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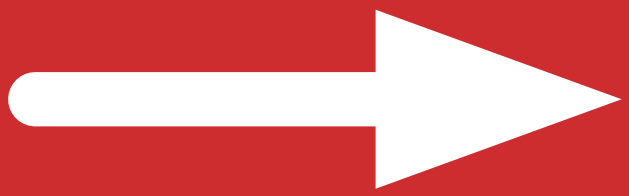

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Designed by @YLMSportScience

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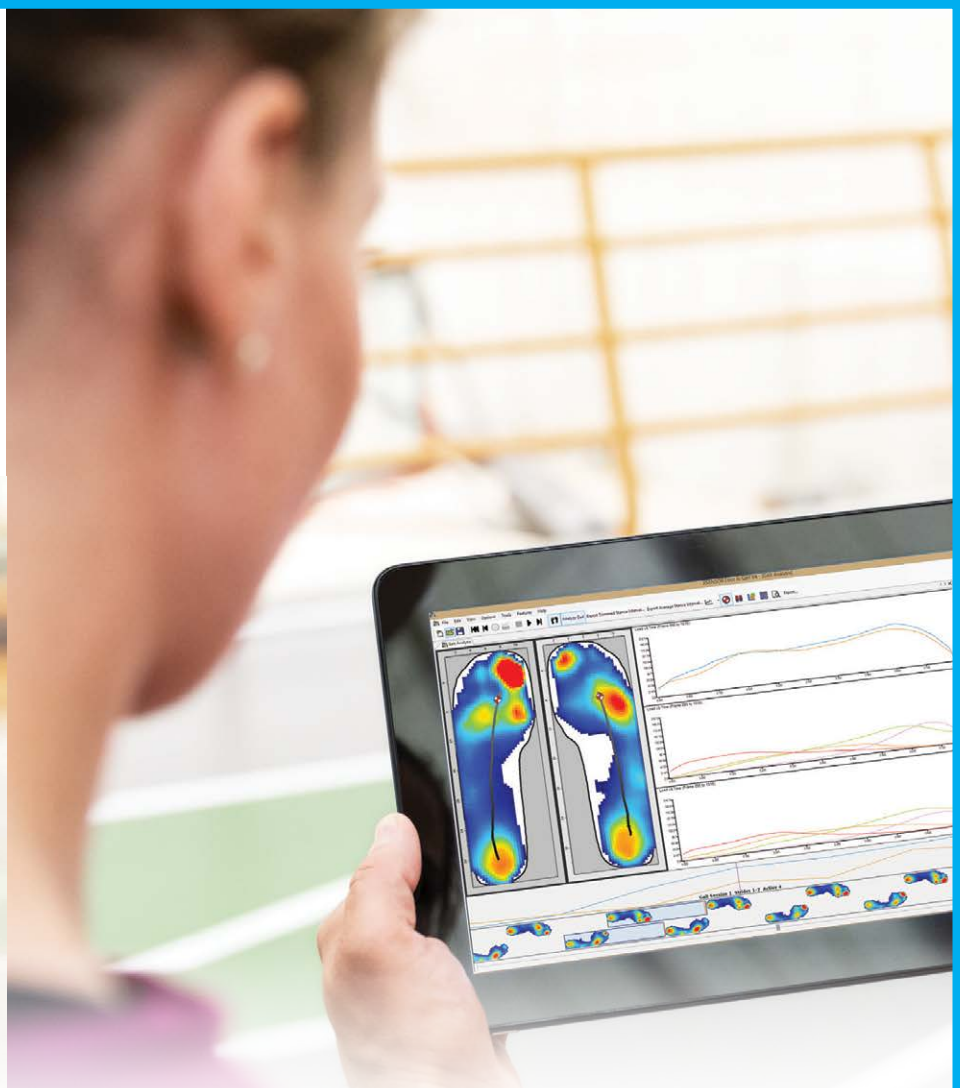

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Lower Extremity Review informs healthcare practitioners on current developments in the diagnosis, treatment, and prevention of lower extremity injuries. LER encourages a collaborative multidisciplinary clinical approach with an emphasis on functional outcomes and evidence-based medicine. LER is published monthly, except for a combined November/December issue and an additional special issue in December, by Lower Extremity Review, LLC.

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

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

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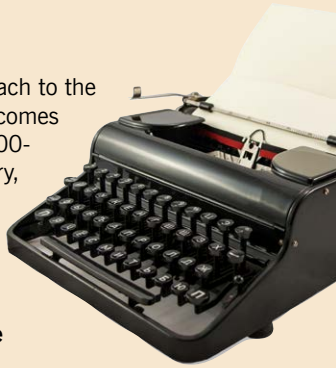

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STATIC STRETCHING DOES NOT APPEAR TO INFLUENCE ANKLE PROPRIOCEPTION

Ankle joint-position sense (A-JPS) is the body's awareness of the ankle's position in space—more commonly known as ankle proprioception. A-JPS plays a crucial role in balance and stability, particularly in sports. This research team wanted to understand if static stretching could improve A-JPS in soccer players.

Researchers from Turkey sought to investigate the influence of 2 different durations of acute static stretching on the A-JPS. Nineteen soccer players (age 18-30 yrs) performed 3 conditions: 2 experimental conditions–static stretching of the gastrocnemius and tibialis anterior, for 30 or 90 seconds, and a control condition (rest). A-JPS of the dominant limb was assessed before and immediately after for the range of 20° of plantar flexion by active repositioning, using a video camera. Absolute, relative and variable angular errors were calculated.

The results suggest that acute static stretching of the gastrocnemius and tibialis anterior, performed for 30 s or 90 s does not seem to influence the A-JPS of soccer players. (ler)

Source: *Azevedo J, Moreira A, Moreira-Silva I, Cardoso R, Seixas A. The influence of acute static stretching on the ankle joint-position sense of soccer players: A randomized controlled crossover trial. J Bodyw Mov Ther. 2025;42:1011-1016. doi: 10.1016/j.jbmt.2025.03.022.*

MRI VS SPECT-CT IN DIAGNOSING FRACTURE-RELATED TALAR OSTEOCHONDRAL LESIONS

Ankle fractures are common, and although treatment is generally successful, up to 50% of patients experience long-term functional issues. One potential cause is the presence of hidden osteochondral talar lesions (OCTLs), which may not be easily detected with traditional imaging methods like MRI. While MRI is widely used, it often reveals OCTLs that are not related to symptoms, making clinical interpretation difficult.

Researchers in Spain compared MRI and single photon emission computed tomography (SPECT-CT) in detecting symptomatic OCTLs after arthrogenic ankle fractures. In an ambispective study of 40 patients who underwent ankle fracture surgery, researchers assessed functional outcomes using AOFAS and EFAS questionnaires and compared them against imaging findings. The results showed that SPECT-CT detection of OCTLs, particularly those showing radiotracer uptake, was significantly associated with worse functional scores. Conversely, bone edema seen on MRI did not show a similar correlation with symptoms. The findings suggest that SPECT-CT may provide a better clinical-radiological correlation than MRI, as it evaluates both anatomical and metabolic activity, offering insights into lesion activity and potential impact on recovery. (ler)

Source: *Ojeda-Jiménez J, Vilá-Vives P, Tejero S, et al. MRI vs SPECT-CT in the diagnosis of fracture-related talar osteochondral lesions. Foot Ankle Surg., 2025. doi.org/10.1016/j.fas.2025.04.004.*

THE EFFECTS OF EXERGAMING IN IMPROVING PHYSICAL HEALTH AND WELL-BEING

Researchers in Singapore explored how different exergaming modes affect exercise intentions, fear of falling, and emotional well-being in older adults, particularly those from low socioeconomic backgrounds—a group often overlooked in such research.

Forty-eight participants took part in a 4-week community-based intervention, divided into 4 groups: conventional exercise, solo exerga-

ming, exergaming with a health coach, and exergaming with a peer. The results showed that all exergaming approaches had positive effects across all measured outcomes.

Exergaming with a health coach significantly boosted exercise intentions and emotional well-being, highlighting the motivational impact of professional support. The findings revealed that all exergaming modes positively influenced exercise intentions, fear of falling, and emotional well-being to varying extents.

Notably, exergaming with a health coach significantly improved participants' exercise intentions and emotional well-being, underscoring the value of expert guidance in motivating and supporting older adults in adopting healthier lifestyles. Exergaming with a peer was most effective in reducing fear of falling, highlighting the importance of social support and peer interaction in addressing physical health concerns among this population. ler

Source: *Bao H, Pai SGS, Singh NB, et al. Single or multiplayer mode? Examining the effects of exergames in improving physical health and well-being among older adults. Games Health J. 2025;14(2):119-126. doi: 10.1089/g4h.2023.0241.*

GROWTH IN USE OF ELECTRIC BIKING LINKED TO INCREASE IN INJURY

Electric biking (E-biking) has been growing in popularity. High-impact injuries are linked to this new recreational and transportation source. A new study brings light to the growth of E-bike related injuries and details the distribution between age, sex and the primary source of E-bike related injuries in the US.

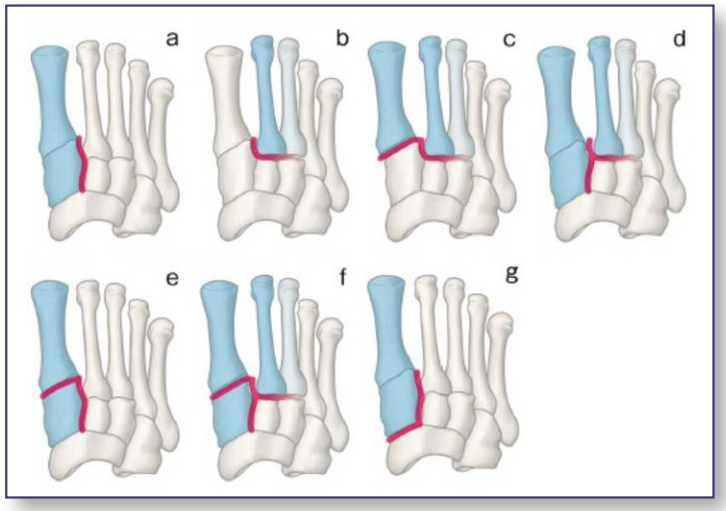
The National Electronic Injury Surveillance System (NEISS) was consulted for E-bike-related injuries that presented to US Emergency Departments (Eds) from January 2013 through December 2022. Only injuries related directly to operating E-bikes were included.

The results were as follows:

- 45,945 total nationally estimated (NE) E-bike-related injuries presented to US EDs from 2013-2022.
- 90.9% increase in injuries due to E-bikes from 2019 (NE: 2,171) to 2022 (NE: 23749) (P = 0.0004).
- Hospitalization was required for 10.9% of patients following E-bike related injuries.
- The most injured part of the body for youth, middle school age groups was the head.
- 30% of injures associated with E-biking had motor vehicle involvement. ler

Source: *Locke AR, Koehne NH., Ramey MD, et al. The rise in electric biking (E-bike) injuries: a 10-year age and sex-specific analysis of national injury data. Physician Sportsmed. 2025:1–8. doi: 10.1080/00913847.2025.2470104*

OPTIMIZING OUTCOMES FOR LISFRANC INJURIES



Patterns of Subtle Lisfranc Injury. The injured joints are indicated in red. (a) Longitudinal type injury. (b) Transverse type injury. In some patients with this type of injury, the joint between the third cuneiform and third metatarsal may be involved. (c) Transverse type injury combined with first tarsometatarsal joint injury. (d) Longitudinal type injury plus transverse type injury. (e) Longitudinal type injury plus first tarsometatarsal joint injury. (f) Longitudinal type injury, transverse type injury, and first tarsometatarsal joint injury. (g) Longitudinal injury extending into the naviculo-first cuneiform joint. *Source: Haraguchi N, Ota K, Ozeki T, Nishizaka S. Anatomical pathology of subtle Lisfranc injury. Sci Rep. 2019;9(1):14831. doi: 10.1038/s41598-019-51358-8.*

Lisfranc injuries, once described fracture-dislocations of the tarsometatarsal joints and considered rare, are now recognized to occur more frequently and in subtler forms due to advancements in imaging. These injuries vary significantly in severity and anatomical presentation. Early

Continued on page 12

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diagnosis is critical for favorable outcomes. Traditional anatomy-based classification systems have limited treatment utility. This review supports a stability-based classification, emphasizing the role of weight-bearing radiographs and CT in diagnosis.

Stable Lisfranc injuries typically respond well to nonoperative treatment-immobilization and non-weightbearing for 6 weeks. Unstable, displaced, or comminuted injuries require surgical intervention, most commonly open reduction and internal fixation (ORIF), with a growing preference for bridge plating. ORIF generally achieves good outcomes but is less predictable in high-energy trauma. Primary arthrodesis is less commonly used in acute settings but may reduce post-traumatic arthritis and hardware removal.

Emerging techniques like suture button fixation offer flexible stabilization with the potential to improve midfoot biomechanics and reduce complications, though more data is needed. Future research should aim to refine classification systems, validate weight-bearing CT, enhance rehabilitation strategies, and tailor surgical methods to specific injury types to optimize outcomes. ler

Source: *Poutoglidou F, van Groningen B, McMenemy L, Elliot R, Marsland D. Acute Lisfranc injury management. Bone Joint J. 2024;106-B(12):1431-1442. doi:10.1302/0301-620X.106B12.BJJ-2024-0581.*

JOINT PRESERVING SURGERY YIELDS POSITIVE OUTCOMES IN RA FOREFOOT DEFORMITY

A new retrospective study evaluated 74 feet in 57 rheumatoid arthritis patients with severe hallux valgus (HV) deformity (Larsen grade ≥3), comparing first metatarsophalangeal (MTP) joint arthrodesis (27 feet) and joint-preserving surgery (47 feet). Procedures were performed at Japan's Kyushu University Hospital between 2008 and 2022. Clinical outcomes were assessed using the Japanese Society for Surgery of the Foot (JSSF) Hallux scale and radiographic HV angle (HVA). After propensity score matching, both groups showed significant functional improvement postoperatively. The arthrodesis group had a longer mean follow-up (5.1 ± 2.6 years) than the joint-preserving group (2.4 ± 2.0 years, $P < 0.01$).

All patients undergoing arthrodesis also received resection arthroplasty on the second to fifth toes. In the joint-preserving group, procedures varied: 5 involved only first MTP surgery, while 42 included additional lesser toe procedures. Joint-preserving surgery yielded significant JSSF scores compared to arthrodesis (preoperative: 22±1 vs 17±8, $P=0.01$), although both had comparable outcomes in foot function over time. A subgroup analysis using propensity score matching performed in 38 feet of 32 patients revealed a significantly greater improvement in the functional scores in the joint-preserving group (32±6 vs 28±8, $P=0.04$). Recurrence of deformity was associated with higher immediate postoperative HVA. The findings suggest that joint-preserving surgery can provide greater functional benefit than arthrodesis, even in advanced joint destruction, making it a viable alternative in treating severe RA-related forefoot deformities. ler

Source: *Sakai S, Fujiwara T, Yamaguchi R, et al. First metatarsophalangeal joint-preserving surgery is effective for forefoot deformity with moderate to severe joint destruction in rheumatoid arthritis. Foot Ankle Ortho. 2025;10(1). doi:10.1177/24730114251322790.*

BALANCE CONFIDENCE AND FALLS IN INDIVIDUALS WITH CHARCOT-MARIE-TOOTH DISEASE

Impaired balance and functional deficits are common in individuals with Charcot–Marie–Tooth disease (CMT). Many individuals with CMT use ankle foot orthoses (AFOs) to improve their balance and function. The aim of this study was to evaluate the fall frequency, perceived effect of AFOs on balance, and balance confidence of individuals with CMT who currently use AFOs; 306 individuals participated in this study. Questions related to fall frequency, questions about the perceived effect of AFOs on balance,

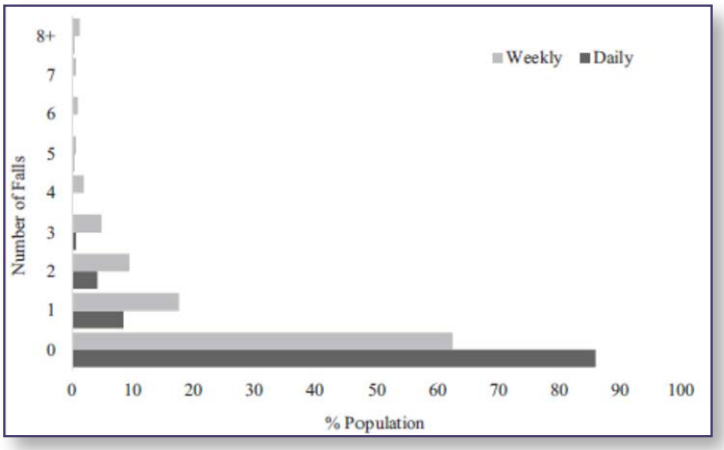

Figure 1. Frequency of falls on daily and weekly basis.

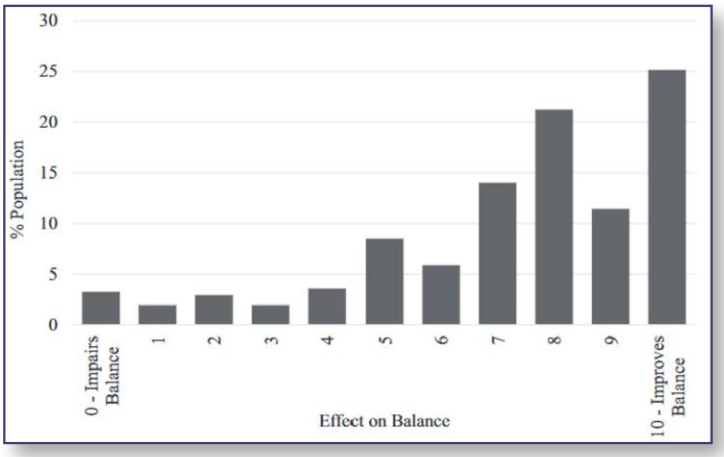

Figure 2. Reported effect of AFOs on participant's balance. Rating of 0 indicates that AFO impairs their balance, rating of 10 indicates that AFOs improve their balance.

and the Activities Specific Balance Confidence Scale were distributed to individuals with CMT via e-mail using a Patient Contact Registry. Many participants reported falling in the preceding 24 h (14% of participants) or week (38% of participants); and 78% of participants indicated their AFOs improve their balance. Participants reported decreased balance confidence across a range of activities, with highest confidence for level ground walking and standing tasks (> 60%), markedly decreased confidence when walking on stairs, slopes, or with external stimuli (40–55%), and poor confidence when walking on icy sidewalks, when bumped, or on unsteady surfaces (< 40%). The data presented here provides insight into the frequency of falls and balance confidence for individuals with CMT who use AFOs. The Activities Specific Balance Confidence Scale can be used as an assessment tool to identify CMT patients with low balance confidence who are at risk for falls. This information can be used to target patient education and tailor treatment plans and interventions to address challenging activities. Further, this study will help to focus future studies investigating the effects of AFO design on balance confidence and falls.

Source: *Anderson KM, Bopha Chrea, Riccardo Zuccarino, Shy ME, Wilken JM. Balance confidence and falls in individuals with Charcot–Marie–Tooth Disease: a cross-sectional observational study. Health Sci Rep. 2025;8(4):e70682. doi: 10.1002/hsr2.70682. Use is per CC BY.*

META-ANALYSIS SHOWS CHINESE THERAPEUTIC MASSAGE IS SAFE & EFFECTIVE FOR CAI

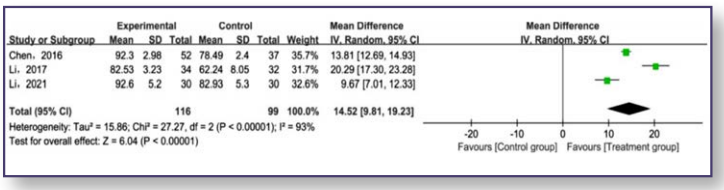

Figure. Forest plot for AOFAS Ankle Hindfood Scale.

Ankle sprains are among today's most common injuries. They can range from mild with no loss of function to debilitating and even disabling. And while a significant number of patients will go on to develop chronic ankle instability (CAI), there remains no ideal management. Conservative therapy is the first line, with surgical interventions used as a last resort. While there are multiple conservative options, ranging from oral non-steroidal anti-inflammatory drugs to bracing to immobilization to functional rehabilitation training, patients have a difficult time sticking to the routine and the outcomes are not ideal.

Tuina is a Chinese therapeutic massage based on traditional Chinese medicine theories, integrating modern biomedical theory (biomechanical function, anatomy, pathology, and physiology) with traditional practice. Several clinical randomized controlled trials have shown that massage plays an important role in CAI and tuina has been specifically shown to relax the tense soft tissues around the ankle joint, improve blood circulation, and promote better recovery of joint function. Yet, its use is not universal. This meta-analysis was conducted to evaluate the effectiveness and safety of tuina in treating CAI and aims to provide high-quality evidence for this promising treatment.

Thirteen randomly controlled trials involving 984 patients were included in this study. While the overall methodological quality of the studies was low, the meta-analysis revealed the following:

1. The clinical effective rate was higher in the treatment group compared to the control group (OR = 6.51, 95% CI [3.76, 11.28]).

2. The treatment group performed better in reducing the Visual Analogue Scale score (MD = -1.59, 95% CI [-2.59, -0.59]).

3. The Baird-Jackson Ankle Score was superior in the treatment group (MD = 8.20, 95% CI [6.37, 10.04]).

4. The improvement in the AOFAS Ankle Hindfoot Scale was greater in the treatment group (MD = 14.52, 95% CI [9.81, 19.23]).

All differences were statistically significant. Regarding adverse events, there were no significant differences in incidence rates between the groups.

The authors concluded tuina is an effective and safe treatment option for CAI.

Source: *Liu L, Huang J, Li T, et al. Efficacy and safety of Tuina (Chinese Therapeutic Massage) for chronic ankle instability: A systematic review and meta-analysis of randomized controlled trials. PLoS One. 2025;20(6):e0321771. doi: 10.1371/journal.pone.0321771. Use is per CC BY.*

A NOVEL SCORING SYSTEM PREDICTS MORTALITY AND MORBIDITY AFTER BKA

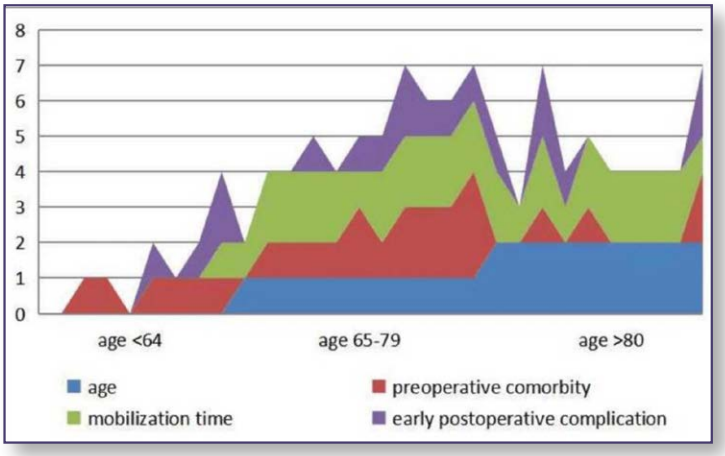

Figure. The 4 parameters that make up the score are age, preoperative disease, postoperative mobilization time, and complications that develop in the early postoperative period. The relationship between this score consisting of these parameters and 1-year postoperative survival and the Katz score at 3 months postoperatively was investigated.

Patients undergoing below-knee amputation (BKA) may experience considerable postoperative mortality risk, particularly in the presence of comorbid conditions. The aim of this study was to present a newly devel-

Continued from page 15

oped risk index and scoring system to predict 1-year mortality, morbidity, and functional independence in patients undergoing below-knee amputation. One-year postoperative follow-up data were obtained retrospectively from 30 patients (average age 71.7 years) who underwent below-knee amputation at our clinic. A novel scoring system was developed using variables including age, preoperative systemic diseases, diabetic foot infection, previous extremity surgery, postoperative mobilization time, and early complications. Survival analysis was performed, and functional independence was assessed using the Katz Activities of Daily Living Scale (Katz scores). The relationship between patients' survival status and Katz scores with the developed risk index was statistically evaluated. Survival analysis indicated that higher scores on the newly developed index were significantly associated with increased mortality and morbidity ($P<0.05$). There was also a strong negative correlation between patients' scores and Katz scores ($r=-0.757$; $P<0.001$), indicating that patients with higher risk scores experienced poorer functional outcomes.

This retrospective study introduced a novel scoring system that reliably predicts functional independence in patients following below-knee amputation. The scoring method highlighted the importance of early mobilization based on age and systemic disease, as well as early complications such as hypoxia and metabolic disease. However, its accuracy in predicting mortality and morbidity remains limited. Further refinement and validation in larger patient populations are required to enhance predictive accuracy and clinical applicability. ler

Source: *Yurdakul G, Golgelioglu F, Olcar H, et al. A novel scoring system for predicting mortality, morbidity, and functional outcomes in patients following below-knee amputation: a retrospective study. Cureus. 2025;17(3): e80967. DOI 10.7759/cureus.80967. Use is per CC BY.*

EFFECTS OF FOOTWEAR DESIGN ON WOMEN WITH PLANTAR HEEL PAIN

Footwear is often recommended in the management of plantar heel pain (PHP), theoretically to reduce tissue stress during standing and walking. However, limited data exist to guide footwear design and recommendations. The aim of this study was to investigate the effect of both shoe and shoe insert designs on in-shoe plantar pressures, vertical ground reaction force and underfoot comfort in individuals with PHP.

Plantar pressures, impact forces and comfort during walking were recorded in 29 women with PHP (mean age 47 ± 12 years) in 6 randomized shoe and insert conditions. A test shoe (polyurethane outsole, 14–mm heel–toe pitch) was compared to a control shoe (rubber outsole, 4–mm heel–toe pitch), and within the test shoe, 5 different insoles that varied by material, density and arch contouring were also compared (Figure).

The test shoe reduced heel peak pressure (15%, $P< 0.01$) and reduced the loading rate but not the peak magnitude of the vertical ground reaction force (average loading rate reduction: 7%, $P < 0.01$; maximum loading rate: 29%, $P < 0.01$) and was more comfortable

Figure. Shoe and insert conditions. The test shoe was a lace-up sneaker with leather upper, 14-mm heel-toe pitch and dual-density molded polyurethane outsole (Jackie sneaker, FRANKIE4, Australia). The control shoe was an athletic lace-up sneaker with canvas upper, 4-mm heel-toe pitch and rubber outsole (Dunlop Volley, Pacific Dunlop Ltd., Melbourne, Australia). Condition A: Control shoe (Dunlop Volley) with a flat low-density ethylene vinyl acetate foam insert (FRANKIE4 Flat + Lite Footbed). Condition B: Test shoe (Jackie sneaker, FRANKIE4) with a flat low-density ethylene vinyl acetate foam insert (FRANKIE4 Flat + Lite Footbed). Condition C: Test shoe (Jackie sneaker, FRANKIE4) with a molded contoured dua-density insert (FRANKIE4 Sole Hero Footbed). Condition D: Test shoe (Jackie sneaker, FRANKIE4) with a molded contoured dua-density insert (FRANKIE4 Sole Hero Footbed) with a molded contoured thermoplastic rubber piece at midfoot (FRANKIE4 Arch Peace). Condition E: Test shoe (Jackie sneaker, FRANKIE4) with a molded contoured bio-derived polyurethane (PU) dual-density insert (FRANKIE4 Sole Hero Bio PU Footbed). Condition F: Test shoe (Jackie sneaker, FRANKIE4) with a molded contoured polyethylene foam insert (Formthotics).

(47%–67%, $P < 0.01$) compared to the control shoe. Within the test shoe, dual-density inserts with arch contouring showed lower heel peak pressure compared to a lightweight flat insert (11%–12%, $P < 0.03$). The insert with the firmest material and higher arch contouring showed higher midfoot peak pressure (16%–21%, $P < 0.01$) compared to other inserts. Forefoot peak pressure did not differ between shoe or insert conditions ($P > 0.05$). There were no differences in impact forces or comfort between the different inserts within the test shoe ($P > 0.05$).

Findings suggest that shoe and insert properties are both important and provide data to guide footwear design and management recommendations for PHP. ler

Source: *Franettovich Smith MM, van den Hoorn W, van den Hoek A, Kerr G, Hurn SE. Immediate effects of footwear design on in-shoe plantar pressures, impact forces and comfort in women with plantar heel pain. J Foot Ankle Res. 2025;18: e70055. DOI: 10.1002/jfa2.70055. https://doi.org/10.1002/jfa2.70055.*

INTRA-ARTICULAR KNEE INJECTIONS AND KOA

At least 10% of all patients with knee osteoarthritis (OA) undergo treatment with injectable corticosteroids or hyaluronic acid (HA). Although both have been shown to help with symptomatic pain relief, their long-term effects on knee OA progression remain inconclusive. The overall

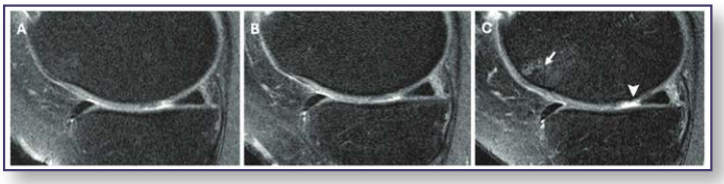

Figure. Knee MRI scans in a 58-year-old female participant in the Osteoarthritis Initiative who was administered a corticosteroid injection. Sagittal intermediate-weighted images obtained **(A)** 2 years before injection, **(B)** at the time of injection, and **(C)** 2 years after injection show a focus on the medial femoral cartilage and trochlea. **(C)** The postin-jection scan shows a new full-thickness cartilage lesion in the medial femoral cartilage (arrowhead), whereas images from the preinjection time points show a well-preserved medial femoral cartilage **(A, B)**. The postinjection scan **(C)** also shows the development of a new full-thickness cartilage lesion in the medial femoral cartilage and a new bone marrow lesion in the trochlea (arrow), both of which were absent in the preinjection scans. These findings suggest structural deterioration following the corticosteroid injection.

aim of this study was to investigate the association between intra-articular knee injections, specifically with corticosteroids and HA, and the progression of knee OA using a detailed whole-joint semiquantitative MRI evaluation and clinical outcomes for a period of 2 years.

This secondary analysis uses data from the Osteoarthritis Initiative (OAI), a multicenter, longitudinal, prospective study (February 2004 to January 2015). Participants who received a reported injection of corticosteroid or HA and propensity-score–matched controls (on age, sex, body mass index, and clinical variables) were analyzed. Using the Whole-Organ MRI Score (WORMS) system for cartilage, bone marrow lesions, and meniscus, 3-T MRI performed at the time of injection, 2 years prior, and 2 years after were semiquantitatively graded. Postinjection progression was quantified using WORMS difference between time of injection and the 2-year follow-up. Associations with injection type were analyzed using repeated measures of analysis of covariance.

There were 210 participants analyzed (mean age, 64 years ± 7.9 years [SD]; 126 female). Corticosteroids were associated with greater WORMS progression compared with controls (mean difference, 0.39; 95% CI: 0.05, 0.75; P = .02) and HA (0.42; 95% CI: 0.01, 0.84; P = .04). HA was associated with decreased WORMS progression compared with the injection-concurrent time frame (mean difference, −0.42; 95% CI: −1.34, −0.28; P = .003). Both corticosteroids (mean difference in Western Ontario and McMaster Universities Osteoarthritis Index scores, −5.20; 95% CI: −6.91, −3.48; P = .001) and HA injections (−2.15; 95% CI: −4.42, −0.13; P = .04) were associated with reduced pain after injection.

Corticosteroid injections were associated with higher OA progression than HA injections and controls, whereas HA was associated with decreased progression at MRI for up to 2 years after injection. ler

Source: *Bharadwaj UU, Lynch JA, Joseph GB, et al. Intra-articular knee injections and progression of knee osteoarthritis: data from the osteoarthritis initiative. Radiology. 2025;315(2):e233081. doi: 10.1148/radiol.233081.*

BUILDING CORE OUTCOME SET FOR FOOT & ANKLE IN RHEUMATIC AND MUSCULOSKELETAL DISEASES

The foot and ankle are frequently affected in rheumatic and musculoskeletal diseases (RMDs), yet there is a lack of high-quality evidence to determine the effectiveness of treatments. Outcomes in research are often inconsistently measured, impeding evidence synthesis. Additionally, clinical decisions are based on research outcomes, but these are not always regarded as important by people with RMDs. This study aimed to determine domains of importance to people with RMDs who have experienced foot and ankle disorders, and aid in developing a standardized core outcome set (COS) to address these issues.

Participants from 4 continents (Europe, Africa, Australia, North America) were recruited to semi-structured interviews through clinical departments and electronic mailing lists. Analysis was conducted using a mixed deductive/inductive approach to the framework method. Patient research partners co-produced the interview schedule and recruitment materials, and co-interpreted results.

Fifty-six participants (age range 27 to 76 years; 66 % female) with foot and ankle disorders in a variety of RMDs (including inflammatory arthritis, osteoarthritis, crystal arthropathies, connective tissue diseases) were interviewed. Sixteen domains were described by participants: pain, physical function, fatigue, deformity, skin and nail health, swelling, temperature, numbness, poor circulation, cramping, activities/participation, footwear impact, psychological impact, sleep, healthcare utilization and personal expenses. Most domains were considered important to participants regardless of RMD or geographic location.

Foot and ankle disorders have far-reaching consequences for people with RMDs. This large qualitative study provides a foundation for achieving international consensus on a core outcome set for foot and ankle disorders in RMDs, to improve the quality of evidence demonstrating effectiveness of treatments. ler

Source: *Chapman LS, Flurey CA, Richards P, et al. What outcomes are important to people with foot and ankle disorders in rheumatic and musculoskeletal diseases? An OMERACT qualitative interview study across four continents. Semin Arthritis Rheum. 2025;72:152671. doi: 10.1016/j.semarthrit.2025.152671.*

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3D Printing Enables Dose-Response Approach to Foot Orthotic Therapy

By Paul Langer, DPM

Low-cost and highly efficient digital technologies are disrupting the foot orthotic paradigm. Here's a step-by-step guide on how to add this technology to your office.

No matter which biomechanical principles we utilize to prescribe and produce custom foot orthoses for our patients, we all must admit that prescribing footwear interventions is not like prescribing medication – no one knows the right dose. How stiff should the shell be? How high should the arch be? How much rearfoot or forefoot posting is optimal for that specific patient? An experienced practitioner can make reasonable inferences and often produce a beneficial device on the first try. But we must admit that this doesn't always happen. So, what if we had a method to easily and at low cost change the dose after assessing how our patients respond? Or, what if we could produce multiple versions of a custom device to start and then have the patient select the most comfortable option after making comparisons? We now have that method via accessible and affordable digital technologies.

The technologies enabling this revolution include iPhone scanning apps, 3D orthotic design software and in-clinic 3D printers. Used together, they have opened the door to a dose-response approach to foot orthotic therapy. Clinicians can now scan, design, and produce custom foot orthoses in their clinic, at 50% to 75% lower cost than a traditional orthotic lab. The time and cost savings alone are worth making the transition, but the elevated service to the patient is achieved via rapid iteration.

Rapid iteration is a term used in product development that refers to a process of making incremental changes rapidly to improve the design and function of a product. In the context of foot orthoses, rapid iteration provides the opportunity for a dose-response approach to treating lower extremity conditions. Orthoses can be dispensed to a patient and then, based on how they respond (both in terms of symptom relief and comfort), the dose can be easily revised digitally and the devices reprinted. For example, if a patient with plantar heel pain perceives the orthoses to be too hard or the arch too high, the digital model can be modified with a lower arch and printed softer with just a few clicks of the mouse. The digital design change takes a couple of minutes, and the revised orthosis can be ready in a matter of hours.

> The elevated service to the patient is achieved via rapid iteration.

Continuing with the dosing analogy, just as we want to use the minimal effective dose when prescribing medications, we should also strive for the minimal effective dose of orthotic devices. So, instead of making a maximum dose orthotic because we don't want to incur the extra cost and time of remaking it, we can now prioritize a minimal effective dose device and incrementally increase the dose, if necessary, based on how that patient responds to the first dose.

Alternatively, multiple versions (or iterations) of the orthoses could be printed prior to dispensing. For example, one could print multiple pairs with varying arch height and/or shell density and allow the patient to try on all versions and select the most comfortable option. Or, for athletes who wear cleated footwear, one could easily make a device scaled to cleats and another device for training shoes. Again, all for much lower cost and faster turnaround time. The author has found that elite athletes are especially appreciative of this new approach.

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The Digital 3D Orthotic Process

To make the digital process work, you need the following equipment: iPhone/cellular phone, application software, technology partner, your computer, and easy access to a 3-D printer.

Step 1. Open app and scan patient's feet using iPhone

Step 2. Upload anonymized patient scan data to technology partner

Step 3. Receive processed mesh model of foot and digital orthotic file via online folder

Step 4. Digitally design the device on your laptop

Step 5. Print orthoses in clinic

Step 6. Dispense orthoses

Step 7. Revise orthoses based on patient's response

Step 8. (If necessary) Repeat steps 4 through 7 as needed

Costs

The start-up costs for in-house 3-D printing are minimal, especially for technology that elevates patient care and dramatically lowers per-pair costs. The app and design software are provided at no cost from the author's 3D technology partner. Rolls of printing filament cost approximately $70 and can print up to 10 pairs per roll. Printers currently cost approximately $700. So, for less than $1000 a clinic could produce foot orthoses. The 3D partner lab the author works with charges a one-time $20 to $40 modeling fee per patient and the devices require approximately $7 in filament material. So, the first pair of orthoses per patient would be approximately $27 to $47 but any additional pairs for that patient would incur just the cost of filament. As you can see, printing multiple pairs is still dramatically less costly than one pair from most traditional orthotic labs.

Capacity & Scalability

One printer can produce 1 pair of orthoses in approximately 5 hours. The printers run unattended so a print job could run while the clinician sees patients, run overnight and a finished pair would be ready for dispensing the next morning. One printer could produce 2 – 3 pairs per day. The author scaled up by adding one printer at a time as volumes increased and now has 2 printers in clinic and 2 printers at home so he can run them 24/7 if needed. The 4 printers can produce 8 – 12 pairs per day and run on weekends if needed.

The Learning Curve

This technology replaces a highly manual workflow with a streamlined digital workflow. For experienced clinicians who are already using smartphones and laptops, the learning curve is very smooth. The 3D printers can be unboxed and running in about an hour with easy-to-follow video tutorials, and they require minimal maintenance. The design software uses the same thought process one would use filling out an orthotic prescription.

Another advantage of this process is that a clinician does not need to fire their orthotic lab and immediately start producing all their own devices. The author started by producing a few orthotics a week in clinic while still using a traditional lab and gradually phased out the lab as his comfort level grew.

The other benefits include precise duplication of devices for those who want multiple pairs and much greater ease scaling a device to specific footwear including skates, ski boots, cleats, and even the ability to 3D print sandals.

Conclusion

In essence, 3D printing revolutionizes foot orthotic therapy by empowering clinicians with a dose-response methodology, facilitating rapid, in-clinic iteration and customization that was previously impractical. This digital approach dramatically curtails costs and production times compared to conventional methods, enabling easy modifications and the creation of multiple device versions based on patient feedback and specific needs, such as varying footwear. With minimal startup expenses, user-friendly design software, and low material costs, the transition to 3D printing is both accessible and scalable for clinics. This technological advancement not only allows for precise device duplication but ultimately elevates patient care by delivering highly personalized, effective, and timely orthotic solutions, offering an unprecedented level of service. ler

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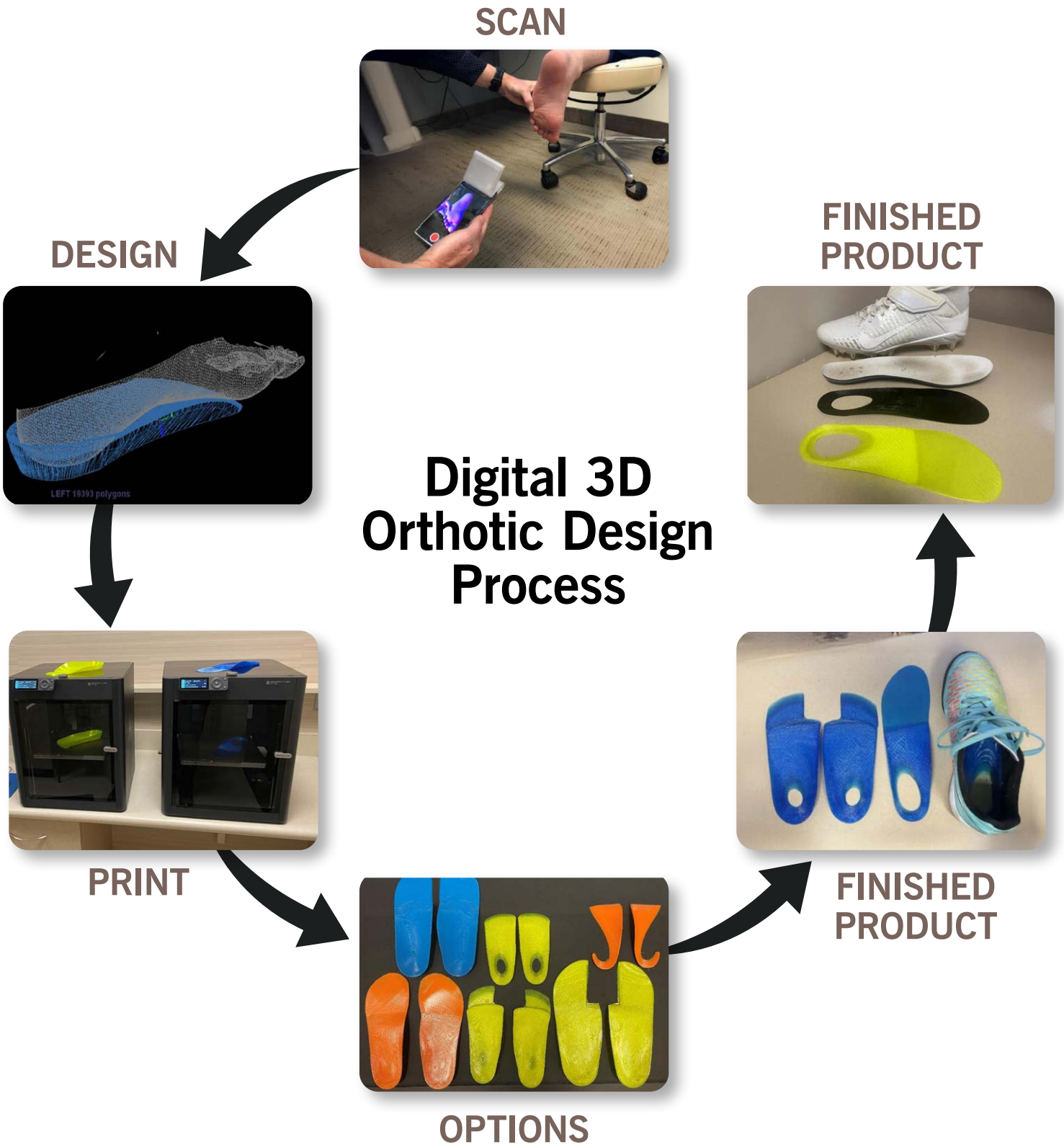
THE 3D ORTHOTIC PROCESS – STEP BY STEP



CAGA 101: The 12 Dirty Truths of Foot Mechanics

Dirty Truth #4: Shock Absorption is Energy Loss– Understanding Loading in Gait Analysis

By Jay Segel, DPM; Sally Crawford, MS

Perhaps the most surprising and unintuitive of all the dirty truths is number four, "Shock absorption via cushion is energy loss." At first blush, cushion seems like a no-brainer benefit. When we delve into this idea a bit deeper, applying our structure, the forces acting on the lower limbs, and applying the physics that we talked about in the last three dirty truths, the truth of number four becomes clear.

Picking up where we left off last month,[1] the physics of collision dynamics that happen when our feet strike the ground include bony deformation, the receipt of impact force, and energy loss as our bone structure recovers after impact.

In the world of CAGA (computer-aided gait analysis), understanding the truths about loading is fundamental, but also easily bypassed in the thinking and patient education process. Every step we take is a complex interplay of forces, each requiring energy to propel us forward. Yet, with each stride, there is an inevitable loss of energy due to shock absorption at impact. To define and differentiate the terms shock and pressure, we would refer to shock as a high-pressure event happening in a very short amount of time. This principle—shock absorption is energy loss—highlights the importance of those collision effects in motion. As discussed in prior articles,[2-4] we know that with each step, deformation occurs, leading to energy and thus the build-up of microtrauma. Using CAGA to understand and better manage the way energy is received and utilized is our golden ticket.

The center of pressure (COP) gait line is seen on the left in Figure 1, expressed one coordinate at a time as gait progresses. The initial point where contact occurs (that collision between the foot and the ground) and the subsequent COP gait lines reveal the intricacies of our motion. These effects can be tracked and analyzed, as well as isolated to phases and specific timing, like the single support phase of gait as introduced last month. CAGA is also not just about numbers. We can actually see, quantify, and measure shock graphically.

The single support phase COP provides valuable insights into how our bodies handle the stresses of walking, running, and weightbearing activities. Given that walking and running, and weightbearing are the opposite of static, we can break the dynamic and variable events into groups, including pronation and supination, mediolateral shifting, and midsection crossover.

Understanding these dynamic events and patterns is crucial for addressing the repetitive microtraumas and wear and tear that our feet take, thanks to energy loss. In Figure 2, one can quickly identify the different morphologies of quick and slow loading of a foot or a particular region of the foot.

Through CAGA, we can utilize the quantified data to devise strategies to mitigate energy loss, ensuring that each step is as efficient and pain free as possible. Thus, the story of loading in gait analysis is one of continual adaptation and improvement, grounded in the truths of physics and biomechanics.

The ground reactive forces return energy to the system to help us propel our way through the gait cycle. Adding a significant cushion to this physics equation affects all 3 reactions that occur during impact. The materials classically used in shoes and insoles are largely foams and low durometer polymers, which allow the foot to sink in deeper and, without proper structure, allow for an increase in foot structure deformation. In other words, by providing cushioning as the foot sinks into the foam during contact, it allows more time for the foot to deform under vertical pressure. And that "sinking in time" wicks energy from an energy-dependent activity, such as walking.

So, the answer to foot management is not adding extra cushion, it's managing the impact by providing structural support.

Please note that we are not saying that cushion is bad in minimal amounts, but adding to it carries the aforementioned complications

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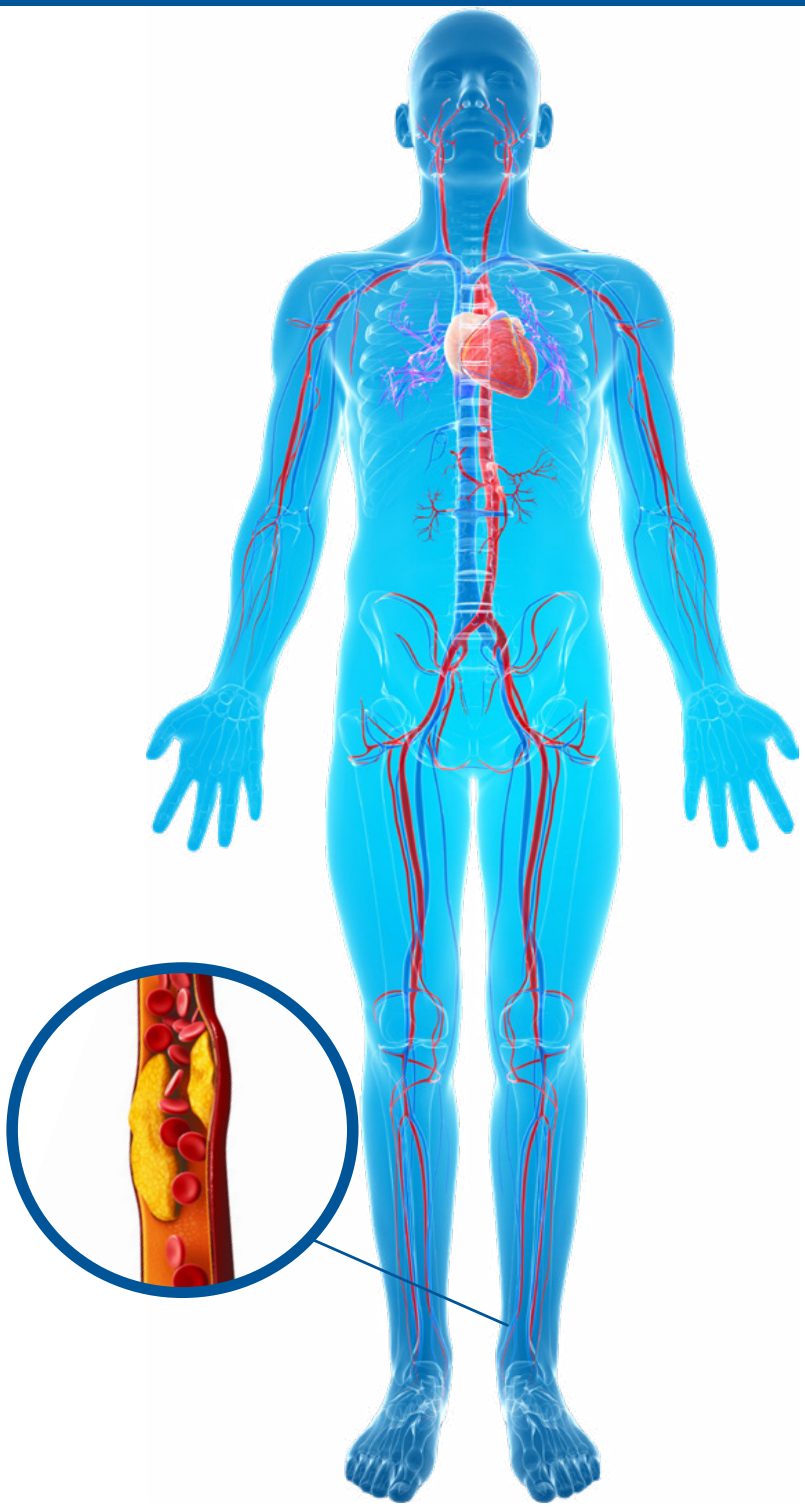
Peripheral Artery Disease

Peripheral Artery Disease (PAD) is a deadly chronic condition that can lead to heart attack, stroke, or amputation.

1 in 3

- » Diabetics age 50+
- » Smokers age 50+
- » Everyone age 70+

Have PAD



$390 billion

annual US healthcare costs attributable to PAD

100,000 amputations

of lower extremities in the US annually, due to vascular disease

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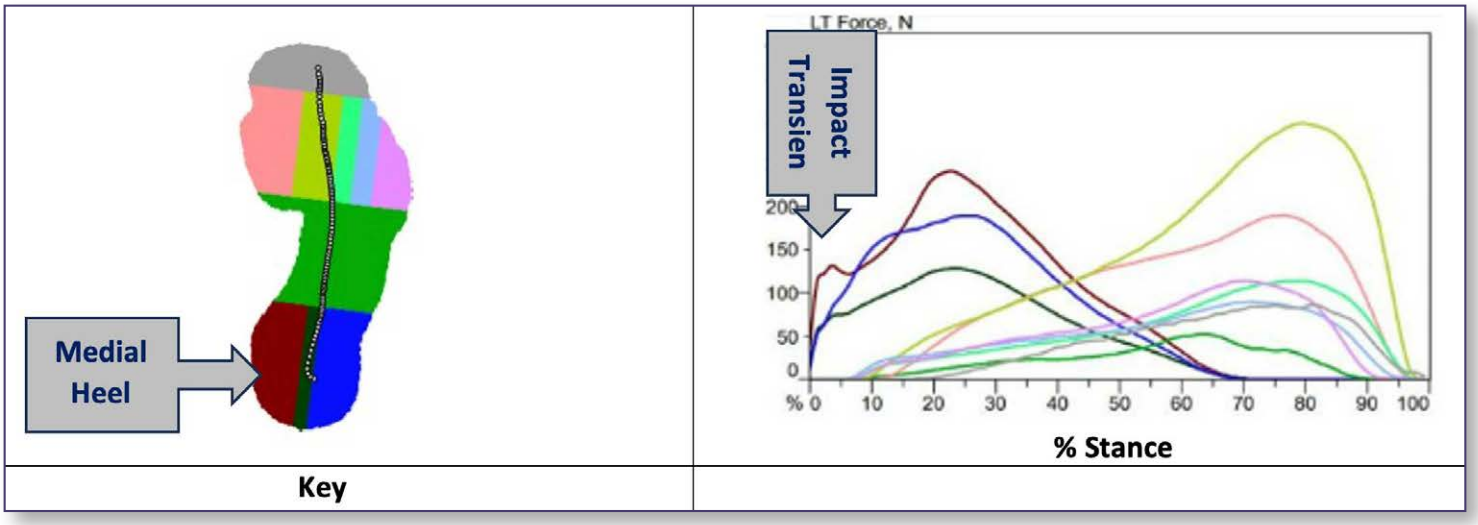

Figure 1: Displays a graphic representation of zonal shock, pointing to the early peak in pressure known as the "impact transient," in this case through the medial zone of the heel.

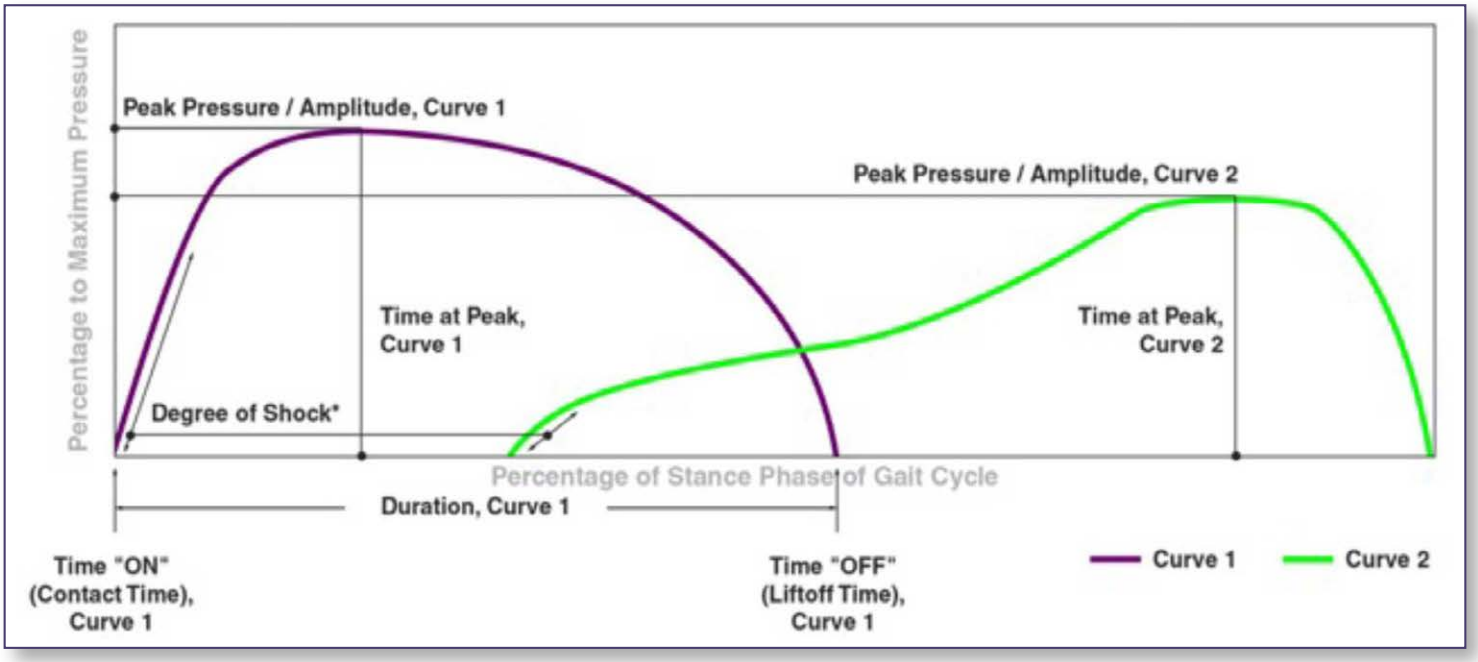

Figure 2. Degree of shock, or impact, for Curve 1 is greater, increasing more quickly, than Curve 2, which is slower loading in the displayed region of the foot.

and can have a destabilizing effect. An ideal analogy might be that of tying a pillow to a subject's foot and then asking them to bear weight or walk.

Understanding the intricacies of ground reaction forces, peak pressure, and the center of pressure gait lines allows us to systematically address the dirty truths of walking, running, and basically all weightbearing activities. By identifying patterns like rearfoot shock absorption, pronation, and supination, we fine-tune care. As we continue to explore these "shocking" truths, more practical insights guide new ways to understand and improve human movement. Stay tuned for more of our golden nuggets on CAGA and advancing to the next generation of gait analysis.

References

1. Segel J, Crawford S. Dirty Truth #3: What We Can't See Is Key. Lower Extremity Review. 2025;17(5):XX.
2. Segel J, Crawford S. CAGA 101: The 12 Dirty Truths Of Foot Mechanics: Introducing the 12 Dirty Truths Playbook: A New LER Series In Biomechanics and CAGA. Lower Extremity Review. 2025;17(2):36-37.
3. Segel J, Crawford S. Dirty Truth #1: The Foot Is Not Symmetrical. Lower Extremity Review. 2025;17(3):22-24.
4. Segel J, Crawford S. Dirty Truth #2: Realities of Center of Pressure in Dynamic World. Lower Extremity Review. 2025;17(4):22-26

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Forefoot Adduction Strengthens the Abductor Hallucis in HV

By Giacomo Farì, Laura Dell'Anna, Francesco Paolo Bianchi, Rachele Mancini, Enrica Chiaia Noya, Carlo De Serio, Riccardo Marvulli, Luisa De Palma, Danilo Donati, Roberto Tedeschi, Maurizio Ranieri, Marisa Megna, and Andrea Bernetti

Integrating targeted exercises focused on AH strengthening, both pre- and post-surgery, offers a comprehensive approach to HV management.

The abductor hallucis (AH) is the most important muscle in the etiopathogenesis of hallux valgus (HV), but the effectiveness of its rehabilitation clashes with the difficulty of identifying the most suitable exercises to activate it. Therefore, the aim of this study was to compare 4 different therapeutic exercises in the activation of AH in these patients.

Methods

In this observational case-control study, 48 patients suffering from HV of moderate/severe grade, according to traditional radiographic classification and the Manchester scale, were divided into 2 groups: the case group underwent a monthly rehabilitation protocol for their foot deformity, whereas the control group was only evaluated without any intervention. The intervention comprised 3 40-minute sessions per week. The exercises were as follows: Toe Spread Out (TSO), Short Foot (SF), Forefoot Adduction (FA), and Flexion of the Metatarsophalanges (FM). Both groups were analyzed at baseline and 1 month later (at the end of rehabilitation for the case group) while performing the 4 exercises. Analysis was conducted using a surface electromyograph (sEMG) to record the muscle activity of AH in terms of root mean square (RMS) and maximum voluntary contraction (MVC).

Results

FA was the only exercise to determine a statistically significant improvement in AH at the end of the rehabilitation cycle, both in terms of RMS ($P = 0.015$; Table 1) and MVC ($P < 0.0001$; Table 2).

Discussion

These findings suggest that FA effectively stimulates the intrinsic AH muscle, enhancing the coordination and control of foot movements. Assessment of the MVC values further emphasized the results observed in the RMS measurements.

TSO, SF, FM, and FA could play an important role in the rehabilitation of individuals suffering from HV, as enhancing the strength of the AH muscle can lead to better foot function, pain reduction, and the prevention of additional deformities. Strengthening the AH supports the medial longitudinal arch, potentially mitigating the severity of HV by maintaining proper foot alignment and reducing excessive pronation. Post-operative rehabilitation could be equally useful in restoring function and minimizing complications. By focusing on AH activation, rehabilitation can accelerate recovery and enhance post-surgical satisfaction by reinforcing foot mechanics and preventing recurrence.

This article has been excerpted from "Which is the best exercise for abductor hallucis activation in hallux valgus? A comparison study for new rehabilitation perspectives" Applied Sciences. 2025; 15(7):3523. https://doi.org/10.3390/app15073523. Editing has occurred, including the renumbering or removal of tables and figures, and references have been removed for brevity.

Table 1: RMS scores for the AH muscle in all the analyzed exercises, by group and detection times

	T0	T1	COMPARISON BETWEEN GROUPS	COMPARISON BETWEEN T0 AND T1	INTERACTION BETWEEN TIME AND GROUP
			RMS TSO		
Control group	102.8 ± 37.2 (57.3–209.6)	106.7 ± 36.6 (68.6–195.4)			
Case group	59.4 ± 38.6 (11.9–133.5)	61.1 ± 38.3 (9.8–150.3)	<0.001	0.337	0.695
Total	81.1 ± 43.4 (11.9–209.6)	83.9 ± 43.6 (9.8–195.4)			
			RMS SF		
Control group	86.1 ± 43.1 (37.1–220.6)	90.6 ± 38.8 (46.8–198.6)			
Case group	69.4 ± 47.4 (16.2–188.3)	74.1 ± 47.2 (18.0–192.6)	0.189	0.124	0.960
Total	77.8 ± 45.6 (16.2–220.6)	82.4 ± 43.6 (18.0–198.6)			
			RMS FA		
Control group	66.2 ± 50.1 (12.2–154.3)	71.6 ± 50.1 (17.3–164.0)			
Case group	55.7 ± 54.4 (6.3–190.3)	79.5 ± 56.5 (21.1–236.2)	0.929	<0.001	0.015
Total	61.0 ± 52.0 (6.3–190.3)	75.6 ± 53.0 (17.3–236.2)			
			RMS FM		
Control group	75.6 ± 54.6 (11.6–206.3)	81.1 ± 53.3 (9.2–206.3)			
Case group	79.9 ± 55.3 (6.0–205.5)	82.7 ± 73.3 (16.2–270.0)	0.855	0.379	0.784
Total	77.6 ± 54.4 (6.0–206.3)	82.0 ± 63.4 (9.2–270.0)			

AH: Abductor Hallux; RMS: Root Mean Square; TSO: Toe Spread Out; SF: Short Foot, FA: Forefoot Adduction; FM: Flexion of the Metatarsophalangeal Joints.

Incorporating these exercises—TSO, SF, FM, and FA—into rehabilitation protocols can further facilitate muscle conditioning and stabilization of the first metatarsal joint, which are key factors in managing HV deformities. Integrating targeted exercises focused on AH strengthening, both pre- and post-surgery, offers a comprehensive approach to HV management.

Heo et al's findings suggest that different exercises elicit varying degrees of AH activation, which is critical for clinicians when designing tailored rehabilitation programs aimed at maximizing muscle engagement. Hwang et al complemented these findings by employing pressure biofeedback units to investigate AH muscle activity specifically in patients with HV. This approach allows for a more comprehensive analysis of muscle function and engagement during rehabilitation exercises, enhancing the understanding of how targeted interventions can lead to improved clinical outcomes. The results on AH performance in TSO and SF can be explained by considering the instability of the first ray joint. The limitations in its range of motion (ROM) in patients with moderate-to-severe degrees of HV deformity hinder the execution of these exercises. The compromised ability to move the first ray is influenced not only by muscle imbalances but also by mechanical joint restrictions.

Exercises such as FA and FM are critical for restoring balance and coordination in individuals with HV. These exercises engage the entire musculature of the foot, bypassing the coordination and ROM necessary to correctly perform TSO and SF.

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Table 2. MVC scores for the AH muscle in all the analyzed exercises, by group and detection times.

	T0	T1	COMPARISON BETWEEN GROUPS	COMPARISON BETWEEN T0 AND T1	INTERACTION BETWEEN TIME AND GROUP
			MVC TSO		
Control Group	260.1 ± 110.3 (21.8–379.7)	273.4 ± 121.4 (105.3–543.6)			
Case Group	165.4 ± 103.1 (21.8–379.7)	177.1 ± 118.3 (22.1–442.1)	0.003	0.322	0.949
Total	212.8 ± 115.9 (21.8–489.2)	225.2 ± 128.2 (22.1–543.6)			
			MVC SF		
Control Group	200.0 ± 80.7 (33.4–313.3)	209.7 ± 140.2 (93.2–802.4)			
Case Group	152.3 ± 80.7 (33.4–313.3)	164.7 ± 97.7 (37.6–458.7)	0.152	0.27	0.849
Total	176.2 ± 110.9 (33.4–760.3)	187.2 ± 110.9 (33.4–760.3)			
			MVC FA		
Control Group	222.1 ± 112.4 (39.2–521.5)	216.2 ± 118.9 (32.5–521.5)			
Case Group	216.6 ± 110.9 (34.6–521.3)	389.9 ± 118.8 (112.6–592.6)	0.009	<0.0001	<0.0001
Total	219.2 ± 114.5 (32.5–521.5)	303.3 ± 143.5 (34.6–592.6)			
			MVC FM		
Control Group	222.9 ± 214.9 (18.8–898.6)	219.9 ± 187.8 (24.4–706.4)			
Case Group	238.9 ± 194.4 (16.6–1003.2)	204.8 ± 140.0 (52.7–649.4)	0.993	9244	0.328
Total	230.9 ± 202.9 (16.6–1003.2)	212.3 ± 164.1 (24.4–706.4)			

AH: Abductor Hallux, TSO: Toe Spread Out; SF: Short Foot, FA: Forefoot Adduction; FM Flexion of the Metatarsophalangeal Joints; MCV: Maximum Voluntary Contraction.

The findings herein suggest that FA may be easier for patients with severe deformities, leading to improvements in AH activity, primarily because it requires minimal abduction mobility of the first ray, which is typically compromised due to bony issues. Since FA involves a lower degree of mobility and coordination, its incorporation into exercise programs was particularly effective in enhancing the performance and activation of the AH in patients with significant deformities. By integrating FA exercises into rehabilitation protocols, physical therapists can create targeted exercise regimens specifically aimed at addressing deficiencies in muscle function for patients with conditions such as HV and other forefoot deformities. As patients engage in FA exercises, they learn to activate and control key muscle groups effectively, enhancing their overall foot biomechanics, ultimately leading to enhanced outcomes and quality of life.

An ideal rehabilitation program for HV should encompass various components to effectively address the multifaceted nature of the condition as HV not only affects toe alignment but also influences overall foot mechanics, stability, and patient quality of life. This program may include the use of orthotic devices, such

as toe separators, HV splints, and protective barriers for the great toe. Strengthening exercises targeting both the intrinsic and extrinsic muscles of the foot can enhance stability and functionality, thereby mitigating the progression of HV. Equally important are proprioceptive exercises, which should be integrated into the program to improve body awareness and balance. These exercises are essential for enhancing gait mechanics and reducing discomfort, particularly in individuals with compromised foot structures. Furthermore, educating patients on proper footwear choices and activity modifications can foster long-term adherence to rehabilitation protocols and contribute to better outcomes.

Conclusions

FA seems to be the best exercise to activate and train AH, so rehabilitation programs for patients suffering from hallux valgus should consider this exercise as the starting point for improving plantar support and overall foot biomechanics. It is essential to tailor these rehabilitation strategies to the specific characteristics of each case of HV, including the severity of the deformity and the individual's unique functional limitations. Further studies are needed to deepen the effectiveness of this exercise, with the aim of implementing rehabilitation strategies and rethinking traditional HV therapies, which are currently predominantly surgical. ler

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Lower Extremity Injuries Managed by Fire Department Emergency Medical Services

By Mathias B. Forrester, BS

Background: Emergency medical services (EMS) calls accounted for 65.2% of all incidents to which United States (US) fire departments responded in 2023. A portion of fire department EMS calls are likely to involve lower extremity injuries. The objective of this study was to describe the pattern of these lower extremity injuries.

Methods: Data were obtained from the National Fire Incident Reporting System (NFIRS), which collects information on incidents to which US fire departments respond. Cases were lower extremity injuries managed by fire department EMS reported to NFIRS during 2014-2023. The distribution of cases was determined for patient characteristics, type of injury, and circumstances of injury.

Results: A total of 182,842 records of lower extremity injuries managed by fire department EMS during 2014–2023 were identified, representing 1.1% of the total records. The symptoms were pain without swelling (35.5%), dislocation or fracture (15.1%), soft tissue swelling (12.5%), laceration (8.0%), blunt injury (7.7%), puncture or stab (3.7%), gunshot (0.9%), burn (0.9%), crush (0.5%), amputation (0.4%), and other type of injury (20.7%). The cause of the injury was fall (34.5%), motor vehicle accident (12.9%), motor vehicle accident (pedestrian) (3.1%), physical assault or abuse (1.5%), other (10.8%), and unknown or not documented (37.3%).

Conclusion: Thousands of lower extremity injuries were managed by US fire department EMS each year. The most common injuries were pain without swelling, dislocation or fracture, and soft tissue swelling. The most common causes of the injury were falls followed by motor vehicle accidents. The information in this study may be useful for creating strategies to manage lower extremity injuries to which EMS respond.

According to the National Association of State Emergency Medical Services Officials (NASEMSO) 2020 National EMS Assessment, local emergency medical services (EMS) agencies respond to nearly 28.5 million 911 dispatches every year in 41 states in the United States (US).[1] Furthermore, EMS calls accounted for 65.2% of all incidents to which US fire departments responded in 2023.[2]

A portion of fire department EMS calls are likely to involve lower extremity injuries. The objective of this study was to describe the pattern of these lower extremity injuries.

Methods

The data source for this study was the National Fire Incident Reporting System (NFIRS), which collects information on incidents to which US fire departments respond.[3] Participation in NFIRS is voluntary, and not all fire departments participate.[4,5] However, over 22,000 fire departments in all 50 states reported incident data to NFIRS as of 2023.[3-5]

Participating fire departments submit information to NFIRS on each incident to which they respond. The information provided includes the kind of incident, the location of the incident, the resources used to mitigate the incident, and other information to understand the nature and cause of the fire, hazardous material, or EMS incident.[3,4] NFIRS consists of 11 modules (data subsets). Not all modules are completed for all incidents. Data from each participating fire department goes to the state agency responsible for NFIRS data. The state agency combines the data from all participating fire departments into a statewide database and then electronically sends the data to the US Fire Administration (USFA) National Fire Data Center (NFDC).[4]

Annually the USFA compiles publicly released NFIRS incident data that were collected by the states during the previous calendar year into a public data release (PDR) that is publicly available free of charge.[6] Each annual database

Table 1. Lower extremity injuries managed by fire department emergency medical services by patient demographics, National Fire Incident Reporting System, 2014–2023

Variable	Number	Percent
Patient age (years)		
0-5	3,249	1.8
6-12	4,260	2.3
13-19	11,994	6.6
20-29	21,212	11.6
30-39	17,582	9.6
40-49	16,625	9.1
50-59	21,938	12.0
60-69	23,842	13.0
70-79	23,029	12.6
80+	32,912	18.0
Not documented	6,199	3.4
Patient sex		
Female	98,974	54.1
Male	79,793	43.6
Not documented	4,075	2.2
Race		
White	77,967	42.6
Black	17,640	9.6
Other (includes multi-racial)	7,469	4.1
Undetermined and not documented	79,766	43.6
Total	**182,842**	

can be downloaded at:[7] https://www.fema.gov/about/openfema/data-sets/fema-usfa-nfirs-annual-data.

Cases were lower extremity injuries managed by fire department EMS during 2014–2023. These injuries were identified using the NFIRS EMS Module. This is an optional module that is used when that option has been chosen by state or local authorities. The EMS Module is completed only if the fire department provides EMS. (If an independent provider performs EMS, this module is not used.) The purpose of the EMS Module is to gather data relating to the provision of emergency medical care. The module may be used by both responding EMS unit(s) and responding fire suppression unit(s) that provide EMS. This module does not include patient care information. The data collected in this module are incident based not patient based.[4]

The EMS Module includes 5 numeric fields for documenting the Body Site of Injury (SITE_INJ1, SITE_INJ2, SITE_INJ3, SITE_INJ4, SITE_INJ5) and 5 numeric fields for documenting the associated Injury Type (INJ_TYPE1, INJ_TYPE2, INJ_TYPE3, INJ_TYPE4, INJ_TYPE5). A record was included in the study if any of the Body Site of Injury fields included the code for the lower extremity (7 – Lower extremities [includes legs and feet]). Thus, a given

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Table 2. Lower extremity injuries managed by fire department emergency medical services by type of injury, National Fire Incident Reporting System, 2014–2023

Type of injury*	Number	Percent
Pain without swelling	64,952	35.5
Dislocate/fracture	27,608	15.1
Soft tissue swelling	22,912	12.5
Laceration	14,645	8.0
Blunt injury	14,011	7.7
Puncture/stab	6,731	3.7
Gunshot	1,629	0.9
Burn	1,609	0.9
Crush	962	0.5
Amputation	677	0.4
Other injury type	37,826	20.7
Total	**182,842**	

*Up to 5 injuries can be documented for a single patient, so a patient with more than 1 different type of injury to a lower extremity will be included in the table more than once, and the sum of the individual types of injuries will be greater than the total number of patients.

record included in the study could have as many as 5 different types of injury.

The distribution of cases was determined for patient characteristics, type of injury, and circumstances of injury. For those records where the patient age was >112 years [sic], the patient was included in the not documented subgroup.

Since the data are publicly available and de-identified, the study is exempt from institutional review board approval.

Results

A total of 182,842 records of lower extremity injuries managed by fire department EMS during 2014–2023 were identified, representing 1.1% of the 17,183,202 total records. **Table 1** shows the distribution of the records by patient demographics. The number of patients tended to increase with patient age with 79,783 (43.6%) being aged 60 years or older. The majority of patients were female. Of those patients with a documented race, most were White. The patient's ethnicity was 9,289 (5.1%) Hispanic, 92,734 (50.7%) non-Hispanic, and 80,819 (44.2%) not documented.

The annual number of reported lower extremity injuries managed by fire department EMS decreased from 26,522 in 2014 to 10,274 in 2020 and then increased to 14,618 in 2023. There were 42,985 (23.5%) reported injuries during December–February, 46,215 (25.3%) during March–May, 49,208 (26.9%) during June–August, and 44,434 (24.3%) during September–November. The number of injuries varied little by day of the week (data not shown). The states with the highest number of reported injuries were 27,811 (15.2%) Nevada, 18,870 (10.3%) California, 15,259 (8.3%) Florida, 10,298 (5.6%) Virginia, 9,020 (4.9%) Massachusetts, and 6,160 (3.4%) Minnesota.

When the distribution of lower extremity injuries managed by fire department EMS by type of injury was examined **(Table 2),** over one-third of the injuries involved pain without swelling. The next most common injuries were dislocation or fracture and soft tissue swelling. The cause of the injury was 63,015 (34.5%) fall, 23,506 (12.9%) motor vehicle accident, 5,694 (3.1%) motor vehicle accident (pedestrian), 2,691 (1.5%) physical assault or abuse, 19,710 (10.8%) other, and 68,226 (37.3%) unknown or not documented.

Table 3 presents the distribution of lower extremity injuries managed by fire department EMS by disposition. The most common disposition was non-fire department transport followed by fire department transport to emergency care facility and not transported under EMS.

Discussion

This study examined lower extremity injuries managed by US fire department EMS reported to NFIRS during 2014–2023. Although lower extremity injuries comprised only 1% of fire department EMS calls, they accounted for

Table 3. Lower extremity injuries managed by fire department emergency medical services by disposition, National Fire Incident Reporting System, 2014-2023

Emergency medical services disposition	Number	Percent
Non-fire department transport	7,0402	38.5
Fire department transport to emergency care facility	6,0743	33.2
Not transported under emergency medical services	2,2343	12.2
Non-fire department transport with fire department attendant	3,798	2.1
Non-emergency transfer	1,061	0.6
Other	1,450	0.8
Not documented	23,045	12.6
Total	**182,842**	

thousands of such calls each year.

The number of patients increased with patient age, and most patients were female. This study found that the highest proportion of lower extremity injuries were due to falls. Since falls and fall-related injuries are more common in older adults and females,[8-11] falls may at least partially account for the observed age and sex pattern of lower extremity injuries. Alternately, older adults and females with lower extremity injuries may be more likely to request or receive fire department EMS assistance.

The annual number of reported lower extremity injuries managed by fire department EMS declined during 2014–2020 then increased through 2023. This annual pattern may suggest that the total number of lower extremity injuries that occurred or the tendency to contact fire department EMS about such injuries changed over time. Another possibility is that the number of fire departments with EMS that participated in NFIRS changed over time.

Nevada reported the highest number of lower extremity injuries managed by fire department EMS, followed by California, Florida, Virginia, Massachusetts, and Minnesota. This may be due to geographic differences in the risk of lower extremity injuries or the likelihood of contacting fire department EMS for lower extremity injuries. The geographic differences also may be due to geographic differences in the participation of fire departments with EMS, use of the optional EMS Module, or the proportion of EMS that are associated with fire departments versus independent providers.

The most common type of lower extremity injury was pain without swelling, accounting for 36% of the injuries. The next most common injuries were dislocation or fracture and soft tissue swelling. These types of injuries generally might not be expected to require extensive medical intervention. This study found that the most common disposition was non-fire department transport followed by fire department transport to emergency care facility and not transported under EMS.

Falls accounted for 34% of the injuries, with motor vehicle accidents accounting for an additional 13%. Any changes in the rates of falls or motor vehicle accidents would likely affect the number of lower extremity injuries managed by fire department EMS.

The number of patients tended to increase with patient age

This study has various limitations. Participation in NFIRS is voluntary. Furthermore, the EMS Module is an optional module and is used when that option has been chosen by state or local authorities. Also, the NFIRS EMS Module is not used if an independent provider performs EMS. Thus, the NFIRS database does not include all injuries where EMS is involved.[4,5] This needs to be considered in the analysis of certain variables, such as geographic region.

In addition, an injury may involve multiple symptoms and/or multiple body parts. Each record only documents up to 5 body sites of injury and associated injury type. If an individual experiences more than 5 injured body parts and/or types of injury, some of the injuries will not be documented in NFIRS. Also, the Body Site of Injury numeric field only includes a single code for the lower extremity; the field does not include separate codes for more specific parts of the lower extremity (eg, knee, ankle, foot).

In conclusion, this study found that thousands of lower extremity injuries were managed by US fire department EMS each year. The most common injuries were pain without swelling, dislocation or fracture, and soft tissue swelling. The most common causes of the injury were falls followed by motor vehicle accidents. The information in this study may be useful for

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creating strategies to manage lower extremity injuries in EMS calls.

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

References

1. EMS1. National Association of State EMS Officials releases stats on local agencies, 911 calls. EMS1.com. April 10, 2020. Available at https://www.ems1.com/ambulance-service/articles/national-association-of-state-ems-officials-releases-stats-on-local-agencies-911-calls-LPQTHJrK2oIpxuR1/. Accessed May 28, 2025.
2. U.S. Fire Administration. Statistics. U.S. fire department responses (2023). Available at https://www.usfa.fema.gov/statistics/. Accessed May 28, 2025.
3. U.S. Fire Administration. National Fire Incident Reporting System. October 9, 2024. Available at https://www.usfa.fema.gov/nfirs/. Accessed May 28, 2025.
4. U.S. Fire Administration. National Fire Incident Reporting System Complete Reference Guide. January 2015. Available at https://www.usfa.fema.gov/nfirs/documentation/. Accessed May 28, 2025.
5. The National Fire Incident Reporting System and the Public Data Release File. NFIRS and PDR Overview 2023. In the 2023 All Incidents data download.
6. U.S. Fire Administration. Access NFIRS Data. October 17, 2024. Available at https://www.usfa.fema.gov/nfirs/access-data/. Accessed May 28, 2025.
7. Federal Emergency Management Agency. Annual NFIRS Public Data. Available at https://www.fema.gov/about/openfema/data-sets/fema-usfa-nfirs-annual-data. Accessed May 28, 2025.
8. Verma SK, Willetts JL, Corns HL, Marucci-Wellman HR, Lombardi DA, Courtney TK. Falls and fall-related injuries among community-dwelling adults in the United States. PLoS One. 2016;11(3):e0150939.
9. Mertz KJ, Lee DC, Sui X, Powell KE, Blair SN. Falls among adults: the association of cardiorespiratory fitness and physical activity with walking-related falls. Am J Prev Med. 2010;39(1):15-24.
10. Kung HC, Hoyert DL, Xu J, Murphy SL. Deaths: final data for 2005. Natl Vital Stat Rep. 2008;56(10):1–120.
11. Centers for Disease Control and Prevention (CDC). Public health and aging: nonfatal injuries among older adults treated in hospital emergency departments - U.S., 2001. MMWR Morb Mortal Wkly Rep. 2003;52(42):1019–1022.

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Antimicrobial Resistance in Wound Care

By Windy Cole, DPM, CWSP, FAPWH

Chronic, hard-to-heal wounds are a major aspect of care in most podiatric offices, which is why antimicrobial resistance (AMR) is an escalating concern for healthcare practitioners. AMR is not only a growing concern for patient health but also poses potential legal and economic ramifications for healthcare providers.

Understanding Antimicrobial Resistance

Antimicrobial resistance occurs when microorganisms such as bacteria, viruses, fungi, or parasites evolve to withstand the antimicrobial drugs designed to eliminate them. This resistance renders standard treatments ineffective, leading to persistent infections and increased transmission of resistant pathogens. The World Health Organization categorizes AMR as one of the top 10 threats to global health, underlining its urgency.

Indeed, the CDC reports that AMR is on the rise, with the 7 most prevalent AMR pathogens causing a combined 20% increase in hospital-onset infections over 3 years.[1]

Statistics highlight the magnitude of this problem. Globally, an estimated 1.27 million deaths were directly associated to drug-resistant infections in 2019, with millions more associated indirectly. In the United States, AMR kills approximately 23, 000 patients a year and incurs over $20 billion in additional medical expenses. Global economic implications are severe, with potential healthcare costs rising by an estimated $1 trillion by 2050 if AMR is not contained.

The Role of Clinicians in Combatting AMR

Healthcare professionals do bear some responsibility for the rise of AMR due to the overprescription and misuse of antibiotics. In 2022 alone, approximately 236.4 million antibiotic prescriptions were issued in outpatient settings in the US, equating to an astounding 709 prescriptions per 1,000 people.

To mitigate these issues, it is imperative that clinicians refine their wound management practices and enhance antimicrobial stewardship. This involves a thorough understanding of the wound infection continuum and utilizing clinical signs to accurately diagnose infections, rather than yielding to patient pressure or relying on surface-level assessments.

Remembering that many of these patients are not in the best of health is key:

- Presence of peripheral vascular disease (chronic) or altered pharmacodynamics (burn) means antibiotics don't always reach the site of injury at the correct dose.
- Low levels of antiseptics such as silver increase the chance of developing resistance.
- Biofilms need higher concentration of antimicrobial to be effective.

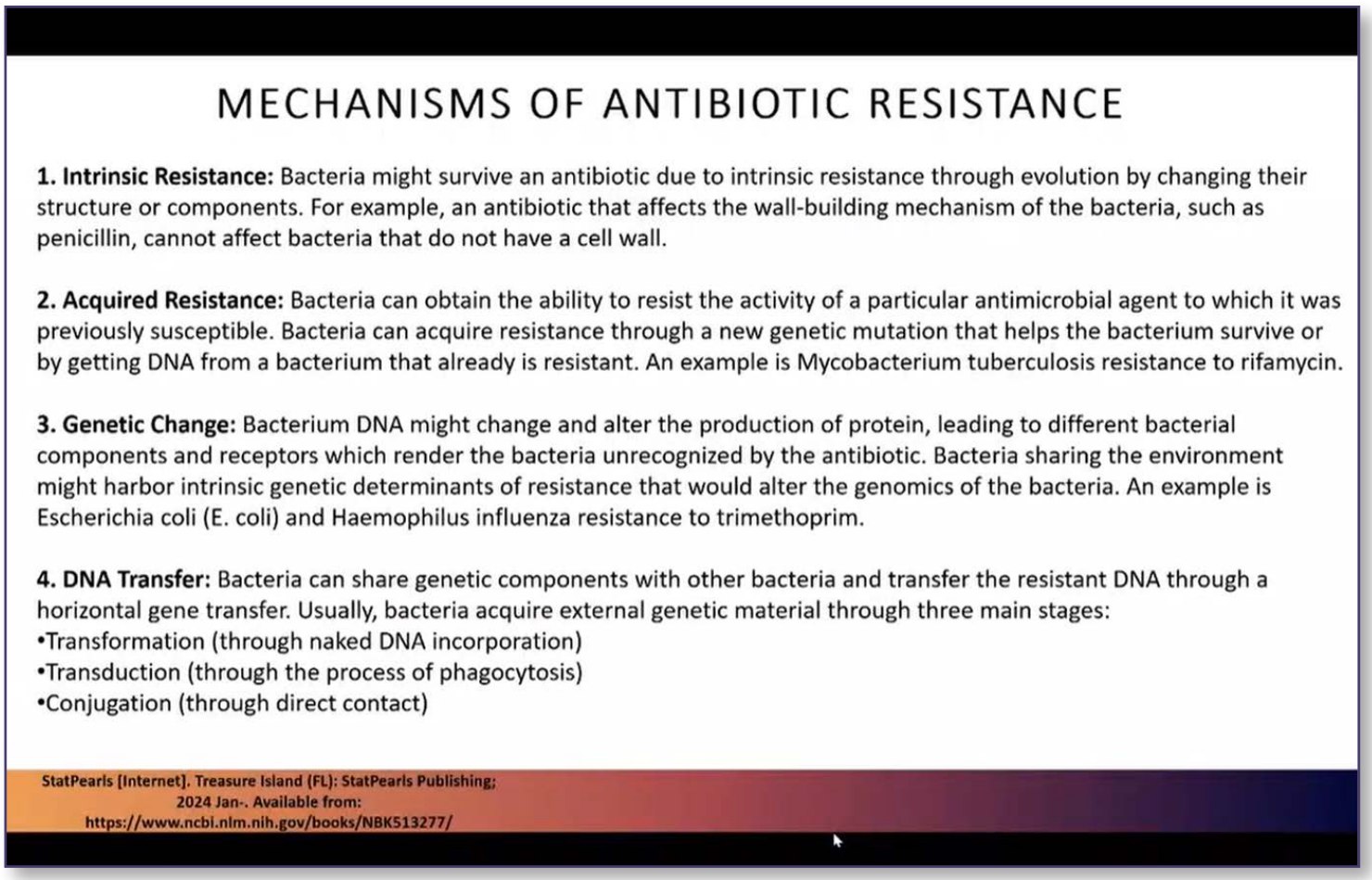
Best Practices in Wound Management

Effective wound management begins with precise identification of the cause of the wound and any external factors that may hinder healing. Debridement, or the removal of dead or infected tissue, is crucial. Achieving a balanced moisture environment is equally important—a moist wound bed facilitates healing more effectively than a wound left overly dry or saturated.

Wound cleansing should extend beyond mere surface cleaning. Clinicians should ensure thorough decontamination of both the wound and the surrounding periwound tissue to prevent reinfection. In some cases, employing point-of-care imaging technology, like autofluorescence cameras, can aid in identifying bacterial load and focus debridement efforts more effectively.

Antimicrobial Stewardship:

This article is a summary of Dr. Cole's presentation, "Best Antimicrobial Stewardship Practices," from the 2025 No-Nonsense Seminar held March 7-9. To view the full presentation with questions and answers—and see the agenda for the 3-day program, visit https://nononsense2025.lerexpo.com. Continuing education credits are available for this and many of the lerEXPO programs.



Best Practices

Key best practices for clinicians include:

1. Infection Identification: Recognizing clinical signs of infection is crucial. Wounds that show signs of infections like purulent discharge, increased pain, or tissue deterioration should be promptly evaluated. Classification of the infection is critical; Table 1, from the International Working Group on the Diabetic Foot,[2] is a good resource.

2. Tissue Sampling: When a wound is suspected of infection, clinicians should prioritize tissue biopsies over swab cultures for more accurate identification of pathogenic bacteria.

3. Antimicrobial Stewardship Programs: These programs involve avoiding unnecessary antibiotic prescriptions, selecting appropriate antibiotic regimens, and ensuring the correct duration of use.

4. Topical Antimicrobial Therapy: In cases where systemic antibiotics aren't necessary or effective, topical treatments, such as silver dressings, iodine, honey, or PHMB, can be utilized. These should be used for brief periods and alternated to prevent resistance.

5. Advanced Imaging Technologies: Utilization of autofluorescence imaging can help detect bacterial loads in wounds, guiding clinicians to more effectively target treatments and reduce unnecessary systemic antibiotic use.

Implementing Antimicrobial Stewardship Programs

Antimicrobial stewardship programs aim to optimize the use of antimicrobials to improve patient outcomes and limit the development of resistance. Such programs encompass various strategies, including:

1. Educational Initiatives: Educating patients about the appropriate use of antibiotics is essential. Not every wound requires antibiotic treatment, and clinicians must convey this to patients.

2. Preventative Measures: Infection prevention should be a priority, incorporating standard protocols such as hand hygiene and aseptic technique.

3. Collaboration with Infectious Disease Specialists: Engaging colleagues from specialized fields can enhance treatment decisions and ensure the most effective antimicrobial therapies are selected.

4. Appropriate Prescribing Practices: Clinicians should prescribe the most suitable antibiotic, considering the narrowest spectrum required, for the correct duration, and based on tissue culture results where feasible.

5. Monitoring and Reporting: Keeping track of antibiotic prescriptions and outcomes can provide valuable data to support ongoing improvements in practice.

Legal and Ethical Considerations

Many of these wounds are incredibly challenging to treat and clinicians may fear legal consequences if infections progress or treatments prove inadequate. However, thorough documentation of clinical decision-making can provide a robust defense in legal scenarios. Recording the rationale

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Table 1. The classification system for defining the presence and severity of an infection of the foot in a person with diabetes[a2]

Clinical classification of infection, definitions	IWGDF/IDSA classification
No systemic or local symptoms or signs of infection	1 / Uninfected
Infected: At least two of these items are present: • Local swelling or induration • Erythema > 0.5 but < 2 cm[b] around the wound • Local tenderness or pain • Local increased warmth • Purulent discharge And, no other cause of an inflammatory response of the skin (e.g., trauma, gout, acute Charcot neuro-arthropathy, fracture, thrombosis, or venous stasis)	2 / Mild
Infection with no systemic manifestations and involving: • erythema extending ≥ 2 cmb from the wound margin, and/or • tissue deeper than skin and subcutaneous tissues (e.g., tendon, muscle, joint, and bone)	3 / Moderate
Infection involving bone (osteomyelitis)	Add "(O)"
Any foot infection with associated systemic manifestations (of the systemic inflammatory response syndrome. [SIRS]), as manifested by ≥ 2 of the following: • temperature, > 38°C or < 36°C • heart rate, > 90 beats/min • respiratory rate, >20 breaths/min, or PaCO2 < 4.3 kPa (32 mmHg) • white blood cell count > 12,000/mm^3, or < 4G/L, or > 10% immature (band) forms	4 / Severe
Infection involving bone (osteomyelitis)	Add "(O)"

Note: The presence of clinically significant foot ischaemia makes both diagnosis and treatment of infection considerably more difficult.

[a] infection refers to any part of the foot, not just of a wound or an ulcer.

[b] in any direction, from the rim of the wound.

[c] if osteomyelitis is demonstrated in the absence of ≥ 2 signs/symptoms of local or systemic inflammation, classify the foot as either grade 3(O) (if <2 SIRS criteria) or grade 4(O) if ≥ 2 SIRS criteria) (see text).

for treatment choices, including instances where antibiotics are withheld, is crucial.

In sum, by adopting rigorous antimicrobial stewardship, practicing diligent wound management, and fostering patient education, lower extremity clinicians can play a pivotal role in curbing the threat of antimicrobial resistance. Such efforts are vital not only for patient safety and clinical efficacy but also for safeguarding the economic and legal interests of healthcare providers.

Windy Cole, DPM, CWSP, FAPWH, has practiced in Northeast Ohio for over 22 years. She is an adjunct professor and Director of Wound Care Research at Kent State University College of Podiatric Medicine. She is double board certified by the American Board of Foot and Ankle Surgery and the American Board of Wound Management. She is an ACCWS board member and a Fellow of the Royal College of Physicians and Surgeons Glasgow. She has been a dedicated wound care advocate for two decades with interests focused on medical education, diabetic foot care, wound care, limb salvage, & clinical research. And she serves on the Editorial Advisory Board of Lower Extremity Review.

References

1. Antimicrobial resistance threats in the United States, 2021-2022. Centers for Disease Control and Prevention. 2024. Https://www.cdc.gov/antimicrobial-resistance/data-research/threats/update-2022.html
2. International Working Group on the Diabetic Foot. Guidelines on the diagnosis and treatment of foot infection in persons with diabetes (Part of the 2023 IWGDF Guidelines on the prevention and management of diabetes-related foot disease). 2023. Available at https://iwgdfguidelines.org/wp-content/uploads/2023/07/IWGDF-2023-04-Infection-Guideline.pdf. Accessed May 30, 2025.

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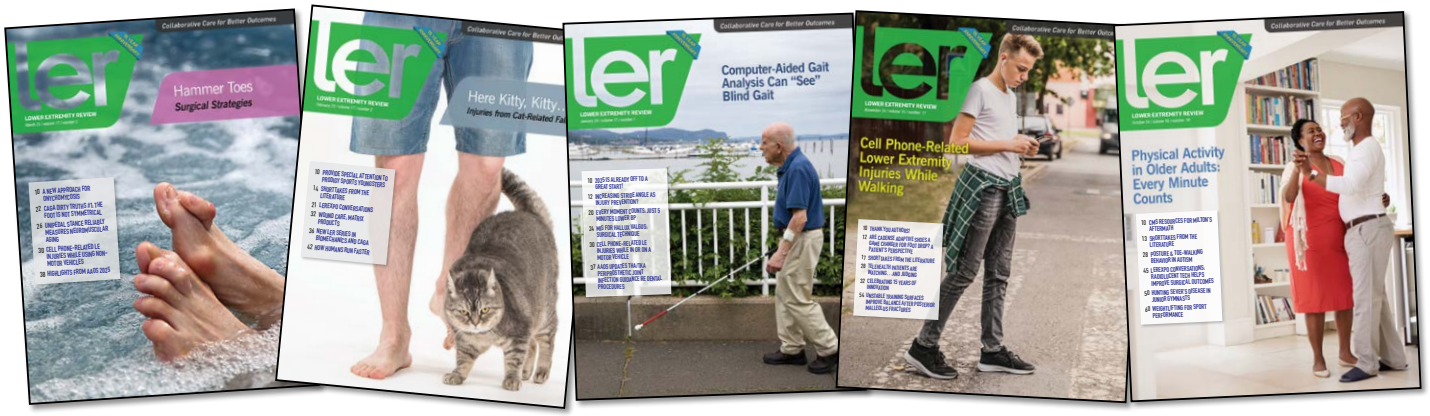

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PFA APPOINTS NEW EXECUTIVE DIRECTOR

The Pedorthic Footcare Association (PFA) announced that its board's executive committee has nominated Teresa Alpert, CO, CPed, BOCO, BOCPD, CMF, to continue her service to PFA as the next executive director effective May 31. Simultaneous to her presidency ending, Jeffery Rich, CPed, will take over as the next PFA president.

Certified by both the American Board for Certification in Orthotics, Prosthetics, and Pedorthics, as well as the Board of Certification/Accreditation (BOC), Alpert has been in private practice for over 30 years. She was past chairwoman for BOC, a past education chairwoman for the National Shoe Retailers Association and recently was appointed to the American Orthopedic Foot & Ankle Society Allied Health workgroup. She also serves on several association and work-related committees and is the founder of the non-profit SHARE, Support Hospice Area Resource Exchange, to benefit hospice homecare.

Alpert currently holds a faculty appointment at the University of Colorado as the orthotist to the Foot and Ankle Institute where she created and implemented the durable medical equipment, orthotics and prosthetics division for the orthopedic department. She is responsible for training the residents and fellows, working with the Gait Lab, research, and direct patient care.

ROBOTIC SHORTS SUPPORT WALKING

Researchers at the Technical University of Munich (TUM) have developed robotic shorts—dubbed WalkON—that enable people to walk more easily while expending measurably less energy. The aim is to keep frail individuals and in particular the elderly mobile and healthy for longer.

According to the researchers' analyses, when a young person walks 500 meters up a hill with the aid of the robotic shorts, the metabolic cost is reduced by 18% as compared to unaided walking. For an older person walking 400 meters on level ground, it is reduced by over 10%. This is comparable to the effects of a reduction in body weight of 10 or 6 kilograms.

The researchers believe this system will be especially useful for people who are somewhat frail but do not yet need a rollator.

When the user transitions from standing to walking, 2 thin, artificial tendons extending from the thigh to a waist belt pull upward at the same time and relieve the hip flexors of some of their load. A measuring device attached to the tendons determines the hip angle and velocity. The device sends a signal to the motors precisely at the transition to the swing phase of walking. Regardless of whether an older person or a sporty teenager is wearing the robotic shorts, the system recognizes how fast or slowly the person is moving, adapts to the respective weight of the legs, and provides individual support accordingly. As the walking shorts do not require any pre-settings, they can be donned and ready to use in just a few minutes.

A questionnaire completed by participants indicated a strong sense of control, with respondents awarding a mean rating of over 6 on a scale from 0 (no control possible) to 7 (very good control possible).

FUSION COLLECTION FROM WACO

Waco Shoe Company's Fusion Collection is an orthotic-grade footwear line that combines casual designs for those who value support and

sporty style. The Fusion Collection for women includes Zest, a strappy sandal; Vitality, a practical clog; Energy, a versatile toe-post sandal; and Strive, a sporty slide. For men, the line-up has Fusion Energy sandal and Strive slide. Each shoe, built with Revitalign® FUSION Technology, has an orthotic-grade arch, deep heel cupping, and metatarsal dome for ultimate alignment. The Full Contact Comfort® footbed fights foot fatigue, absorbs shock every step, and ensures optimal foot support. Sizing options include women's 5–12 medium and 6–12 wide and men's 7–14 medium, with some styles in wide. Additionally, these monochromatic shoes feature antimicrobial odor control technology and 1-piece injection-molded EVA for cushioning and protection. They are 100% machine washable in cold water only.

Waco Shoe Company
844/827-0439
wacoshoecompany.com.

UV SHOE SANITIZERS

The SteriShoe® shoe sanitizer is designed specifically for footwear. This patented product features dual, non-ozone producing 5-watt UVC germicidal bulbs safely housed in steel frames that slip into your shoes. Once activated, they emit light at a wavelength that disinfect and "zap" organisms that thrive in the warm, dark, damp shoe environment to help prevent odor and skin and nail infections. An integrated fan hidden inside dries shoes to further retard germ and fungus growth. For simpler shoe disinfection at lower cost, the ShoeZap® 15 Minute UV Shoe Sanitizer offers sturdy plastic frames, 3-watt ozone-free UVC bulbs and an automatic off safety feature. These fit in any shoe size, including children's. The replaceable UVC bulbs in both devices last for more than 8,000 shoe treatments. Daily or weekly use is recommended to keep footwear clean and more hygienic.

PediFix
800733-4349
pedifix.com

CBD TOPICAL PAIN RELIEF

Haylex Laboratories has announced the global release of Ortho Freeze Plus, an over-the-counter topical pain reliever combining the power of lidocaine, diclofenac, and a potent 6,000mg dose of CBD extract isolate (NO THC). Recommended by sports medicine doctors, orthopedic surgeons, podiatrists, professional sports team physicians, and collegiate athletic training departments across the country, Ortho Freeze Plus is quickly becoming a trusted solution for those suffering from muscle, joint, and nerve pain. Whether you're recovering from a sports injury, managing chronic discomfort, or dealing with acute flare-ups, this advanced formulation provides fast, targeted relief. The product is set apart by its triple-action approach to pain: numbing, anti-inflammatory, and cannabinoid support. The feedback from both physicians and customers has been overwhelmingly positive. Each batch undergoes third-party laboratory testing to ensure it meets the highest standards of safety, purity, and effectiveness.

Haylex Laboratories
contact@orthofreeze.com
orthofreeze.com

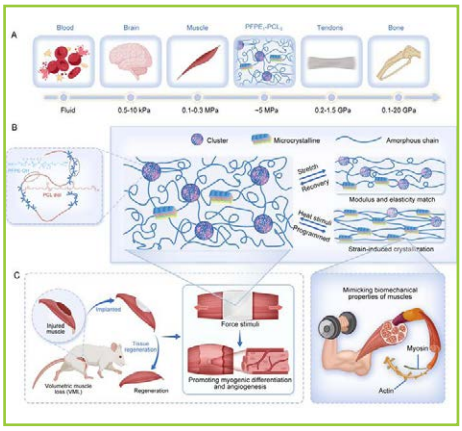
WALKING ASSISTANCE WEARABLE ROBOT

WIM (We Innovate Mobility) is a walking assistance wearable robot designed for the active young generation, seniors seeking improved mobility, and patients recovering from lower extremity injuries. Weighing just 1.6 kilograms, it can be donned or doffed in under 30 seconds, and its compact dimensions (23cm x 6cm when folded) make it easy to carry. The device is powered by a proprietary single actuator system. With a 1-size-fits-all design, WIM adapts seamlessly to users of all body types. WIM goes beyond mobility assistance by integrating advanced artificial intelligence and big data technologies to offer personalized coaching. The accompanying mobile app provides real-time analysis of gait metrics to create tailored exercise plans to help users achieve their mobility and fitness goals. It adapts to various user needs through 4 operating modes: assist mode, resist mode, hiking mode, and slow gait mode. Water- and dust-resistant.

WIRobotics
wirobot@wirobotics.com
wirobotics.co.kr/en/main.php

BIOMIMETIC ARTIFICIAL MUSCLE PROPERTIES SIMILAR TO NATURAL MUSCLE TISSUE

Researchers from China have successfully developed an artificial muscle with mechanical properties similar to natural muscle tissue. They utilized molecular design to synthesize the artificial muscle through block copolymerization of biocompatible perfluoropolyether



(A) A summary plot illustrating the elastic modulus range of the artificial muscle compared to representative biological tissues, highlighting the biomimetic mechanical properties of the artificial muscle. (B) A schematic representation of the designed multifunctional artificial muscle, showcasing its structural features tailored for enhanced functionality. (C) Demonstrations of the artificial muscle's versatility: on the left, its ability to treat volumetric muscle loss by promoting myogenic differentiation and angiogenesis; on the right, its capacity to mimic the functional dynamics of natural muscle tissue.

(PFPE) and polycaprolactone diol (PCL). By precisely tuning the intra- and intermolecular interactions of PFPE and PCL (eg, dipole-dipole interactions) under controlled conditions, they achieved self-assembly and microphase separation, suppressing the crystallization of PCL moiety. Their work has implications for use in prosthetic devices, tissue engineering, and regenerative medicine.

The biocompatible material exhibits an amorphous state at room temperature and without external force, maintaining a low elastic modulus and high elasticity. Under tensile stress, the amorphous polymer chains unfold, align, and reorient along the loading direction, significantly enhancing the material's tensile strength and toughness. The material also demonstrates remarkable tear and puncture resistance as well as exceptional shape memory and actuation performance. Under thermal stimulation, the material can lift objects weighing more than 5,000 times its own weight and reliably perform reversible contraction and extension motions over multiple heating and cooling cycles.

Histological evaluations after implantation in rats revealed that the material facilitated muscle tissue growth along the scaffold. After 4 weeks, regenerated muscle exhibited well-organized structure and morphology, with muscle contractile force comparable to that of normal rats. Furthermore, vascular regeneration indicated enhanced angiogenesis, crucial for muscle regeneration.

REDUCING MUSCLE SPASTICITY IN INCOMPLETE SCI PATIENTS

"This is a safe and effective surgical procedure that offers a new perspective in the treatment of patients with severe damage to the spinal cord," said Pietro Mortini, MD, head of the neurosurgery and stereotactic radiosurgery unit at IRCCS Ospedale San Raffaele (Milan) and full professor of neurosurgery at the University Vita-Salute San Raffaele.

Electrical stimulation of the spinal cord is a promising strategy for reestablishing walking after spinal cord injury (SCI), recent studies show. But for patients suffering from muscle spasms, the stimulation protocols have a limited effect due to the unpredictable behavior of involuntary muscle stiffness related to spasticity. Muscle spasticity affects almost 70% of patients with SCI.

Now, scientists at École Polytechnique Fédérale de Lausanne (EPFL), Switzerland; Università San Raffaele, Italy; and Scuola Sant'Anna, Italy, have found a way to address and reduce muscle spasticity in patients with incomplete SCI. It involves zapping the spinal cord with high-frequency electrical stimulation that blocks the abnormal muscular contractions. This high-frequency treatment gives patients suffering from spasticity access to rehabilitation protocols that were previously inaccessible to them with a very good clinical outcome.

"We've found that high frequency electrical stimulation of the spinal cord, coupled with the usual continuous, low-frequency spinal stimulation, is effective during rehabilitation after spinal cord injury, overcoming muscular stiffness and spasms in paralyzed patients and effectively assisting the patients during locomotion," said Silvestro Micera, PhD, professor at EPFL's Neuro X Institute and Scuola Sant'Anna.

Electrical stimulation of the spinal cord is an indirect way to reach the motor neurons that make muscles move. That's because the backside of the spinal cord contains sensory neurons which in turn communicate with the motor neurons. In muscle spasticity, it is known that the spinal sensory-motor circuits are overreactive. By indirectly stimulating the motor circuits, the research team has found that high-frequency stimulation of the spinal cord is an artificial and safe way to inhibit that over-reactivity without producing discomfort in patients.

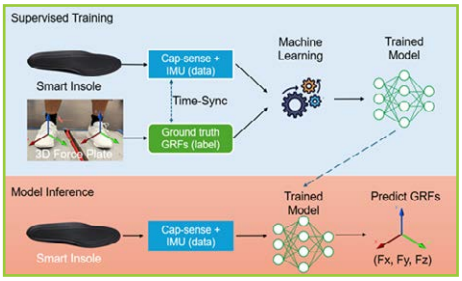
VIRTUAL REALITY GAIT-TRAINING PLATFORM

GaitBetter is a state-of-the-art motor-cognitive virtual reality (VR) intervention for gait rehabilitation and fall prevention. It uses gamification and semi-immersive VR to simulate motor-cognitive challenges that patients experience in everyday life. Clinically proven to accelerate more positive outcomes and reduce falls by over 70%, this innovative solution enables clinicians to tailor therapy intensity and

specificity to the unique needs of their patients. Harnessing artificial intelligence–based gait tracking, patients play a fun and safe "game" as they see their feet movements projected into a VR environment displayed on a TV screen in front of them. Easily added to any treadmill, patients face virtual obstacles to improve gait while performing complex tasks requiring attention, memory, motor planning and execution to enhance motor-cognitive skills.

GaitBetter
301/678-1769
gaitbetter.com

SMART INSOLES ARE A BREAKTHROUGH IN 3D GRF ESTIMATION



Depiction of how the smart insole estimates #D GRFs by using an AI model.

A team of researchers in the United Kingdom has developed a smart insole system that can accurately measure the body's interaction with the ground, opening new possibilities in sports science and healthcare by estimating ground reaction forces (GRFs). The TG0 Smart Insole captures fine-grained movement information such as the pressure distribution under different parts of the foot, while the built-in inertial measurement unit (IMU) provides precise motion tracking.

"This combination makes it an exceptionally versatile data acquisition platform, not only for supporting research but also for practical applications in healthcare, rehabilitation, and sports science," said Liucheng Guo, PhD, the project lead and CTO of TG0.

Leveraging the advanced TG0 Smart Insole with an innovative artificial intelligence (AI) method, their method demonstrated high accuracy with an error rate as low as 4.16%. Specifically, the team designed and implemented an experimental setup involving various movement protocols.

What sets this study apart is that the team also created a publicly available dataset that combines sensor data from insoles with gold standard force plate readings. This dataset is the first of its kind dataset includes multi-modal sensor data from smart insoles with force plate readings and could accelerate research in biomechanics and wearable technologies.

THAI "EXOSKELETON WHEELCHAIR" HELPS PEOPLE WITH DISABILITIES SIT, STAND, WALK

Image courtesy of Chaichaowarat and Chulalongkorn University.

Associate Professor Ronnapee Chaichaowarat, PhD, faculty of engineering, Chulalongkorn University, Thailand, has developed an Exoskeleton Wheelchair prototype for the elderly and people with mobility problems so they can leave their wheelchair behind to stand and walk with 1 robot. The "Transformable Wheelchair-Exoskeleton Hybrid Robot for Assisting Human Locomotion" was designed by Chaichaowarat and fabricated with carbon fiber because of its light weight and because it can be fabricated by 3D printers. The motion control is divided into 2 parts. The first part is the wheels, which have a group of students programming the front wheel speeds to make the robot travel straight or turn. The second part is the hip and knee joint motors' control, which is programmed by Chaichaowarat.

"The lower leg can change mode between sitting and walking using a motor to help with the movement of the hip and knee joints," said Chaichaowarat. "The ankle joint is a free joint with no drive. The left and right wheels can be retracted to the lower leg area to transform into a walking posture or get over obstacles."

He further explained that he used kinematics compatibility in the design with linkage knee joints so that the motion of the rotational center can mimic the actual bone. For the joints supporting lots of leg bending and flexion, a 4-bar linkage allows the pivot point to change with the joint. He also applied his biomechanical knowledge to calculate the torque generated from around the ankles, knees, and hips to create robots that fit a person's physiology.

MINIMALLY INVASIVE ACL REPAIR IMPLANT

The proprietary bio-engineered Bridge-Enhanced® ACL Repair (BEAR®) Implant is used to facilitate healing of the torn anterior cruciate ligament (ACL) by acting as a bridge between the 2 ends of the torn ligament. The surgeon injects a small amount of the patient's own blood into the implant and inserts it between the torn ends of the ACL in a minimally invasive procedure. The combination of the implant and the patient's blood enables the body to heal the torn ends of the ACL back together while maintaining the ACL's original attachments to the femur and tibia. As the ACL heals, the implant is absorbed by the body, within approximately 8 weeks. It is now cleared to treat torn ACLs in children and adolescents of any age, as well as partial tears.

Miach Orthopaedics
800/590.6995
miachortho.com

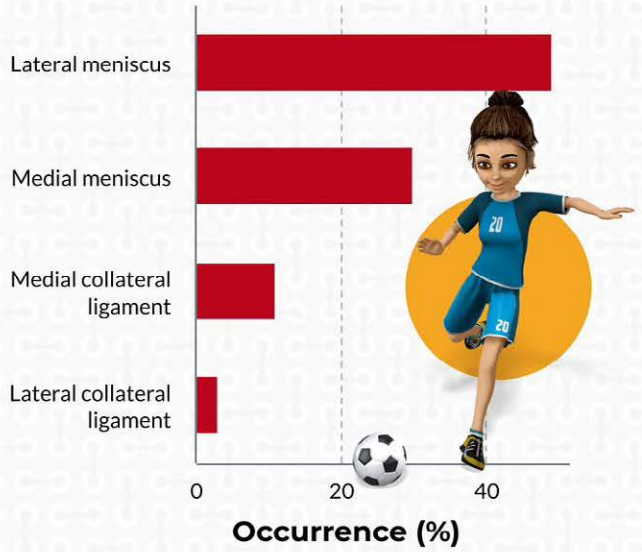
Patterns of ACL injury in women's football

Reference: Achenbach et al. BJSM 2024

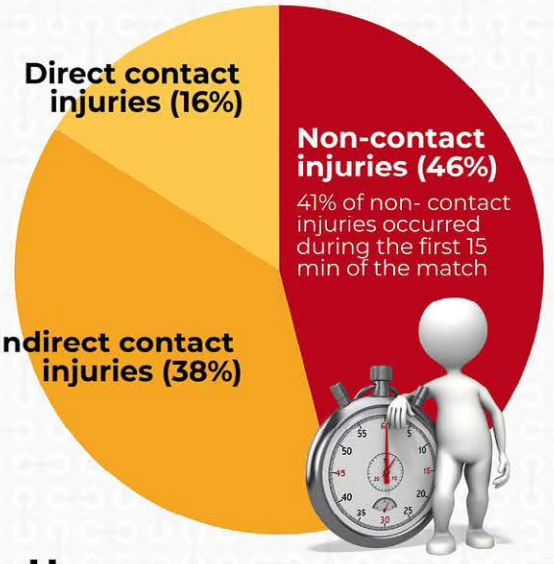
Designed by @YLMSportScience

ACL match injuries sustained in Germany's first women's league during the 2016–2017 to 2022– 2023 seasons were prospectively analysed

Associated injury



Mechanisms



Images provided by PresenterMedia

Recurrent patterns

A high proportion of 80% of ACL injuries occurred during horizontal movements such as sprinting, stopping, change- of-direction manoeuvres and lunging

Pressing ACL injury

Parallel sprinting & tackling knee injury

Knee-to-knee injury

Landing ACL injury

Pitch condition There was no rain (0%) in any of the observed injury match situations.

Source: Achenbach L, Bloch H, Klein C, et al. Four distinct patterns of anterior cruciate ligament injury in women's professional football (soccer): a systematic video analysis of 37 match injuries. Br J Sports Med. 2024;58(13):709-716. doi: 10.1136/bjsports-2023-107113.

Put Some Spring in Their Step

Posterior Spring AFO Stores & Releases Energy with Every Step

A Dynamic AFO with Progressive Flexibility from Heel to Toe

Ultra Light Carbon Fiber Construction

Made from Prepreg Carbon Fiber

Custom Foot Bed with Foam Padding

Or Custom Proflex® SMO for Enhanced Ankle Control

Easily Fits in Shoe

Dynamic Energy Return

Adjustable Anterior Shell

Overlapping posterior section allows for compression of the proximal tiba. Removable for easy donning.

Open Heel Design

Provides soft initial floor contact preventing sudden knee flexion

Suggested L- Codes: L1945, L2755, L2820

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