bite were 43% sports and recreation, 24.4% yardwork and landscaping, and 32.6% other and unknown.

Conclusion: Snake bites to the lower extremity treated at U.S. hospital EDs most often involved the lower leg followed by the foot, ankle, and toe and rarely the upper leg and knee. The bites were



seasonal, with the highest proportion occurring in May–July followed by August–October. The bites most often occurred during sports and recreation followed by yardwork and landscaping. This study may provide information useful for developing strategies to prevent snake bites to the lower extremity.

According to the Centers for Disease Control and Prevention (CDC), 7,000–8,000 bites by venomous snakes occur in the U.S. annually.¹ Two subfamilies of venomous snakes are native to the U.S. The Crotalinae (pit vipers, subfamily of family Viperidae) includes rattlesnakes, copperheads, and water moccasins (cottonmouths). The Elapidae (subfamily of family Colubridae) includes coral snakes.¹⁻⁵ Although venomous snakes can be found throughout the continental U.S., the ranges of the particular venomous snakes vary.³ In addition, exotic snakes, including venomous species, may be kept as pets in the U.S.^{2,6}

Snake bites can occur in a variety of circumstances. A study of U.S. snake bites involv-

ing toxicologist consultations reported that the most common circumstances or activities at the time of snake bite were sports and recreational (30%) and hobbies (14%). The most common sports and recreational activities were walking (62%) and hiking (17%). The most common hobbies were playing and gardening.⁷

Venomous snake bites can produce serious adverse effects. Commonly reported symptoms include puncture marks, bleeding (including from locations other than the bite site), pain, erythema, edema, nausea, vomiting, tachycardia, hypotension, ecchymosis, numbness or tingling, coagulopathy, and rhabdomyolysis.^{1,3-5} During 1999–2022, 159 deaths in the U.S. had a multiple cause of death including snake venom.⁸ In addition, bites from nonvenomous snakes can result in infection or allergic reactions.^{4,9}

Many people with snake bites, particularly by snakes known or suspected of being venomous, seek treatment through emergency departments (EDs) or first-aid providers who consult with emergency clinicians.³ According to a study of snake bites reported to the National

Electronic Injury Surveillance System-All Injury Program (NEISS-AIP), which collects data on all injuries treated by a sample of U.S. hospital EDs, approximately 10,000 snake bites were treated at U.S. hospital EDs annually during 2001–2004. Thirty percent of the bites were reported to have involved venomous snakes (although most records did not mention the species of snake).¹⁰

The objective of this study was to describe snake bites to the lower extremity treated at U.S. hospital EDs. Prior studies reported that the lower extremity was the second most bitten body part, after the upper extremity.^{2,10}

Methods

The study's data source was the National Electronic Injury Surveillance System (NEISS) available at <https://www.cpsc.gov/cgibin/NEISSQuery/home.aspx>. Previously described in detail in Lower Extremity Review,¹¹ the NEISS collects data on consumer product- and activity-related injuries from a probabilistic sample of approximately 100 U.S. hospital EDs. National estimates can be calculated from these data according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample.^{12,13} The study is exempt from institutional review board approval because the data are publicly available and de-identified.

Cases were snake bites to the lower extremity reported to NEISS during 2000–2024. To select snake bite cases, first all records with “bit,” “sting,” or “stung” in the Narrative text field (a text field that summarizes the circumstances of the injury) were identified. Then, all records in this subset with “snak,” “ratt,” “copp,” “moc,” “cotton,” or “coral” in the Narrative field were identified. The Narrative fields in this final subset of records were individually reviewed to identify those that indicated a snake bite had occurred. At the same time, the type of snake (venomous, nonvenomous, unknown venomous status) and circumstance of the bite (what the patient was doing at the time of the bite) were documented.

The study examined the following

variables: type of snake, affected body part, symptoms (diagnosis, type of injury), patient disposition, circumstance of the bite, location of the incident, year and month of treatment, and patient age and sex. The symptoms could be documented in 5 fields: Diagnosis (a numeric field for coding the most severe diagnosis), Diagnosis_2 (a numeric field for coding a second diagnosis—first used in 2019), Other_Diagnosis and Other_Diagnosis_2 (first used in 2019) (both text fields for documenting additional diagnoses), and the Narrative field. All 5 fields were used to identify all reported symptoms of the snake bite. Any symptoms clearly not related to the snake bite (eg, the patient fractured a wrist when they fell running from the snake) were excluded from the analysis.

The affected body part is documented in 3 fields: Body_Part (a numeric field for coding the body part associated with the most severe diagnosis), Body_Part_2 (a numeric field for coding the body part associated with a second diagnosis—first used in 2019), and the Narrative field. All 3 fields were used to identify the body part that was bitten. The study was limited to those snake bites where the body part was the lower extremity.

Microsoft 365 Access and Excel (Microsoft Corp, Redmond, WA) was used for the analyses. The distribution of the national injury estimates was determined for the selected variables by summing up the values in the Weight numeric field in the NEISS database. The U.S. Consumer Product Safety Commission (CPSC), which operates the NEISS, considers an estimate unstable and potentially unreliable when the estimate is <1,200.¹²

Results

Based on the NEISS database, there were an estimated 14,837 snake bites to the lower extremity treated at U.S. hospital EDs during 2000–2024, representing 53.8% of the 27,561 total snake bites. The snake was 4,942 (33.3%) venomous, 499 (3.4%) nonvenomous, and 9,396 (63.3%) venomous status unknown. The bitten body part was 5,589 (37.7%) lower leg, 4,221 (28.4%) foot, 2,667 (18.0%) ankle, 1,719 (11.6%) toe, 323 (2.2%) upper leg, and 317

(2.1%) knee. The most common symptoms were 4,651 (31.3%) puncture, 1,858 (12.5%) pain, 1,676 (11.3%) edema, and 1,037 (7%) abrasion.

There were an estimated 1,804 (12.2%) snake bites to the lower extremity reported during 2000–2004, 2,555 (17.2%) during 2005–2009, 2,447 (16.5%) during 2010–2014, 3,781 (25.5%) during 2015–2019, and 4,250 (28.6%) during 2020–2024. By 3-month period, an estimated 496 (3.3%) snake bites to the lower extremity were treated during November–January, 1,666 (11.2%) during February–April, 7,260 (48.9%) during May–July, and 5,415 (36.5%) during August–October. The patient age was 549 (3.7%) 0–5 years, 1,158 (7.8%) 6–12 years, 1,640 (11.1%) 13–19 years, 2,750 (18.5%) 20–29 years, 2,481 (16.7%) 30–39 years, 1,903 (12.8%) 40–49 years, 1,811 (12.2%) 50–59 years, 1,300 (8.8%) 60–69 years, and 1,244 (8.4%) 70 years or older. The patient sex was 9,838 (66.3%) male and 4,999 (33.7%) female.

The location of the incident was 7,787 (52.5%) home, 3,951 (26.6%) place of recreation or sports, 1,274 (8.6%) other public property, 228 (1.5%) street or highway, 16 (0.1%) school, and 1,581 (10.7%) not recorded. The circumstances of the bite were 6,379 (43%) sports and recreation, 3,627 (24.4%) yardwork and landscaping, and 4,831 (32.6%) other and unknown. Of the estimated 6,379 snake bites to the lower extremity involving sports and recreation, 2,675 (41.9%) involved walking, running, or hiking; 1,003 (15.7%) fishing, 776 (12.2%) swimming, 696 (10.9%) golf, 325 (5.1%) bicycling, and 904 (14.2%) other. Of the estimated 3,627 snake bites to the lower extremity involving yardwork and landscaping, 1,431 (39.5%) involved mowing, 1,223 (33.7%) trimming and pruning, and 973 (26.8%) other.

The patient disposition was 9,404 (63.4%) treated or examined and released from the ED, 4,241 (28.6%) treated and admitted for hospitalization (within same facility), 726 (4.9%) treated and transferred to another hospital, 135 (0.9%) held for observation (includes admitted for observation), and 331 (2.2%) left without being seen or left against medical advice.

Continued on page 16

Discussion

This study examined snake bites to the lower extremity treated at U.S. hospital EDs. This is important, thousands of snake bites occur in the U.S. each year,¹ many of which are treated at hospital EDs.³ Snake bites, even those involving nonvenomous snakes, may have serious adverse effects and, in rare instances, may result in death.^{1,3,4,8,9} A high proportion of snake bites are to the lower extremity.¹⁰

In this study, most of the snake bites to the lower extremity involved the lower leg and below, with only 4% of the bites to the upper leg and knee. More bites involved the lower leg with smaller proportions involving the foot and ankle. A prior study using U.S. hospital ED data found that, of an estimated 5,140 snake bites to the hip or lower extremity, 0.7% involved the hip or thigh, 34.1% involved the knee or lower leg, and 65.2% involved the ankle or foot.² The body part pattern observed in the present study may reflect the mechanics of snake bites to the lower extremity. With most bites, the snake is likely to be on or near to the ground and more likely to bite the body parts they can reach, ie, the lower leg and below. If most people are wearing shoes when encountering snakes, then they might be relatively protected from bites to the ankle, foot, and toe while the lower leg may be less well-protected. Although some of the records mentioned that the patient was barefoot or wearing sandals, the patient's clothing was not consistently documented. Future research may examine the impact of a person's clothing on snake bite risk.

The most commonly reported symptoms—puncture, pain, edema, and abrasion—were consistent with that reported in the literature.^{1,3,4,9}

The estimated number of snake bites to the lower extremity increased during the 25-year period of the study. This increase may be due to an increase in snake bites in the U.S. or an increase in people experiencing snake bites seeking treatment at hospital EDs. Another possibility is that those who submitted records to the NEISS increasingly documented that the injury involved a snake bite in the record Narrative field.

Almost half (49%) of the snake bites were

treated during May-July, and over one-third (36%) during August-October. Almost half (48%) of the patients were aged 20–49 years, and 66% were male. This pattern was consistent with the literature, which reported most snake bites to occur in the warmer months of the year and most patients were male and in their 20s to 40s.^{2,5,10} The increase in snake bites to the lower extremity during warmer months may be due to both people being more likely to engage in outdoor activities and snakes to be active during that time period.

Over half (52%) of the snake bites to the lower extremity occurred at home, with the next most common location being a place of recreation or sports (27%). The highest proportion (43%) of the bites involved sports and recreation (particularly walking, running, and hiking; fishing, swimming, and golfing) followed by yardwork and landscaping (particularly mowing, and trimming and pruning) at 24%. This information may prove useful when formulating strategies to reduce the risk of snake bites to the lower extremity.

While most (63%) of the patients were treated or examined and released from the ED, over one-third (34%) of the patients required further hospital management, suggesting that a portion of the snake bites were severe.


There are ways to prevent snake bites.¹⁴ Avoid places where snakes may be found, such as tall grass or brush, rocky areas, fallen logs, bluffs, swamps, marshes, and deep holes in the ground. When moving through tall grass or weeds, poke at the ground in front of you with a long stick to scare away snakes. Watch your step and where you sit when outdoors. Wear loose, long pants and high, thick leather or rubber boots. If you are out at night, shine a flashlight on your path. Never handle a snake, even if you think it is dead.

This study has limitations. The NEISS database only includes product- and activity-related injuries, so it does not include all snake bites treated at U.S. hospital EDs. Cases were identified by searching for all records with “bit,” “sting,” or “stung” in the Narrative text field, then the Narratives of this subset of records were reviewed to determine whether the injury

involved a snake bite. Records of snake bite injuries where the terms of interest were not included in the Narrative field would not have been included in the study.

In most cases, the type of snake and whether it was venomous or non-venomous was not mentioned. Whether a snake was venomous or nonvenomous might affect the expected symptoms and management of a snake bite. As a result, this study could not focus on either venomous or nonvenomous snake bites or examine any differences between the two. Furthermore, information on the symptoms resulting from the snake bite were limited, and information on the treatment of the bite was usually not documented.

Only the author selected the records for inclusion in the study. In addition, the study only included those patients treated at hospital EDs. Examination of patients treated elsewhere would provide a more complete understanding of snake bites to the lower extremity.

In conclusion, snake bites to the lower extremity treated at U.S. hospital EDs most often involved the lower leg followed by the foot, ankle, and toe and rarely the upper leg and knee. The bites were seasonal, with the highest proportion occurring in May-July followed by August-October. The bites most often occurred during sports and recreation (particularly walking, running, and hiking; fishing, swimming, and golfing) followed by yardwork and landscaping (particularly mowing and trimming and pruning). This study may provide information useful for developing strategies to prevent snake bites to the lower extremity. 

Mathias B. Forrester, BS, is an independent researcher in Austin, Texas. Now retired, he has performed public health research for various universities, government programs, and other organizations for 40 years.

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LEREXPO HIGHLIGHTS

Digital Solutions for Early Detection, Prevention and Personalized Treatment of the Diabetic Foot



BY BIJAN NAJAFI, PHD, MSC

The current model for managing diabetic foot syndrome is characterized as reactive and fragmented, contributing to a global crisis where a limb is lost to amputation every 20 seconds. Dr. Bijan Najafi, a bioengineer and research director at UCLA Center for Advanced Surgical and Interventional Technology (CASIT), says that “we can’t manage what we can’t measure,” advocating for a shift toward decentralized, proactive care facilitated by digital health technologies.

Key takeaways from the analysis of remote patient monitoring (RPM) and intervention tools include:

- **Measurement Metrics:** Critical factors for ulcer prediction include plantar peak pressure (eg, pressures exceeding ~200 kPa), sustenance pressure (prolonged low-magnitude pressure lasting longer

than 15–20 minutes, similar to loading conditions associated with pressure ulcer development), and thermography (identifying inflammation “hot spots”).

- **Technological Shift:** While peak pressure measurement remains difficult to implement remotely due to technical constraints (high sensor density and battery drain), sustenance pressure and temperature monitoring offer more practical pathways for RPM.
- **Patient Engagement:** Data collection alone is insufficient. Successful prevention requires patient empowerment through actionable, easy-to-understand feedback. Studies indicate that timely and appropriately delivered alerts (eg, periodic notifications such as every 2 hours) can improve adherence to monitoring technologies without necessarily increasing

alert fatigue, when designed carefully.

- **Smart Offloading:** The integration of sensors into offloading devices (smart boots) significantly improves patient compliance and wound healing rates compared to standard removable cast walkers.
- **AI Integration:** Artificial intelligence and chatbots serve as 24/7 companions, bridging the gap between clinical visits by providing personalized education, mood support, and timely behavioral reminders.

The Crisis in Diabetic Foot Care

The burden of diabetic foot ulcers (DFUs) remains high despite clinical progress. The primary challenges identified are:

- **Reactive Care:** Clinicians often wait for

Table. Comparative Analysis of Monitoring Metrics

METRIC	DESCRIPTION	CLINICAL SIGNIFICANCE	RPM FEASIBILITY
Plantar Peak Pressure	High pressure occurring in fractions of a second (eg, heel-off phase).	Major risk factor; guides custom insole design.	Low: Requires high sensor density (50+ per foot) and high sampling frequency, leading to battery drain.
Sustenance Pressure	Low-magnitude pressure lasting >15 minutes.	Blocks blood flow; leads to callus formation and ulcers.	High: Requires fewer sensors and lower sampling frequency. Can provide simple, actionable feedback.
Thermography	Identification of “hot spots” (temperature spikes).	Predicts ulcers with a 37-day lead time and 97% sensitivity.	High: Does not require complex calibration; compares one foot against the other.
Thermal Stress Response	Temperature increases as a function of walking.	Serves as a surrogate for shear force (rubbing/friction).	Moderate: Emerging technology; often integrated into smart socks or insoles.

This article is a summary of Dr. Najafi’s presentation, “Digital Solutions for Early Detection, Prevention and Personalized Treatment” from the Diabetes Technology and Prevention Summit November 15, 2025. To view the full presentation with questions and answers—and see the agenda for the program, visit <https://diabetestech.lerexpo.com/>. Continuing education credits are available for this and many of the lerEXPO programs.

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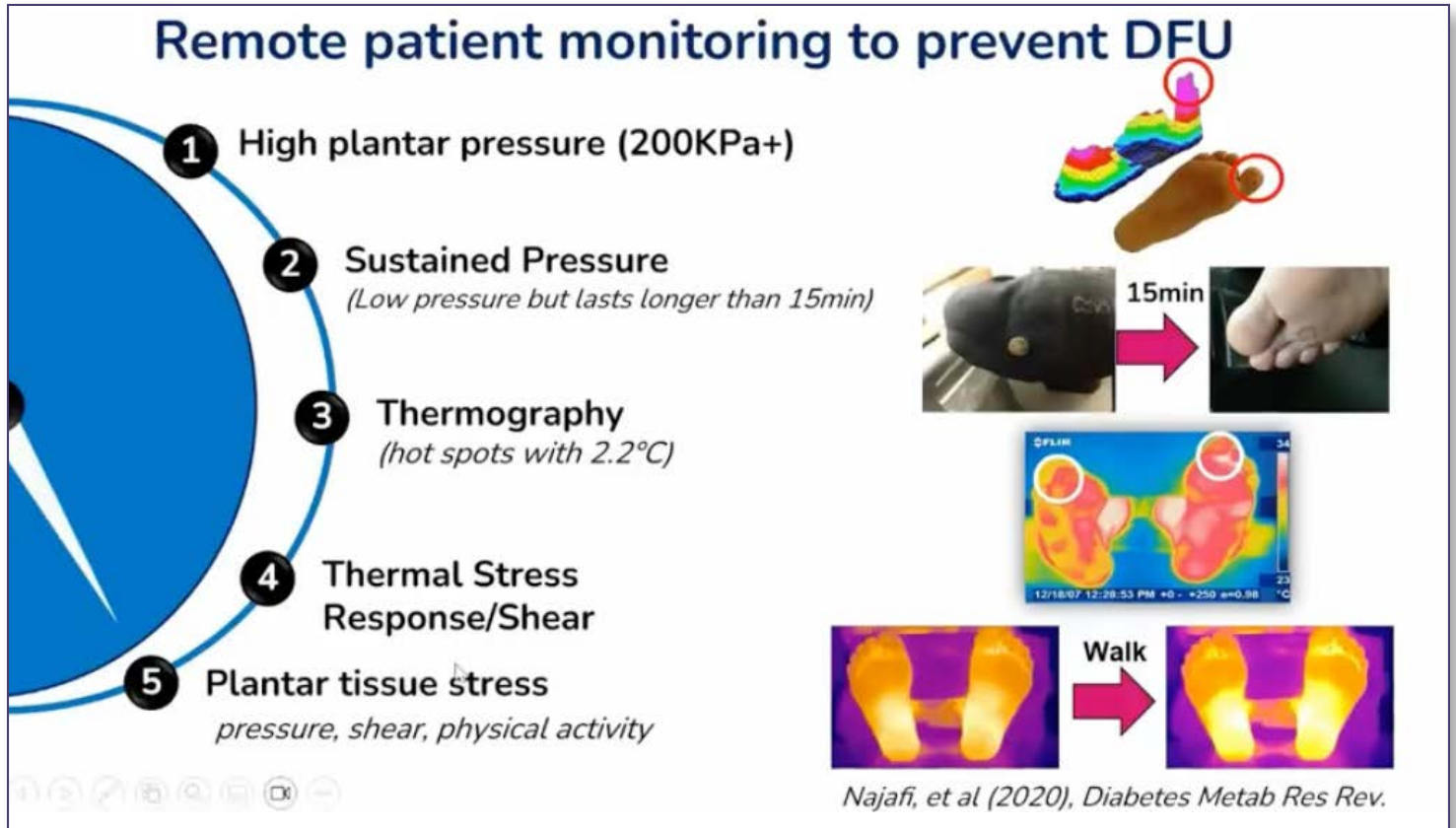
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visible signs of ulceration, which frequently results in interventions occurring too late to prevent amputation.

- **Access Gaps:** Proximity to specialized care is a predictor of outcomes. Patients living 50 miles or more from an experienced hospital face a significantly higher likelihood of limb amputation.
- **Information Retention:** Patients typically forget 40% to 80% of the information discussed during a doctor’s visit, leading to poor adherence to home-care protocols.

Remote Patient Monitoring: Metrics and Technology

Effective prevention relies on identifying tissue stress before skin breakdown occurs. The following table outlines the primary metrics used in digital monitoring:

Limitations of Current RPM Tools

While smart mats and sensors are effective, they face specific hurdles:

- **Specificity Issues:** Some smart mats have a high false-alert rate (specificity as low as 57%), though some argue these alerts help maintain patient engagement.
- **Context Deficiency:** Many tools measure temperature or pressure without recording physical activity (step counts), making it difficult to determine if a temperature spike is due to inflammation or recent exercise.

Enhancing Patient Engagement and Compliance:

Overcoming Alert Fatigue

Research contradicts the assumption that frequent digital alerts lead to patient disengagement.

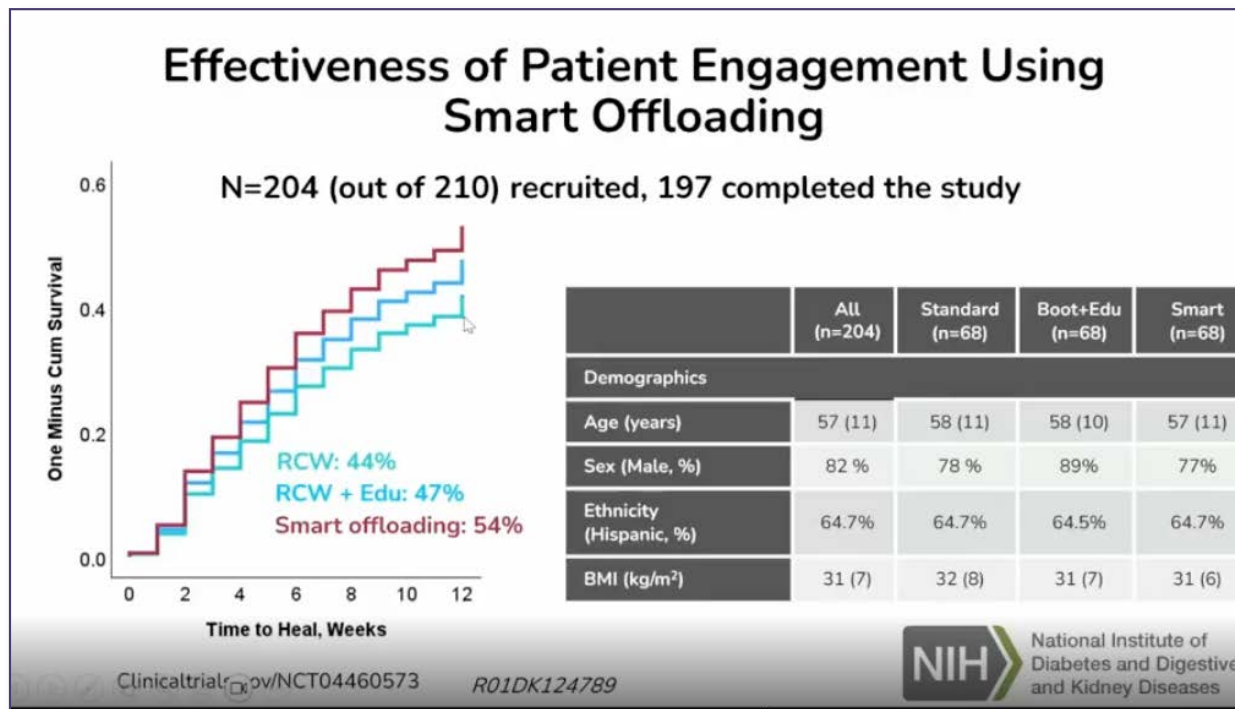
- **Frequency:** Patients receiving at least 1 alert every 2 hours demonstrated higher engagement and better response rates over a 3-month period than those receiving fewer alerts.
- **Perception:** Frequent, comprehensive alerts reassure patients that the technology is

actively working for them. Conversely, a lack of alerts often leads patients to assume the device is non-functional, resulting in them stopping use.

The Impact of Smart Offloading

Offloading is the most critical intervention for healing DFUs, yet compliance with removable cast walkers is notoriously low. A study comparing standard walkers, education-reinforced walkers, and smart boots (equipped with accelerometers) revealed:

- **Healing Rates:** The smart boot group achieved a 23% increase in successful wound healing over 12 weeks compared to the standard cast walker group.
- **Retention:** Patients using smart boots showed higher resiliency and lower dropout rates. The technology—utilizing simple feedback like “happy” and “sad” faces on a smartwatch—improved the patient’s perception of the treatment’s importance.



The Role of Artificial Intelligence and Data Visualization:

AI Chatbots as Care Extensions

AI-driven chatbots address the fragmented nature of care by acting as a 24/7 companion.

- **Behavioral Prompts:** AI can detect when a patient is not wearing their offloading boot and send personalized, tone-specific reminders (eg, action-oriented or encouraging messages).
- **Education and Support:** Unlike generic AI, these tools provide validated, personalized information and mental health support, helping patients manage the frustration and mobility limitations associated with DFU treatment.

Clinical Decision Support

To prevent clinician overwhelm, complex sensor data is synthesized into simplified visualizations.

- **Normalized Metrics:** Various data points (age, compliance, weakness, gait) are converted to a 0–10 scale.
- **Visual Triage:** Using “green” (healthy) and “red” (unhealthy) benchmarks allows clinicians to quickly identify which specific

risk factors are impeding a patient’s healing process, facilitating personalized adjustments to care plans.

The integration of digital tools—from smart insoles to AI companions—represents a fundamental shift toward a proactive health-care framework. By empowering patients with real-time data and bridging the gap between clinical visits with intelligent monitoring, these technologies aim to significantly reduce the incidence of diabetic-related amputations over the next decade. Success in this field requires continued collaboration between engineers and clinicians to ensure these tools are both scalable and medically sound.

Dr. Najafi is a dedicated professional in digital health, committed to advancing healthcare equity through decentralized models. As co-founder and leader of NSF IUCRC C2SHIP, he has brought together academic institutes, community health organizations, and industrial partners to support a care-in-place model, empowered by digital technologies. This program has received recognition from the National Science Foundation and Industry-University Research Partnerships program.

As a professor at UCLA and Research Director of founder of Center for Advanced Surgical & Interventional Technology (CASIT), he and his

team have pioneered the use of wearable sensors, mobile health platforms, and AI to transform patient care beyond the clinic. Their innovative work emphasizes continuous monitoring of chronic conditions, fall prevention, and personalized care solutions that empower patients and support caregivers. By integrating cutting-edge technology with healthcare, his goal is to make care more accessible, proactive, and personalized, ultimately improving health outcomes and quality of life for older adults and individuals with chronic illnesses. Dr. Najafi is a strong advocate for diversity and inclusion in digital health research and has mentored over 300 junior researchers. He has received numerous awards and recognition, including being listed as one of the most Influential Health and Medical Leaders and among the top 1% of scholars worldwide in the field. With 200+ scientific publications, 20 patents, and 80+ grants totaling over \$100 million, he brings extensive knowledge and experience to the table. His editorial and advisory roles, co-founding of a successful startup, and successful commercialization of various remote patient monitoring technologies showcase his ability to conduct creative research, manage grants and teams, and provide scientific and administrative leadership.

Minimally Invasive Achilles Tendon Repair and Post-op Rehabilitation: How Quick Can We Go



BY KIRK MCCULLOUGH, MD

Achilles tendon ruptures are among the most devastating lower extremity injuries an athlete can face. Historically, the medical community has been divided between traditional open surgery and non-operative management. While open surgery effectively lowers the risk of re-rupture, the posterior ankle's poor blood supply can sometimes lead to severe wound complications that can end careers. High-profile cases, such as NFL player Robert Mathis and MLB star Ryan Howard, highlight how wound-related issues—not the initial injury—can derail a professional trajectory. Conversely, non-operative treatment, though avoiding surgical wounds, carries a 10 times higher risk of re-rupture and often results in persistent calf muscle strength deficits that are still measurable 18 months post-injury.

The Paradigm Shift: Minimally Invasive “Mini-Open” Repair

To address these challenges, a minimally invasive approach has emerged as a superior middle ground. This technique utilizes a percutaneous Achilles repair system featuring an anatomic jig that allows surgeons to perform locked suture repairs through much smaller incisions.

A key advantage of this method is that the repair is performed deep to the paratenon, which minimizes soft tissue disruption and preserves the skin's sensitive environment. This “mini-open” approach provides the strength of a traditional open repair while drastically reduc-



ing the risk of infection and wound dehiscence. Research into elite populations, specifically NFL players, showed a 100% return-to-play rate, with athletes returning to the field in an average of 5 and a half months. The general public sees similar success in published studies, with 98% of patients returning to their activities significantly faster than those treated with traditional open surgery.

Technical Nuances: Adhesion Release and Specialized Suturing

The effectiveness of this procedure often depends on tips and tricks gained from clinical experience. For example, in cases where the presentation is delayed, surgeons can use a traction stitch and a malleable instrument to free up adhesions between the tendon and the paratenon.

This allows for the necessary excursion of the muscle-tendon unit proximally, ensuring a more functional repair even in complex, delayed-presentation cases.

Furthermore, surgeons must be meticulous about skin closure. Placing incisions transversely along the Langerhans lines helps the skin come together more naturally during flexion and extension, which creates less shear and promotes better healing. Closing the paratenon as a separate layer from the skin is another critical step in preventing long-term complications.

The “Golden Rule” of Tensioning: Fighting the 50% Elongation

Perhaps the most critical technical realization in modern Achilles repair is the management of tension. A common mistake is to tension the

This article summarizes Dr. McCullough's presentation, “Minimally Invasive Achilles Tendon Repair and Postop Rehabilitation: How Quick Can We Go,” delivered at the 2025 Lower Extremity Sports Injuries Event (October 25, 2025). To view the full presentation with audience questions and answers—and to see the complete agenda for the program—visit <https://sportsmed.lerexpo.com/en/#agenda>. Continuing education credits are available for this and many other lerEXPO programs.

Achilles Rupture

Background



Operative vs Non-Operative Treatment

Cochrane Review – Khan et al 2010

- 12 RCTs
- 844 patients
- Open surgical vs Non-Op (536 patients – 6 studies)
 - Cetti 1993; Nistor 1981; Moller 2001; Twaddle 2007; Metz 2008; Schroeder 1997
- Open vs Percutaneous (180 patients – 4 studies)
 - Aktas 2009; Assal 2002; Gigante 2008; Lim 2001
- CONCLUSIONS:
 - Open operative repair significantly reduces risk of re-rupture compared to non-op
 - Significantly higher rate of complications including infection with operative
 - Complications may be reduced by percutaneous repair – further studies needed

repaired tendon to match the uninjured side at the time of surgery. However, published studies emphasize that 50% of tendon elongation occurs within the first 3 months of recovery, regardless of the rehabilitation protocol used.

Because the tendon inevitably “stretches out” during the healing and early rehabilitation process, surgeons must overtension and excessively plantarflex the foot relative to the opposite limb during the repair. Failing to account for this elongation results in a permanent loss of power, which is considered a clinical complication in itself. By “over-tensioning” initially, surgeons ensure that once the stretching occurs, the patient is left with a muscle-tendon unit that provides optimal power and function.

Beyond Ruptures: Treating Chronic Tendinopathy

The advancements in Achilles care also extend to chronic conditions like insertional and non-insertional tendinopathy. When conservative treatments—such as shockwave therapy, night splints, and stretching—fail to provide relief, surgical debridement of “diseased tissue” may be required.

In these cases, surgeons are now utilizing flowable scaffolds to fill the gaps left by the removal of diseased tissue. This approach treats soft tissue defects much like a surgeon would


treat a bone defect: by providing a scaffold that cells can bind to, modulating the healing process from acute inflammation toward regenerative healing rather than just allowing functional scar tissue to fill the void.

Insertional Disease and the Suture Bridge Technique

For insertional issues, particularly calcific changes at the heel, the Suture Bridge technique offers a robust solution. This method creates a strong, knotless construct that often removes the need for an FHL (flexor hallucis longus) transfer, particularly in high-level athletes. It is important to note, however, that the recovery for insertional disease is typically much longer—often 2 and a half times the recovery time of an acute rupture.

A Better Standard of Care for Achilles Rupture

The traditional “long extensile” open repair is increasingly falling out of favor because its risks to the soft tissue are simply too high. By combining minimally invasive techniques with precise tensioning and advanced biological scaffolds, surgeons can achieve the best of both worlds: the structural integrity required for a full return to high-level athletics and the minimized risk of life-altering wound complications. As technology

continues to evolve with insertional Achilles tendinopathy management toward arthroscopic and burr-assisted techniques, the focus remains clear: minimize disruption to maximize the body’s native healing potential. 

Originally from Kansas City, Dr. McCullough spent his first 2 years of college as a cadet at the US Air Force Academy before completing his Bachelor of Arts degree in Biology from William Jewell College. Following graduation, he earned his medical degree from the University of Kansas School of Medicine in Kansas City. He then completed his residency in Orthopaedic surgery at Vanderbilt University Medical Center Center in Nashville, TN. Following residency, he completed a one-year fellowship in Orthopedic Sports Medicine and Shoulder Surgery at OrthoCarolina in Charlotte, NC, and then completed a second one-year fellowship in Orthopedic Foot and Ankle Surgery at the Cleveland Clinic Foundation in Ohio. Dr. McCullough has served on the NFL Foot/Ankle Committee, as a team physician for the Kansas City Chiefs, KC Ballet, Sporting KC (MLS), and the KC Current (NWSL). Outside of the region, he continues to serve the US Soccer Federation as a team physician for the USMNT and consultant for the USWNT and is the FI-FA-appointed Venue Medical Director in Kansas City for the 2026 World Cup.

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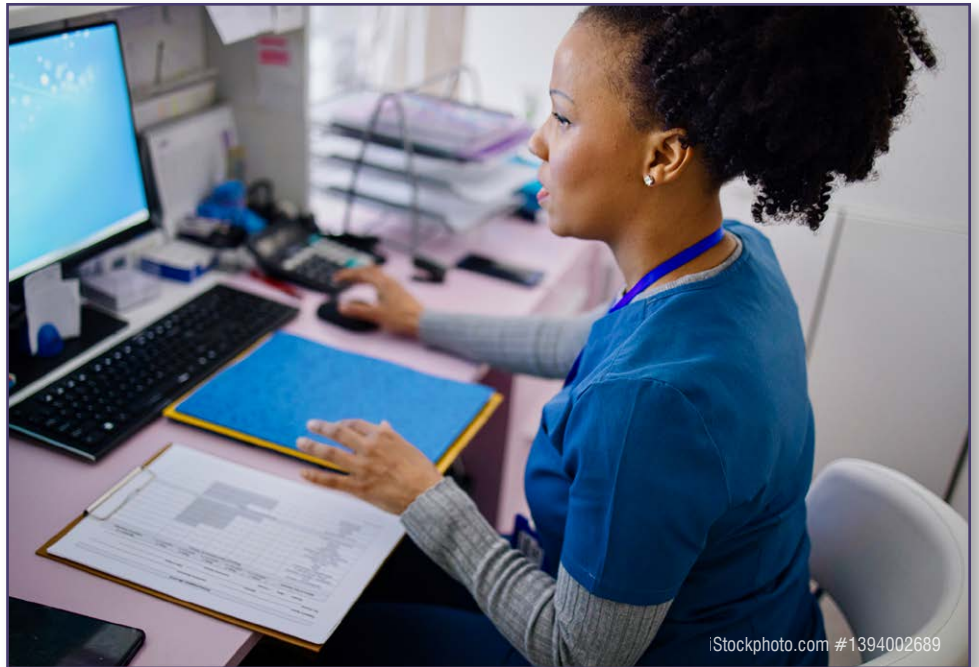


BY MIKEL D. DANIELS, DPM, MBA, PRESIDENT AND CHIEF MEDICAL OFFICER, [WETREATFEET PODIATRY](#)

Like many physicians, coming out of residency I thought I'd fix the world one bunion at a time. Somewhere between my 745 and 746th bunion procedure, I came to the realization that while I was helping to relieve the pain my patients were feeling, this might not be a way for me to make a difference. Taking an objective look at my practice, I decided to focus on diabetics. That was the point that made me ask how I could make a practice financially viable with this as a focus. I needed a care model that improved outcomes and could pay for itself. But how?

Ensuring that diabetic foot care is both clinically thorough and financially sustainable requires more than good intentions or a strong technical skill. It demands a deliberate structure. Efficient visit design, strategic coding, and accurate documentation are essential elements that must be integrated into this process. All are necessary to protect reimbursement and reduce administrative strain. For many clinicians, the challenge is finding the right balance between patient-centered care and the financial realities of running a thriving practice, all in an environment of rising costs and declining reimbursement. Poorly structured programs burn out clinicians or lose money. Well-designed programs become one of the most sustainable service lines in the practice.

The foundation of sustainability begins with how visits are designed and executed. A well-structured visit allows for thorough assessments without overwhelming the clinician's schedule. When providers spend most of their time on data entry or repetitive tasks, efficiency and morale plummet. Optimizing clinical workflow around the strengths of the care team helps prevent that. Medical assistants and nurses can



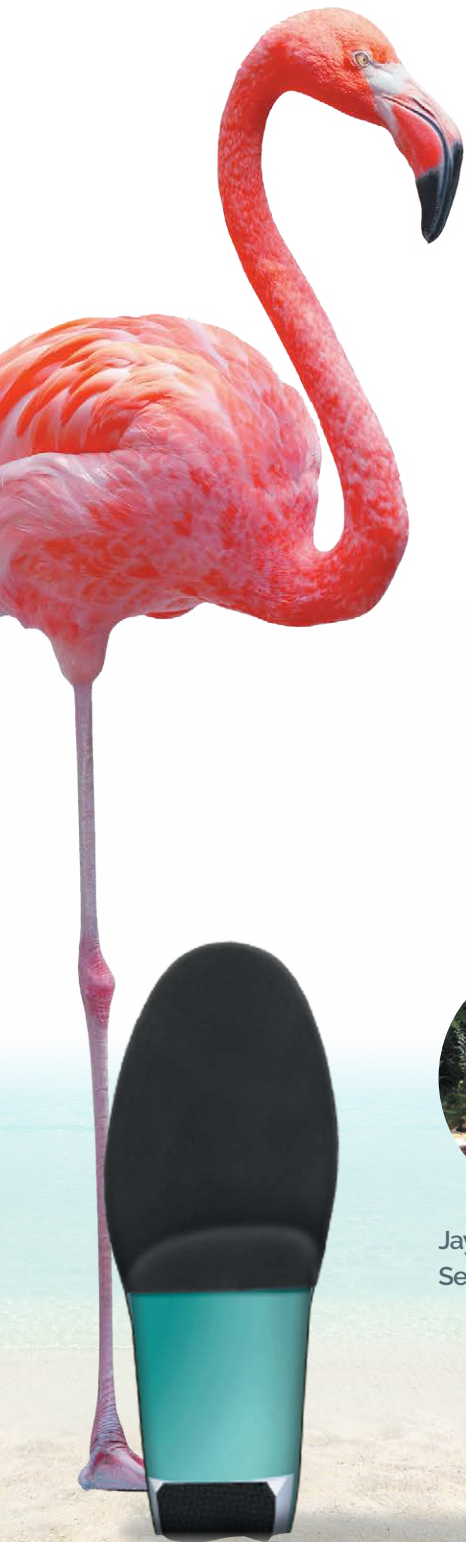
handle standardized elements such as removing shoes and socks, performing basic vital signs, and completing a monofilament test before the clinician enters the room. This "rooming protocol" accomplishes 2 things. First, it ensures that key screening steps are never missed, and second, it frees the clinician to focus their time on interpreting findings, making decisions, and documenting results that require higher-level medical judgment.

Another critical piece is the use of structured electronic health record (EHR) templates designed specifically for diabetic foot assessments. With pre-populated fields for skin integrity, pulse quality, neurological status, loss of protective sensation, and footwear evaluation, these templates minimize cognitive load. They also make auditing and coding far more consistent. In practices where each provider documents differently, billing errors and under-coding are common. Standardized templates create a uniform language across the care team,

streamline documentation, and provide clearer evidence of medical necessity. The efficiency we see here can now be supercharged with the use of ambient artificial intelligence, especially if clinically trained on the necessary items performed during the visit.

Understanding and identifying risk stratification further strengthens this model. By applying an objective tool such as the Wagner Ulcer Classification System, clinicians can categorize patients by their level of risk, establishing a protocol to determine how frequently the patient should be seen. For example, a diabetic patient without any identifying risk factors should be seen once a year. However, a diabetic patient with minor neuropathy may return every 3 to 6 months, while someone with a prior ulcer or active loss of protective sensation may require visits every 61 to 90 days. This not only personalizes care but also distributes visit volume in a predictable way. All of which supports

Continued on page 26



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scheduling efficiency and financial planning. Over time, such systems reduce preventable hospitalizations and amputations, generating measurable value not only for the patient, but also for payers and healthcare systems.

Once the care model is streamlined, the next element that is needed is to understand and accurately perform documentation and coding. When it comes to the medical record, if it isn't there, it didn't happen, and this is exactly how reimbursement is defined. This simple concept determines a practice's financial viability. Under Medicare's rules, "routine foot care" by itself is not covered. However, when systemic conditions like diabetes and neuropathy are properly documented, coverage becomes possible and sustainable. This distinction makes accurate coding essential. Evaluation and Management (E/M) codes 99202 through 99205 for new patients and 99212 through 99215 for established patients must align with the complexity of medical decision-making. Documentation must clearly reflect why the level chosen is justified based on the work performed. In addition to E/M codes, procedural codes play

a vital role in revenue integrity. Common ones such as 11055 to 11057 for paring or reducing corns and calluses, and G0127, 11917, 11720 to 11721 for nail debridement, should be used accurately, and only when clinically indicated.

For patients with confirmed loss of protective sensation (LOPS), using the specific G-codes that Medicare established for this purpose is key. Code G0245 applies to the initial visit, G0246 for follow-up care, and G0247 for diabetic foot maintenance in patients with diabetes and neuropathy. Linking these accurately to documented findings removes ambiguity in reimbursement and prevents denials. Quality reporting codes further enhance sustainability when aligned with federal programs. For example, HCPCS code 2028F indicates that a diabetic foot exam was performed, which counts toward MIPS and other pay-for-performance metrics. Consistent use of this code benefits both practice benchmarking and eligibility for incentive payments.

These are the essential backbone of financial sustainability, and it all ends with sound documentation. Without it, claims are

vulnerable to denials and audits, and even correct coding can fail. Each note must tell a clear story of medical necessity. The diagnosis must justify the intervention; a problem list must be included that reflects active conditions. The note must show that the care delivered was necessary to manage or prevent complications. One of the most critical steps in this process is appropriately connecting procedures to the diagnosis codes that accurately reflect diabetic complications such as E11.621 (Type 2 diabetes mellitus with foot ulcer). By using the correct ICD-10 pairing, clinicians protect reimbursement and ensure their documentation stands up to review.

Modifiers further refine accuracy. The -25 modifier should be applied whenever a significant, separately identifiable E/M service is performed on the same day as a procedure. Without it, payors may deny payment for one of the services, assuming overlap. Similarly, Q-modifiers (Q7, Q8, Q9) communicate the severity of systemic findings that justify coverage for foot care under Medicare. These small coding details collectively determine whether an encounter is reimbursed fairly or flagged for review.

Practices must also document the patient's broader care context. Medicare requires that the provider record the date the patient last saw the physician managing their overall diabetes. This detail confirms that the patient is under active care for the systemic disease that qualifies them for coverage. It seems minor, but missing even a small detail like this can lead to missed revenue and rejected claims. Establishing internal workflows or EHR prompts to capture this information ensures not only compliance, but also consistency across providers.

Ancillary services are another essential part of a practice's financial survival. Access to necessary tests such as x-ray or ultrasound ABI help with the diagnosis and accurate identification of diabetic patients risks. Providing durable medical equipment like diabetic shoes, bracing, orthotics, and compression garments provide patients with the necessary tools to reduce risks and treat active medical problems. Having these available in the office or clinic streamlines care, leading to reduced overall costs, while potentially adding to the bottom line of a practice.


To sustain care financially, every member of the care team must understand their role in the process. Clinicians should feel confident in which codes apply, MAs and nurses should recognize how their work feeds into billing accuracy, and billing staff should be proficient in spotting documentation gaps. The goal is to create a circle of accountability that keeps the care model intact. When everyone knows that their documentation supports both patient safety and financial health, burnout decreases, and teamwork strengthens.

It's also crucial to acknowledge that coding accuracy is not just a financial issue. It is both a legal, ethical, and even quality measure. Accurate documentation captures the true complexity of a patient's condition, allowing public health data, payor analytics, and value-based programs to reflect the real burden of diabetic complications. This information shapes resource allocation and supports preventive initiatives at the population level. It also ensures that clinicians are recognized for the high level of medical decision-making involved in managing

these chronic, risk-laden conditions.

One common pitfall is assuming that efficiency means rushing through visits. In all medical practice, optimization is about precision, not speed. This is essentially crucial in a diabetic foot practice. When each step of the visit, from rooming, data collection, exam, documentation, and coding are clearly defined, staff and provider have a more meaningful patient interaction. That results in fewer documentation errors, higher patient satisfaction, and sustained revenue. Over time, it builds resilience against burnout, as the burden of repetitive administrative tasks shifts off the provider.

Financial sustainability in diabetic foot care should also be viewed as part of a larger system of preventive health. Reducing ulceration and amputation rates saves enormous downstream costs for health systems and payors, thus reinforcing the importance of coverage for this preventive service. When clinicians document and bill accurately, they not only protect their own practice, but also justify the continuation and expansion of coverage for diabetic foot exams. In the end, this benefits the entire patient population.

Ultimately, making diabetic foot care financially sustainable comes down to aligning clinical excellence with administrative precision. Efficient visit design, strategic coding, and strong documentation processes form a comprehensive program that protects both the patient and the practice. The outcome is a healthier patient population and a stronger, more sustainable business model. All of which provide continuous care without compromising quality or burning out the professionals who provide it. 

Dr. Mikel Daniels is a board-certified podiatrist and healthcare executive with more than 2 decades of experience in foot and ankle surgery, wound care, and medical economics. As President and Chief Medical Officer of WeTreatFeet Podiatry, he has grown the practice from 1 office into a regional network of surgical centers, and retail health services across Maryland, Pennsylvania, and Washington, D.C.

Dr. Daniels earned his Doctor of Podiatric Medicine from Temple University and an MBA

in Healthcare Administration, combining clinical expertise with business strategy to deliver efficient, patient-centered care. His work focuses on complex reconstructive procedures, diabetic limb salvage, sports injuries, and minimally invasive techniques designed to accelerate recovery.

A Fellow of the American College of Foot and Ankle Surgeons and the American Professional Wound Care Association, Dr. Daniels also consults for biomedical technology firms and serves as a principal investigator in clinical research. His insights have appeared in Forbes, Parade Magazine, and CNN, and through his writing and mentorship, he continues to advance innovation

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A Simple Temperature Test Can Help Save Limbs and Lives

One simple step in every patient evaluation can help save limbs and potentially save lives: assess the feet and lower legs for temperature on every patient who enters your office.

A basic infrared temperature gun is inexpensive, easy to use, and widely available. Many clinicians already have one at home. These devices typically cost around \$20–\$25 and can be easily incorporated into daily clinical screening.

Why This Matters

A temperature difference of approximately 3°F (or more) between the left and right foot can be an early warning sign of inflammation or early Charcot neuroarthropathy.

Early detection of this difference allows clinicians to intervene before structural collapse, ulceration, or amputation occurs.

In addition, localized temperature elevations of approximately 7°F or more in the lower leg or foot may raise suspicion for deeper infection, including possible osteomyelitis, and should prompt further diagnostic evaluation.

When Abnormal Temperatures Are Found

If a temperature difference is identified:

- Perform a thorough clinical evaluation
- Order appropriate laboratory tests
- Consider advanced imaging, such as MRI, to rule out infection, Charcot changes, or other pathology




The Bottom Line

This screening takes less than 30 seconds and can dramatically improve early detection of limb-threatening conditions.

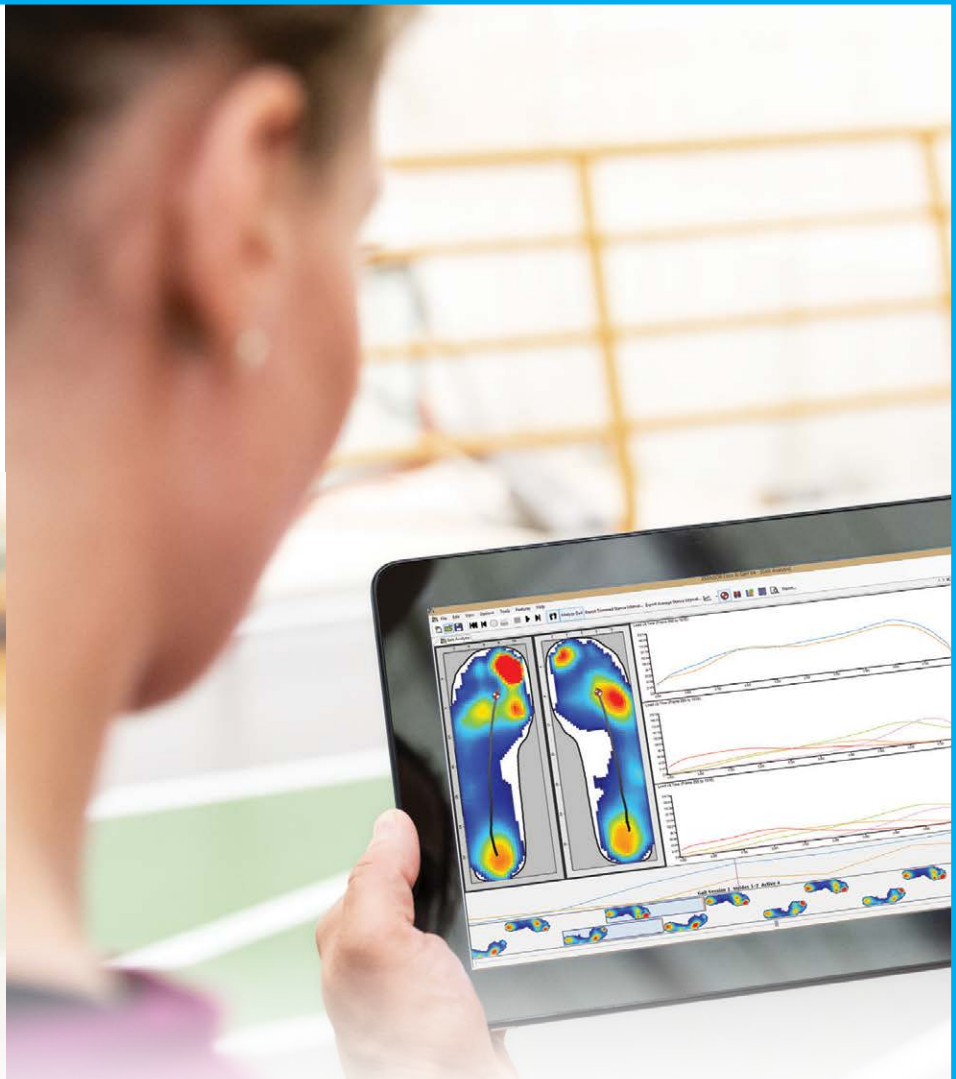
By simply measuring temperature, we can:

- Detect early Charcot foot
- Identify developing ulcers
- Recognize possible infection
- Prevent amputations

An ounce of prevention is worth a pound of cure. 

Jeff Rich is a Board-Certified Pedorthist and the owner of the U.S. Orthotic Center in New York

City, which specializes in orthotic manufacturing and shoe modification. For the past 46 years, he has employed a unique orthotic fabrication method that combines traditional craftsmanship with modern technology and serves professional athletes, including teams from the NBA and the US Olympic team. Additionally, he co-founded Masterfit Enterprises, which focuses on orthotic and footwear solutions, and has contributed significantly to the snowsports industry through training programs and product innovations. Rich holds seven US patents, including 3 for orthotic designs. Jeff is the President of PFA and serves on several committees. He also heads the Pedorthic lab and teaches Pedorthics at Hamad Hospital in Qatar.



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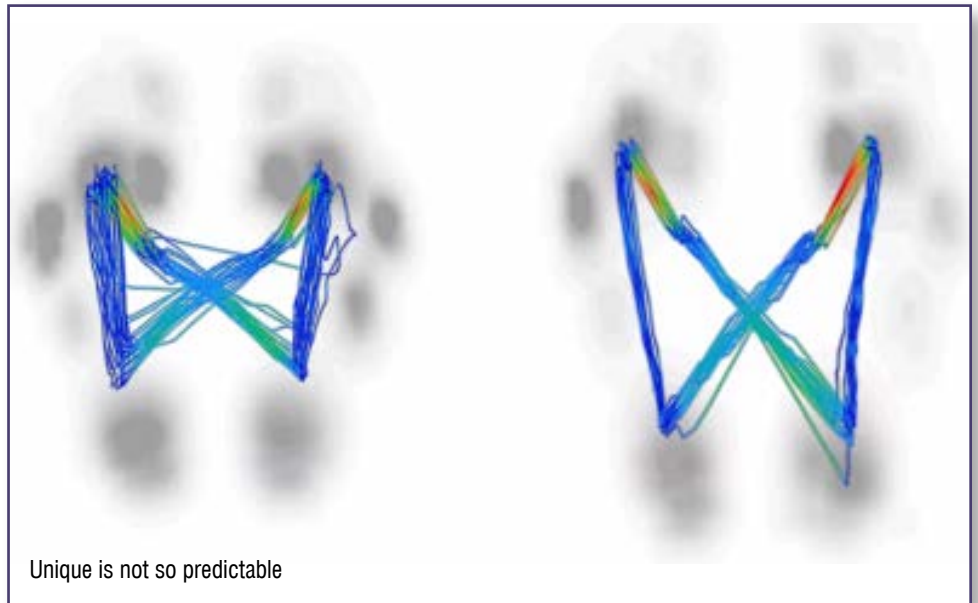
CAGA 101: THE 12 DIRTY TRUTHS OF FOOT MECHANICS

Dirty Truth #8: Every step is different—The Importance of Tracking Gait Variability Through Aging

BY JAY SEGEL, DPM; SALLY CRAWFORD, MS

This dirty truth sits like an unrecognized norm in our DNA and plays out like a knee-jerk reaction until we give it a little thought. We have 2 legs, 2 knees (no pun intended), 2 ankles, and 2 feet. The general public thinks they are the same in both form and function, but that is rarely the case. The easiest way to break this thought pattern clinically is to ask our patients, “Are you right-handed or left-handed?” Which opens the idea of variability. The dominant side will often show differences because of muscular recruitment, usage, and wear and tear. Then, we introduce the real-life traumatic events that rarely occur symmetrically, such as ski or skate accidents, or even dropping a soup can on your big toe, and other such scenarios. Finally, it is time to reintroduce an earlier dirty truth: within the foot itself, there is no symmetry top to bottom, back to front, and medial to lateral. The above thoughts speak mainly to form and hint at function, but with that grounding, we can begin the discussion of computer-aided gait analysis (CAGA), where we can clearly demonstrate that “Each Step Is Different.”

The classically described gait cycle breaks down how we should walk when moving in a forward manner, but not how we function throughout daily life. In reality, movement is unique and not so predictable. This concept is an important structural component in patient diagnosis and treatment. When performing a gait analysis on repetitive steps, which is the preferred paradigm, we make observations and collect data without the concern of, “Was that 1 step representative of the way the patient walks?” We then can compare those specific gait parameters to established normative values (norms), which can be found in the better CAGA systems. But do those norms really apply to the patient in question?



Below, we look at how the unique nature of impact, loading, weight shifting, and the off-loading process, in any direction, can be good, and also very, very “dirty,” especially as we age.


Some variability in gait as measured in CAGA reflects the body’s ability to adapt to diverse conditions and environmental stimuli. Controlled variability in human motion promotes resilience and enhances coordination, all of which are crucial as we age. However, excessive or uncontrolled variability in walking can indicate instability, making it helpful to track and interpret these changes over time using CAGA.

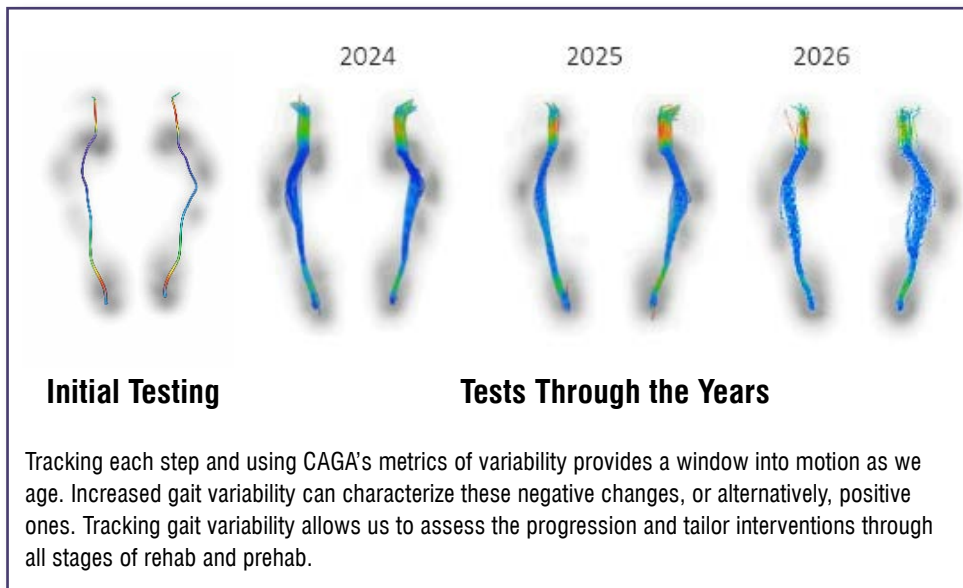
Macro-level variability refers to changes caused by external factors like different walking surfaces, where variations require the body to adapt, promoting better balance and coordination through differing muscle recruitments and general neuromuscular responses. Micro-level variability, on the other hand, results from more subtle differences, like variations in footwear cushioning or placement, support, or orthotic modifications

and adjustments, like fixed posting versus more dynamic, load management solutions.

These small-scale changes can influence specific gait parameters in a major way. For example, alterations in orthotic or midsole shoe structure can modify how the foot interacts with the shoe, resulting in center of pressure (COP) changes and increased variability in changes between each step’s interactions. Tracking these COP changes allows identification of fatigue, improper alignment, compensatory movements, or simply the unpredictable nature of how we move in our unique environments. Carrying further the thought going into custom orthotic prescription writing, 2 immediate considerations come to mind regarding posting. Why do most prescriptions ask for the same rearfoot canting bilaterally, and secondly, how does static posting make sense when each step is different? Perhaps that is why there has been a great effort coming from leading orthotic manufacturers to identify and develop dynamic posting solutions.

Tracking gait variability, specifically, using

CAGA allows true outcome tracking to support healthy aging. We know from our article on repetitive microtrauma that impact is a linear equation; CAGA data becomes inherently necessary to continue to monitor changes over time. Every step is different, yes, it's normal, but not ideal, yes, and as we age, the changes become more significant. These differences can, in turn, inform lifestyle recommendations, such as shoes, orthoses or exercise protocols to promote safety, adaptability and resilience. It is a dynamic indicator of mobility and health, and by understanding and objectively tracking CAGA parameters, we can assess functional status, reduce fall risk, and educate both the patient, and their health-care team on best practices. 




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A Foot Forward for Optimum Health



“A Foot Forward for Optimum Health” is a column designed to enlighten the old guard in a new way about lower extremity impairment as it pertains to foot drop. The intent is to challenge evidence-based research and practice so that it addresses real world issues shaped by social determinants

of health. For every common issue is an uncommon response that will provide insight to improve health outcomes by putting one foot forward at a time—efficiently and effectively.

Charcot-Marie-Tooth (CMT): College is My Time...to Put My Foot Forward for Lifespan and Healthspan Success

BY DR. JENNIFAYE V. BROWN

Epilogue: Sometimes you have to start with the end.

“You helped our daughter, Laylah, with getting AFOs last year. They have been wonderful for her and we are happy with the service provided by Hanger. She heads down to the College of Charleston in August to live in a dorm and start freshman year. She no longer tries to hide her AFOs. You were instrumental in getting her to this point. Thank you so much! Warm regards,” Catherine.

Prologue: Background Knowledge

Charcot-Marie-Tooth (CMT) is the most common heredity lower motor and sensory neuron disease that causes progressive muscle weakness and sensory loss leading to foot deformities and debilitating gait patterns.¹ There are over 100 genetic subtypes, however, the 2 major causes are genetic mutations of the peripheral myelin protein and chromosomal organization and architecture and second, genetic defects damaging the Schwann cell and the axon's myelin sheath as well as aggregating mutant proteins in the endoplasmic reticulum causing cell death (apoptosis).²⁻⁶ This disease process is characterized

as being nerve-length dependent disorder and comes in 2 forms categorized as demyelinating (CMT1) and axonal (CMT2).¹

CMT1 pathophysiology involves a malformation of and inappropriate maintenance of myelin such that there is an abnormal thickening of it around peripheral nerve fibers. This abnormal thickening, which produces an onion bulb appearance causes a reduction in nerve conduction velocity leading to motor and sensory dysfunction.^{3,7-8} CMT1, considered a segmental demyelination neuropathy, tends to be slow and progressive in nature whereas CMT2 is characterized by severe functional impairments with an early onset.^{3,7-8} CMT2 involves the anterior horn cell and axonal degeneration and diminution causing peripheral nerve dysfunction resulting in progressive muscle weakness, atrophy, and sensory deficits.^{3,7-8} Nerve conduction velocity is relatively preserved.^{3,7-8}

The physical therapy examination should include an assessment of pain, range of motion addressing talocrural motion in addition to that in the hindfoot, midfoot and forefoot, weakness (and may I add isometric, concentric and eccentric as it pertains to gait), atrophy, reflexes, gait appearance (foot drop versus steppage) in addition to kinematic (motion), kinetic (force), and spatiotemporal (time/distance) features, and foot musculoskeletal deformities. The most common foot deformity is pes cavovarus, progressive in nature and described as an abnormally high arch (pes cavus) and inverted heel.⁹ These details are essential to get the proper AFO and shoes.¹⁰⁻¹²

The patient/client may complain of having difficulty walking at increased speeds or with running, tripping, falls, twisting or spraining their ankles and therefore, wear high top sneakers.¹²⁻¹³ Atrophy of muscles more distal than

proximal may lead to the appearance of “stork leg deformity.”¹⁴ Complaints of creeping sensations are a result of damage to axons associated with sensory structures in leg muscles.¹⁵

First Dialogue: Client, Caregivers, and Physical Therapist

I am humbled and always in awe that people request my services for a physical therapy examination regarding an ankle foot orthosis (AFO). I was referred to Laylah who has a diagnosis of Charcot-Marie-Tooth (CMT) and was unhappy with her last set of AFOs. She had completed her physical therapy and wanted a new pair that would allow her to fully engage in the activities of life as a teenager which included traveling with her parents and exploring the thought of going to college. Laylah would have to walk a whole lot more than she was accustomed to and wanted to be comfortable amongst her peers in the new environment of collegiate life. I was up for the challenge with the focus on optimizing Laylah's ability to participate in life and not so much trying to change a disease process known to be progressive in nature at the body structure function level.^{1-6, 16} The narrative was hers, not what I knew about CMT. I made this a ‘team’ effort with Laylah being the center of attention and her parents having a supportive role to confirm and clarify her truths. An interprofessional team with a patient-centric approach is highly recommended in the literature.¹¹ Lastly, after completing the examination for an AFO, I prescribed some advanced gait activities to prepare for bilateral AFO use and met with them at the orthotist's office.^{13,17-18}



Left AFO and Shoe Medial View



Left AFO and Shoe Lateral View



Left AFO and Shoe Top-Down View



Bilateral AFOs for CMT


Second Dialogue: Client, Caregivers, Physical Therapist, and Orthotist

Laylah was able to speak about what she wanted and wore shoes similar to what she wears and would wear daily at the appointment with the orthotist. She preferred high top sneakers because they supported her ankles once fatigue sets in. I conveyed the findings of my physical therapy examination which supported the decision to get an AFO that primarily had medial lateral support and free range for plantarflexion and dorsiflexion as well as a flexible foot play to accommodate toe hyperextension needed for preswing and accentuated push off if she wanted to walk faster. Research indicates that predictors of walking recovery (and in Laylah's case, also walking sustainability and endurance) are walking speed and the ability to generate lower extremity propulsion at push off.¹⁹ Furthermore, research indicates meaningful gait changes occur when AFOs are tailored to the patient which includes not only musculoskeletal and neuromuscular impairments but the perceptions of the AFO's appearance, fit and function.²⁰⁻²⁶ The orthotist, Dave Adams, CPO was someone I had worked with before and he knew my style of AFO fabrication: total contact and contoured fit with the edges beveled and thinned out away from the skin; original thickness of the thermoplastic only in the areas of sustained weakness but other areas flexible to allow dynamic stability and mobility between the hindfoot, midfoot

and forefoot; and last, tension straps added based on the isometric, concentric and eccentric strength of the anterior, posterior and lateral leg muscles that controlled the foot. After some questions from Dave to Laylah, her parents and me and a few suggestions from him, it was time for the casting process. I knew Laylah was in good hands, and therefore left to get to another appointment. Everyone that I have sent to Dave gets educated on an AFO wearing schedule and what to look for in terms of complications from wearing the AFO such as skin irritations or pain, be it neuromuscular or musculoskeletal in origin. Here is the kicker: I never received a call from Laylah or her parents indicating that she was having problems with her AFOs during the spring and summer season before entering college. Laylah was so pleased with the fit and function, her family took it upon themselves to order another pair. I did not know until I asked them (the parents) if they would read my book for clarity and understanding.²⁷ And not only did they read it and provide edits, but wrote the kind words in the epilogue.

The Real Story: Communication

The success of this outcome was embedded in the dialogue. Conversations had were about communicating to be heard and acknowledge what was heard by offering solutions that took into consideration social determinants of health from the perspective of a teenager. As I say,

we as healthcare providers are experts in our professional roles, but the people we serve are experts in their lived experiences. We should be able to communicate impairments from disease processes with the clarity and simplicity of a glass of refreshing water but package it with the hope that the water will taste as good as sweet tea. I am so glad to be a part of a team that recognizes my strength in gait analysis and treatment as well as lower extremity examination and recommendations for AFOs. When the orthotist and the physical therapist work together as a team, the patient/client wins every time. 

Jennifaye V. Brown, PT, MSPT, PhD, NCS, CAPS is an American Physical Therapy Association 4-time 10-year board certified neurologic physical therapist in Charleston, South Carolina, specializing in stroke rehabilitation, specifically gait analysis and treatment, AFO design, and the redesign of lived spaces allowing individuals with disAbilities to age in place. She is the author of the book, Brace Yourself: Everything You Need to Know About AFOs After Stroke. Visit her YouTube channel @jobneuropt for more information regarding stroke rehabilitation.

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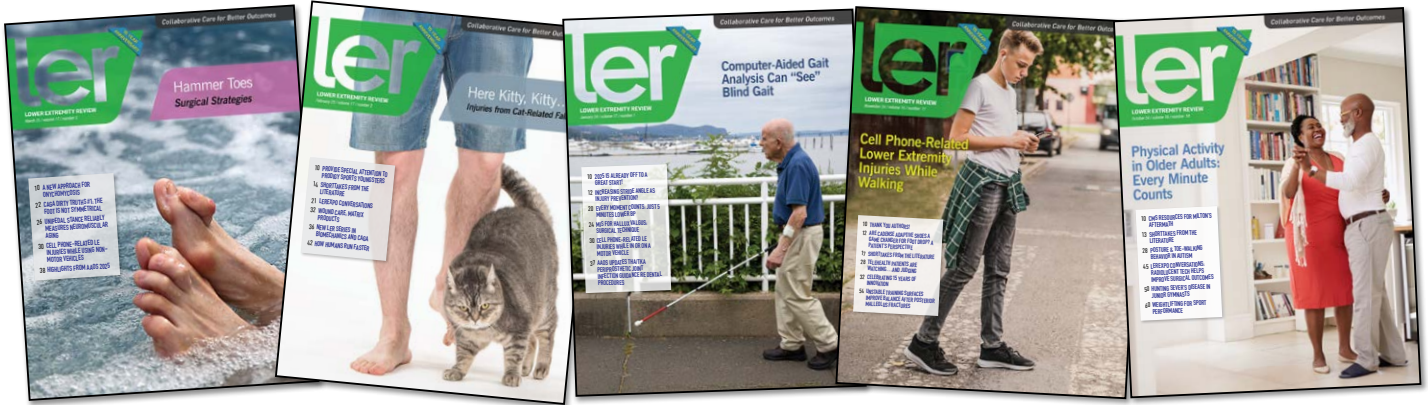
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Noteworthy products, association news, and market updates

HANGER INC. ACQUIRES LTI

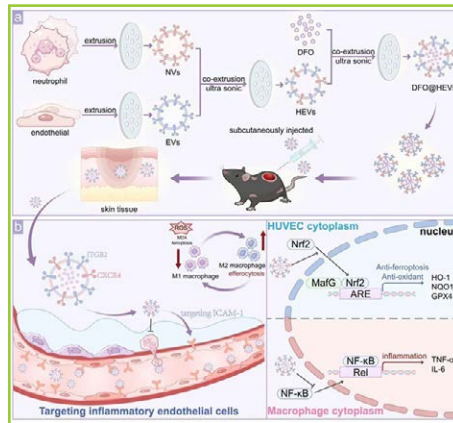
In March, Hanger Inc. announced the acquisition of Liberating Technologies (LTI), a research organization founded in 2000 and previously owned by Coapt. Since 2008, LTI's specialized research team has secured numerous government-funded grants to pursue cutting-edge, high impact concepts and develop next generation technologies for the O&P field.

LTI will join Hanger Ventures and the Hanger Institute for Clinical Research and Education in driving innovation and accelerating progress in clinical care. The LTI team will continue leading its current grant funded initiatives—including advancing voice recognition technology for improved prosthesis control, developing socket cooling systems to support residual limb skin health, and optimizing electrode configurations for pattern recognition control to help prosthesis users achieve optimal functional outcomes—while also actively pursuing new research and development opportunities to expand the impact of their work.

Hanger announced the acquisition of LTI's previous owner Coapt in 2025, and with this acquisition, the full Coapt portfolio is now a part of the Hanger family.

DUAL-TARGETED NANOTHERAPY ACCELERATES DIABETIC WOUND REPAIR

Researchers from Huazhong University of Science and Technology report a novel nanotherapeutic platform that accelerates diabetic wound healing by simultaneously targeting blood vessels and inflamed tissue. The research team engineered hybrid extracellular vesicles by merging vesicles derived from endothelial cells and neutrophils, then loading them with deferoxamine. By fusing endothelial- and neutrophil-derived membranes, the system achieves precise dual targeting while



Schematic illustration of the design, targeting behavior, and therapeutic mechanisms of DFO-loaded hybrid extracellular vesicles in diabetic wound repair.

delivering antioxidant and anti-inflammatory signals—the nanovesicles homed to damaged blood vessels through CXCR4 signaling while simultaneously targeting inflamed tissue via β 2-integrin interactions. Once delivered, the system addressed multiple pathological drivers of diabetic wounds.

In endothelial cells exposed to diabetic conditions, the nanovesicles restored cell survival, migration, and tube formation by activating the PI3K/AKT/HIF-1 α pathway and boosting VEGF-mediated angiogenesis. At the same time, iron chelation suppressed lipid peroxidation and ferroptosis through Nrf2-dependent antioxidant responses. Immune regulation represented another critical advantage. The nanovesicles reduced neutrophil over-adhesion, shifted macrophages from a pro-inflammatory M1 state toward a reparative M2 phenotype, and enhanced efferocytosis, the clearance of dying cells that is essential for inflammation resolution.

In diabetic mouse wound models, treatment led to faster wound closure, thicker re-epithelialization, increased collagen deposition, and dense new blood vessel formation. Inflammatory cytokines, oxidative stress markers, and ferroptosis indicators were all significantly reduced, demonstrating a comprehensive remodeling of the wound microenvironment. This research highlights a new direction for treating chronic

wounds by moving beyond single-target interventions. The hybrid nanovesicle strategy could be adapted to deliver other therapeutic agents or tailored for different inflammatory or ischemic diseases. Its strong biocompatibility and precise targeting suggest translational potential for diabetic foot ulcers, pressure sores, and other non-healing wounds.

FOOT PAIN RELIEF DEVICE



FootRenew is a therapy device designed to provide relief from neuropathic foot pain. This product is tailored to support individuals who experience discomfort caused by various factors, including diabetes, arthritis, or prolonged periods of standing and walking. The product combines thermal therapy, electrical stimulation, and a soothing massage to improve blood circulation, alleviate nerve pain, and promote the recovery of damaged nerves. With thermal therapy, the warmth penetrates deeply into the tissues, enhancing circulation and relieving stiffness. Electrical stimulation technology sends low-frequency pulses to activate nerves and muscles, providing a tingling sensation that can help alleviate pain and induce a feeling of relaxation. The gentle massage action helps to relieve tension, ease muscle fatigue, and enhance relaxation. Designed for daily use, this easy-to-use, portable, and lightweight device can fit seamlessly into any lifestyle, allowing users to enjoy a pain-free experience without interrupting their daily activities.

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LIGHTWEIGHT EXOSKELETON HELPS STROKE SURVIVORS WALK



Pruin adjusts the exoskeleton on a study participant. Image courtesy of Dan Hixson, University of Utah.

Researchers led by Tommaso Lenzi, associate professor in the mechanical engineering department at the University of Utah's John and Marcia Price College of Engineering, are piloting a portable, lightweight hip exoskeleton that can reduce the energy required to walk by nearly 20% in individuals with post-stroke hemiparesis. The 5.5-pound device is worn around the hips and straps to the user's thighs. Battery-powered motors help move the user's legs with every step, leading to a more efficient gait. The level of motor assistance on each side is custom-tuned for each user, and an intelligent control system synchronizes with them in real time, providing a boost exactly when the hip needs to lift or push off.

Other types of powered exoskeletons have been explored in earlier attempts at solving this problem. Identifying foot drop and impaired ankle propulsion as key contributors to this problem, these prototypes were built to assist with ankle mobility.

"Patients with ankle weakness often compensate with their hip joints, which requires extra energy," said Kai Pruyn, a graduate student in Lenzi's HGN Lab for Bionic Engineering. "Hip exoskeletons can also be extremely lightweight because they are worn closer to the user's center of mass and have lower torque requirements compared to ankle exoskeletons. We found that the hip assistance effectively compensated for reduced ankle propulsion."

The study implemented motion-cap-

ture techniques to analyze the gait of seven patients with hemiparesis as they walked on an instrumented treadmill, both with and without the exoskeleton. The participants also wore equipment that estimated their caloric expenditure. From that data, the researchers calculated the metabolic cost of walking under both conditions. Using the exoskeleton offloaded nearly 30% of the work from the hip joints, translating into an 18% decrease in the overall metabolic cost of walking. Study participants reported significant improvements in mobility.

Next steps for the research team include ensuring the hip exoskeleton is safe and effective at home and in daily life.

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ZenToes' Magnesium Foot Cream with Arnica and 40% Urea Foot Cream topicals were developed with ingredient-led formulas designed to soften, condition, and refresh the skin on hardworking feet. Magnesium Foot Cream with Arnica is a calming recovery cream designed for tired, overworked feet. Formulated to help feet unwind at the end of the day, the product offers soothing comfort as part of an evening wind-down or nighttime care ritual. 40% Urea Foot Cream is a refreshing, softening treatment that helps improve the look and feel of dry, rough skin. It is designed for consistent daily use to support smoother, more conditioned, and visibly cared-for feet over time.

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The Mako RPS (Robotic Power System) for Total Knee is an intuitive handheld robotic system that combines Stryker's proven robotics and power tool legacies and represents Mako's expansion into a new robotics platform. Compatible with Stryker's Triathlon® Total Knee System, Mako RPS for Total Knee offers a solution for surgeons who are interested in the potential benefits of robotic technology and want the familiarity of a manual power tool. It features intraoperative planning and a robotically enabled saw with Stryker's patented active adjustment technology, which responds to a surgeon's hand movements, guiding the saw to stay aligned with the surgical plan. The system integrates easily into a surgeon's workflow and provides a familiar cutting experience without the use of cutting blocks. It is built to work with Stryker's multi-specialty guidance platform, Q Guidance System. This product is being offered with a limited market release.

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CUSTOMIZABLE 3D-PRINTED SOCKET IS LIGHTWEIGHT, MORE COMFORTABLE

A reimagined limb socket interface combines highly personalized pressure mapping with



SFU researchers are working on a new, fully customizable 3D printed socket design set to transform the prosthetics industry. Image courtesy of SFU.

artificial intelligence (AI) software and a lighter infill, creating a customized prosthesis that's more comfortable to wear, for much longer, said researchers at Simon Fraser University (SFU).

"For the first time, this 3D-printing technology is capturing unique pressure and force distribution data from a patient and using that data to design a custom prosthetic device and fabricate a much lighter, more breathable and pressure-responsive socket," said Woo Soo Kim, professor at the School of Mechatronic Systems Engineering.

According to key study findings, the 3D-printed sockets with lightweight lattice infill showed 1,600% more energy absorption compared to solid infills when standing and 1,290% more energy absorption compared to solid infills when walking.

Traditional prosthetic fittings use casts or digital scans of the residual limb to make a mold for the final socket. These molds are very precise in terms of measurements and shape, but don't account for individualized pressure points and force distribution unique to each person, explained Kim.

In the study, researchers embedded a silicone liner with a miniature 3D-printed pressure sensing mat with a network of origami sensors to measure pressure and force. The test patient wore the pressure mapping liner inside a temporary socket while standing, walking on a flat surface, walking down a ramp, and leaning left and right, to mimic everyday activity. Customized AI software translated this data into a personalized 3D-printed socket design using a custom lattice structure—a highly

organized, repeating 3D pattern often found in nature and biology, like a honeycomb or the inside structure of human bone. Researchers said their new 3D-printed sockets improve comfort and quality of life for prosthesis wearers, and may also reduce common complications like ulcers, pain, instability, musculoskeletal issues, and osteoarthritis by absorbing more energy.

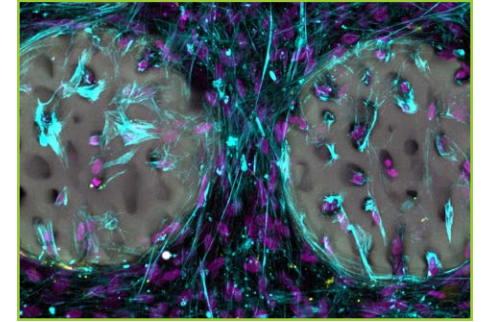
ANKLE FUSION CAGE SYSTEM



restor3d's Ossera™ AFX Ankle Fusion Cage System, a comprehensive platform engineered to address complex ankle fusion cases, is available in both standard off-the-shelf and made-to-order configurations. The Ossera AFX portfolio includes a standardized implant offering in Cylinder, Dome, and Pill geometries. These geometries were developed through years of analysis of restor3d patient case data to optimize fit across a broad range of anatomies. Designed specifically for foot and ankle procedures, the system combines 3D-printed titanium alloy implants, foot- and ankle-specific reusable instrumentation, and TIDAL Technology™, the company's proprietary porous architecture engineered to support osseointegration. The device is designed for rapid delivery, with sterile-packed implants and reusable instrumentation available immediately. The system's design, including cannulated reamers, flat cut guides, and lateral fibular relief across implant geometries, supports efficient, reproducible surgical workflows while providing intraoperative flexibility.

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JELLY-LIKE MATERIAL USED TO PRODUCE BONE IMPLANTS



A promising sign: bone-forming cells (light blue) with nuclei (purple) have already colonized a hydrogel-based bone structure (gray). Image courtesy of Margherita Bernero/ETH Zurich.

If a broken bone is too severe to heal on its own or a bone tumor needs to be removed, surgeons insert an implant that enables the bone to grow back together. These implants often consist of pieces of the patient's own bone, known as autografts, or metal or ceramic parts. A key drawback of many implants is that they require a second surgery to harvest the tissue for the autografts. Additionally, metal implants tend to be too rigid and may loosen over time, compromising stability. A successful repair of this nature depends on various cell types that must colonize the implant before forming new bone tissue. "For proper healing, it is vital that biology is incorporated into the repair process," said Xiao-Hua Qin, professor of biomaterials engineering at ETH Zurich.

Toward this end, Qin, along with his team and ETH Professor Ralph Müller, has created a novel hydrogel that is as soft as jelly, dissolves gradually in the body, and could potentially be used for personalized bone implants. The hydrogel, which is made up of 97% water and 3% biocompatible polymer, is modeled on the natural bone healing process. To make it solidify, the researchers introduced 2 special molecules: 1 that links the polymer chains together and another that, when exposed to light, triggers the reaction.

Wanwan Qiu, Qin and Müller's former doctoral student, developed the connecting molecule specifically for this application. The

polymer chains are linked as soon as laser pulses of a certain wavelength hit the hydrogel. The irradiated areas immediately solidify, while the non-irradiated parts can be washed out later. In this way, the researchers can use the laser beam to print any shapes and structures into the hydrogel with very fine resolution and extreme precision. The structures can be as small as 500 nanometers.

In their study, the researchers created complex, structured hydrogels that resemble real bone and feature a fine network of bone trabeculae. They used medical imaging as a template. While the material has only been tested in a test tube, results showed that bone-forming cells rapidly colonize the structured hydrogel and begin forming collagen, a vital component of bone. The tests also confirmed that the material is biocompatible and does not damage the bone-forming cells. The researchers have patented the base material and plan to make it available to the medical industry with the goal for the hydrogel-based implant to be used in clinics to repair broken bones.

LINED CLOG BUILT AROUND A CUSTOM ORTHOTIC



Surefoot has launched a footwear collection engineered entirely around a patient's custom orthotic. Powered by Amfit® full-contact foot-scanning technology, the collection represents a fundamental shift in how supportive footwear is designed, prescribed, and worn. The result is total alignment for comfort, built to preserve therapeutic intent without compromise. The collection includes a sneaker, classic clog, lined clog, and sandal. For clinics,

the model is intentionally effortless. Clinicians simply scan the foot, transmit the data, and deliver a finished product built to integrate seamlessly with the prescribed orthotic. The Surefoot Lined Clog is constructed from waterproof premium full-grain leather or waterproof premium suede. It is finished with genuine shearling for natural temperature regulation. A durable rubber outsole provides traction, and dual ski-inspired straps with functional buckles nod to Surefoot's alpine heritage.

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NEW SHOE BETTER ACCOMMODATES AN AFO



Aflatoony shows off the first prototype of the Ultra Adapt shoe. Photo by John Cline and Hannah Tran/CSU Photography.

When 2 faculty members in the Colorado State University (CSU) Department of Design and Merchandising learned from ankle-foot orthosis (AFO) users that most of the shoes used to accommodate the brace are big, black, and bulky, they decided to reinvent it. Associate Professor Kristen Morris and Assistant Professor Lida Aflatoony started their project to create the new Ultra Adapt shoe by interviewing people who wear AFOs to learn about the common barriers they face.

Aflatoony said she and Morris set out to create a new shoe that is not just roomy enough to accommodate the foot brace, but attractive

and fashionable too. Their first prototype, completed in summer 2024, was a casual shoe with a flat sole. And it was bright green. Based on feedback from their AFO users, they made a second prototype last summer, 1 that was more of an athletic shoe with a rocking feature that promotes foot launch when walking.

Now they have their sights set on a third and final prototype that will be a combination of the 2. They describe it as a shoe that functions like a sneaker but has a nice upper, making it appropriate to wear to work. "It has to be functional, aesthetic, and expressive," Morris explained. "There is a lot of expression in the shoes you choose. Some of our participants have told us, 'People might look at me differently because I use a wheelchair, but if I have awesome shoes on, it breaks the ice and is a good conversation starter.' Providing something like that is one of our main goals and values."

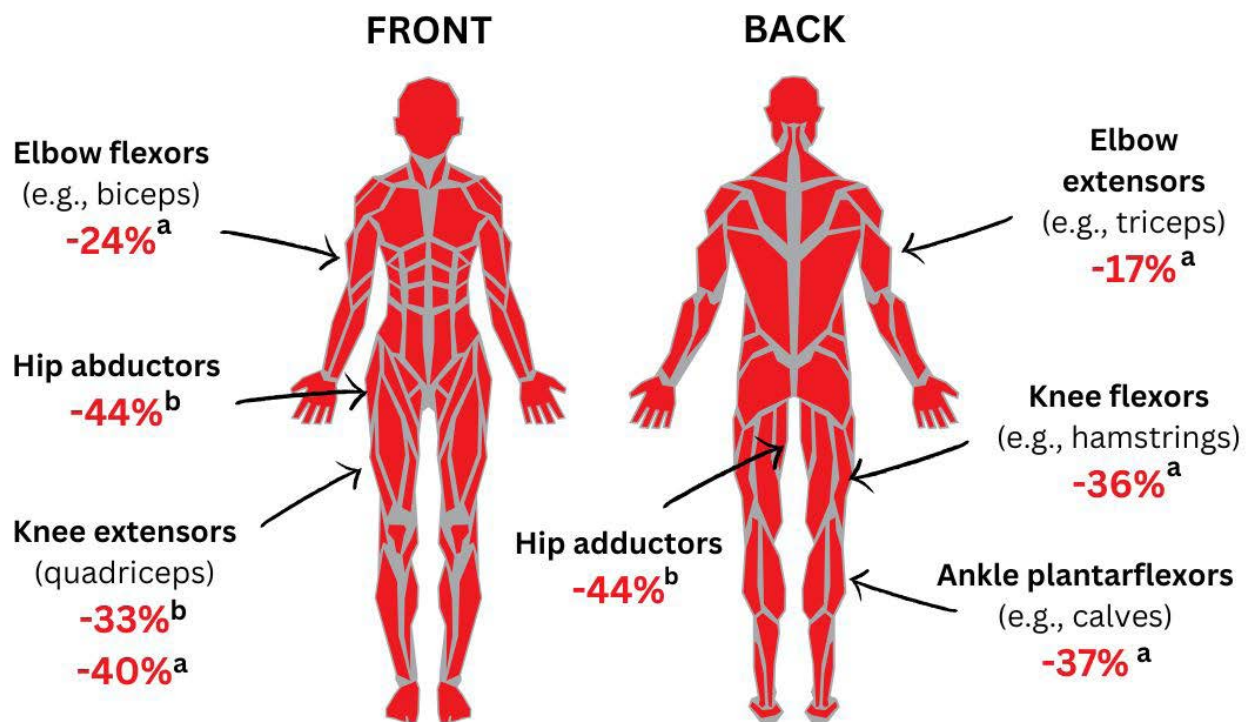
They have a patent pending for their new shoe design and plan to launch a spinoff company to produce the shoes for AFO users.

Do you have news or new product announcements?
Send them to:
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Muscle strength loss discriminates.

Between muscles, that is... We often blame ageing for muscle weakness, and think all muscles suffer the same. But in fact, that's not the case. And that tells us something important about what's really going on. Because the muscles hit hardest—our lower-body and stabilizing muscles (like those around the hips)—are the same ones we rely on most for daily movement. In other words, it's not just aging. It's inactivity. When we stop using these muscles as much, they pay the biggest price. And that's bad news for mobility, balance, and independence.

STRENGTH LOSS WITH AGE IS **NOT** EQUAL



Data from: a) Candow & Chilibeck (2005) *J Gerontol A Biol Sci Med Sci*
b) Daun & Kibele (2019) *PLoS One*

Jackson Fyfe, PhD @jacksonfyfe

Source: Candow DG, Chilibeck PD. Differences in size, strength, and power of upper and lower body muscle groups in young and older men. *J Gerontol A Biol Sci Med Sci*. 2005;60(2):148-56. doi: 10.1093/gerona/60.2.148.

Daun F, Kibele A. Different strength declines in leg primary movers versus stabilizers across age—Implications for the risk of falls in older adults? *PLoS One*. 2019 7;14(3):e0213361. doi: 10.1371/journal.pone.0213361.

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