Collaborative Care for Better Outcomes

15 YEAR ANNIVERSARY

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LOWER EXTREMITY REVIEW

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15 Celebrating 15 Years of Healthcare Innovations

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11 Readers offer their thoughts on the greatest innovations of the last 15 years.

The dictionary defines innovation as the introduction or use of new ideas or ways of doing things. But it's really much more than that:

- In *What Customers Want*, innovation expert Anthony Ulwick wrote, "Innovation is not the result of thinking differently. It is the result of thinking deliberately (in specific ways) about existing problems and unmet needs."
- Others have added that innovation is a corporate mindset of continuous quality improvement that encourages improving processes or revising products in response to customer needs.

As part of LER's 15th anniversary celebration, we asked readers to weigh in on the many facets of innovation that have helped improve patient outcomes in lower extremity care. Here, we share some of their thoughts.

SMARTPHONE CLINICAL PRACTICE IN GAIT ANALYSIS

By Sarah A. Curran, PhD

Smartphones have revolutionized clinical practice through enhancement of communication with colleagues and patients, information access, and workflow efficiency for healthcare providers. With the continuous evolution of technology, smartphones have increasingly been used for assessing gait—providing a convenient and accessible way to monitor mobility, balance, and walking patterns. Gait assessment using smartphones typically involves using built-in sensors, such as accelerometers, gyroscopes, and magnetometers, which can capture detailed motion data. In essence, the use of smartphones for gait assessment has been linked to a growing body of research with several studies providing evidence supporting its validity and reliability, as well as application to a range of conditions. In a review of wearable devices and smartphones for gait analysis, Muro-de-la-Herran et al[1] found that smartphone sensors, particularly accelerometers and gyroscopes, were able to reliably capture gait parameters such as step length, cadence, and velocity. They concluded that smartphones could be a valid alternative to more traditional motion capture systems for basic gait assessment in non-laboratory settings.

Storm et al[2] validated the use of smartphone accelerometers to estimate spatiotemporal gait parameters in a group of healthy individuals. The authors found, when worn at the waist, smartphones provided estimates of gait speed, step length, and cadence with accuracy comparable to clinical tools such as the GAITRite system (CIR Systems, Inc.; New Jersey, USA), a commonly used gait analysis tool in rehabilitation. These findings are further supported by a most recent study by Tao and colleagues[3] who developed a WeChat mini-program (*MobileGait*) and used smartphone sensors to determine reliability and validity with healthy individuals, and to demonstrate the impact on gait parameters during single-task and dual-task walking in a cohort of cerebral small vessel disease patients. Additional studies have been undertaken in other patient populations, which includes the risk of falls prediction in older adults. Using smartphone sensors, Del Din et al[4] demonstrated that gait characteristics measured correlated well with clinical fall risk assessments, such as the Timed Up and Go test. Such findings can serve as a cost-effective and scalable solution for early detection of fall risk. Likewise, Su et al[5] investigated the potential of smartphone-based gait analysis to monitor Parkinson's disease progression. They showed that smartphone sensors could detect subtle changes in gait related to disease severity, such as reduced stride time and variability during single-task and dual-task conditions, making it a valuable tool for monitoring functional symptoms and outcomes.

While these studies are not an exhaustive list, they do collectively demonstrate that smartphones, with their ubiquitous availability and advanced sensor technology, are a practical and effective tool for gait assessment across a range of settings and populations. As technology evolves and becomes more accessible, so will our ability to work with it to enhance our patient assessments and outcomes, as well as to monitor rehabilitation.

Prof. Sarah A. Curran, PhD, Professor of Podiatric Medicine and Rehabilitation, School of Sport and Health Sciences, Cardiff Metropolitan University, UK

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3-D PRINTING ALLOWS FOR ANATOMICALLY PRECISE PRODUCTS

By Patrick DeHeer, DPM

A close-up of a 3D-printed cobalt chrome talus bone implant printed by Restor3D. The company, spun out of Duke University in 2017, specializes in custom implants used for trauma and oncology cases, and off-the-shelf 3D-printed implants that have been cleared by the FDA.

In the past 15 years, lower extremity healthcare has seen numerous innovative products that have improved patient outcomes. Determining which product has had the greatest impact is debatable, but 3-dimensional (3D) printed technologies stand out. These include non-customized implants, custom implants, patient-specific instruments and cut guides, and anatomic biomodels.

3D printing utilizes 2 methods: additive manufacturing, where material is built up in layers, and subtractive manufacturing, where material is removed from a base to create patient-specific products.

The complexity of the foot and ankle often leads to significant deformities due to disease, trauma, or biomechanical issues, which previously lacked reliable solutions. Now, engineering teams can create anatomically precise products based on CT scans and radiographs, collaborating closely with surgeons to tailor these devices to individual needs.

In complex cases involving segmental bone loss, deformity correction, and arthrodesis, 3D-printed implants enable predictable results that help maintain limb function and enhance patients' quality of life. Osseous integration, or direct bonding of bone to an implant, offers an advantage over traditional bone grafts, making 3D-printed implants a valuable tool in complex reconstructive surgeries.

Patrick DeHeer, DPM FACFAS, FFPM RCPS (Glasg) is now Medical Director at Upperline – Indiana and Podiatric Residency Director at Ascension St. Vincent Hospital in Indianapolis.

MPFF INTRODUCED INTO U.S. FOR VENOUS & LYMPHATIC DISEASE

By John Chubak, MD, FACS

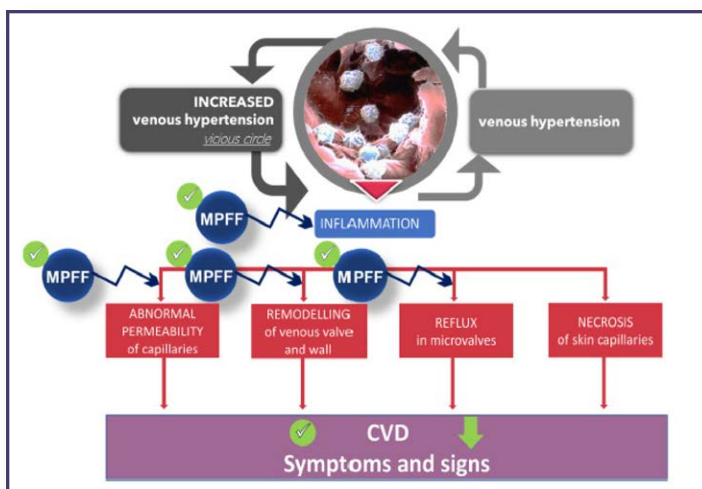

Figure 1. Effects of MPFF on the pathophysiological processes that cause the signs and symptoms of Chronic venous disease. MPFF, micronized purified flavonoid fraction. Reprinted from Lurie F, Branisteanu DE. Improving chronic venous disease management with micronised purified flavonoid fraction: New evidence from clinical trials to real life. Clin Drug Investig. 2023;43(Suppl 1):9-13. doi: 10.1007/s40261-023-01261-y. Use is per Creative Commons License CC BY 4.0.

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As a board-certified cardiovascular surgeon specializing in venous and lymphatic disease, I firmly believe that the introduction of micronized purified flavonoid fraction (MPFF) into the U.S. market represents perhaps the most important innovation in daily practice we've seen in the last 10 years. This advancement is crucial for supporting venous and lymphatic function by preventing inflammatory sequela and microcirculatory dysfunction caused by venous hypertension (Figure 1). Venous or lymphatic disorders are believed to affect 50% of U.S. citizens, creating a substantial public health burden.

MPFF, a dietary supplement, has garnered significant recognition, being recommended in all clinical practice guidelines from esteemed organizations such as the Society for Vascular Surgery, the American Vein and Lymphatic Society, and the American Venous Forum. These endorsements underscore its efficacy and safety, marking a pivotal paradigmatic shift in philosophy.

The benefits of MPFF are manifold. It not only helps support vein function in patients with chronic venous insufficiency, but also supports overall vascular health. By improving microcirculation and reducing inflammation through its antioxidant mechanism of action, MPFF aids in the prevention of more severe complications, ultimately enhancing patients' quality of life.

Vein Formula and Lymphatic Formula, introduced by VitasupportMD, are simple to incorporate into daily routines and act as excellent adjuncts to other standard treatments. This innovation aligns with our ongoing efforts to provide holistic care, emphasizing patient well-being and compliance.

The availability and guideline endorsement of MPFF in the U.S. is a significant step forward in the management of the venous and lymphatic systems and reinforce the importance of improving patient outcomes by providing a comprehensive approach to care, which includes systemic dietary supplements.

John Chuback, MD, FACS, is co-founder of VitasupportMD in Paramus, NJ.

CONTINUOUS TOPICAL OXYGEN THERAPY FOR WOUND CARE

By Windy Cole, DPM, CWSP

The utility of supplemental oxygen to support wound healing has been well-documented in the literature. Following injury, poor blood circulation, edema, injured microcirculation, and contraction of vessels in traumatized tissue limit oxygen distribution to a wound, thereby reducing the wound's capacity to heal. Oxygen plays an essential role in multiple wound-healing processes including oxidative killing of bacteria, cellular signaling through growth factors and cytokines, and proliferation, collagen deposition, and angiogenesis. Thereby, increasing oxygen levels via supplemental oxygen in the ischemic tissue reverses hypoxic conditions, reduces ischemic pain, supports the healing process, reduces inflammation, and decreases the risk of infection and biofilm.

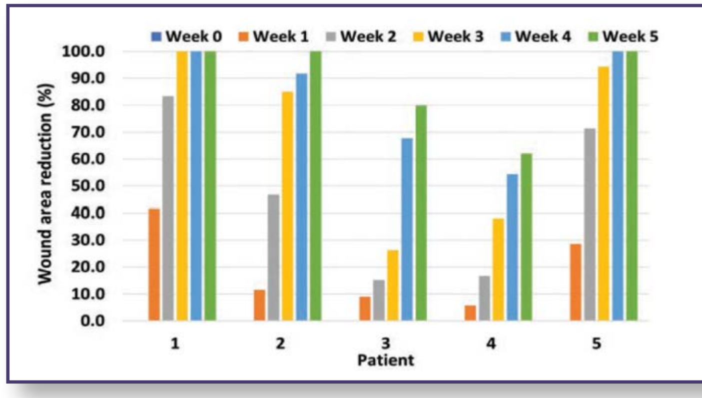

Figure 2. Percentage wound area reduction over the 5-233k observation period. Reprinted from Cole W, Woodmansey E. Monitoring the effect of continuous topical oxygen therapy with near-infrared spectroscopy: a pilot case series in wound healing. Wounds. 2024;36(5):154-159. doi: 10.25270/wnds/23150.

Various methods of supplying supplemental oxygen therapy include hyperbaric oxygen therapy (HBOt) and topical oxygen therapy (TOT). HBOt involves delivering systemic oxygen to the patient via a high-pressure chamber for 90 minutes 5 days a week. HBOt is available at specialty clinic or hospital locations and is not portable. Thus, HBOt is not suitable for home or community use. However, continuous topical oxygen (cTOT) devices are now widely available. cTOT represents a significant advancement in delivering supplemental oxygen treatments to patients suffering with chronic wounds. cTOT devices are innovative, easy to use, and lightweight, delivering continuous oxygen directly to the wound bed. cTOT devices are portable, thus oxygen delivery is maintained 24 hours a day, 7 days a week, allowing the patient to continue to perform activities of daily living uninterrupted. The treatment is low-risk and is easy to use in a wide range of care settings and in a variety of chronic wound types. Understanding the utility of cTOT as an alternative method of chronic wound pain management has

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the potential to impact a large segment of the population who do not have access to effective treatment options.

Dr. Cole 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.

SMARTPHONE SCANNING FOR ORTHOTICS

By Robert Weil, DPM

Prescription orthotics have always been a crucial part of my sports podiatry practice. Athletes of all sports, levels, and ages expect comfort and positive results with their foot, ankle, knee, and postural problems from using their orthotics. Let's also include enhanced performance among those benefits. However, preciseness and accuracy of the prescription along with manufacturing turnaround time are key! My figure skating specialty with boot-fitting demands and alignment criteria are good examples.

An exciting innovation advance to the orthotics world with the new smartphone 3D technology was introduced to me by orthotics consultants at Henhat's lab and my long time "orthotics guru" lab manager Darrin Harpham. I have forever used neutral position plaster casting with FAB results from superstars to kids and grandmas and was a very tough sell for any scan alternatives (Figure 3), let alone scans with my iPhone! Even with the time-consuming and messy casting always included, as well as turnaround time challenges, I was always stubborn and reluctant to depend on any of the available alternatives. Darrin also initially felt the same cautious reluctance. Well, my how times have changed!

Orthotics and foot scanning has been available for some time at walking and running shoe stores and with some podiatrists and physical therapists, but I always questioned their accuracy and results. Too many patient complaints and necessary orthotics adjustments were needed. I was pleasantly surprised with not only my personal positive consistently great results with patients and athletes over this past year, but also with lab feedback from other podiatrists and doctors with the new iPhone 3D phone scanning. Big step up!

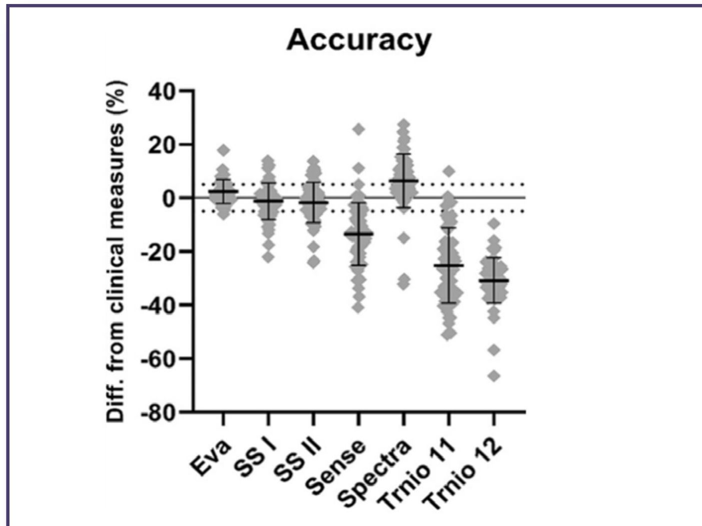

Figure 3. Percentage difference between clinical measures and 3D scans of the foot, ankle and lower leg. The 3D scanners are: Artec Eva (Eva), Structure Sensor I (SSI), Structure Sensor II (SSII), Sense, Spectra, and Trnio applications for iPhone 11 (Trnio 11) and iPhone 12 (Trnio12). Positive differences in the y-axis show that the 3D scan was larger in size than the clinical measurement. Dotted line represents 5% difference.

**Trnio has since retired the apps used here.*

Reprinted from Farhan M, Wang JZ, Lillia J, Cheng TL, Burns J. Comparison of multiple 3D scanners to capture foot, ankle, and lower leg morphology. Prosthet Orthot Int. 2023;47(6):625-632. doi: 10.1097/PXR.0000000000000230. Use is per Creative Commons License CC BY.

With some easy and proper instructions for technique and methods provided by the lab, podiatrists can really take advantage of this progressive innovation for themselves and their patients.

Robert A. Wei, DPM,l is a sports podiatrist in private practice in Lisle, Illinois. He hosts "The Sports Doctor," a live weekly radio show on bbsradio.com, or you can visit his website, thesportsdoctorradio.com. His book, #HeySportsParents written with Sharkie Zartman, is available on Amazon.com. Dr. Weil was inducted into the prestigious National Fitness Hall of Fame in April 2019. Find him at thesportsdoctorradio.com.

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ADVANCEMENTS IN SURGICAL SOLUTIONS AND PATIENT REHABILITATION

BY GARY JUSTAK

The STAR® Ankle 3-piece mobile bearing ankle implant.

Over the last 15 years, the foot and ankle landscape has witnessed a seismic shift marked by ingenious solutions that have transformed surgical techniques, introduced a new breed of innovative products, and reshaped patient recovery. Close collaboration with surgeon partners has been key in the development of multiple innovations. Three advancements stand out for me:

1. The integration of NiTiNOL technology in hindfoot fusion surgeries, highlighted by DynaNail Helix™. NitiNOL (a combination of nickel and titanium) is a metal alloy that has the unique ability to change shape and still fully recover back to its original geometry. By incorporating NiNiTOL's sustained dynamic compression, known for improving fusion rates and times, Helix enhances surgical efficiency and facilitates optimal healing.
2. Minimally invasive surgery (MIS) has gained prominence, enabling better outcomes for some of the most high-volume procedures in lower extremity care. As a leader in the MIS charge, our latest percutaneous Lapidus correction system, Tarsoplasty, merges multiple clinical advantages of percutaneous surgery with the powerful correction of a traditional Lapidus procedure, ensuring accurate anatomical alignment and guided fixation.
3. STAR® Ankle, the first 3-piece mobile bearing ankle implant approved for uncemented use by the US Food and Drug Administration in 2009 in the United States. And the recently added surgical e+™ Polyethylene vitamin upgrades—1, a moderately-cross linked formula for sliding and gliding kinematics, and a second highly-cross linked formula for ball and socket–type kinematics, both have been demonstrated to significantly reduce oxidation and long-term wear.*

With excitement for the future, we remain committed to redefining every step for every patient.

**Data on File.*

Gary Justak, is President and General Manager of Enovis™ Foot & Ankle in Lewisville, Texas. To learn more about the Enovis journey, visit www.enovis.com/foot-and-ankle.

PCR TESTING FOR PODIATRIC NAIL & SKIN DISORDERS

BY WILLIAM P. SCHERER, DPM, MS

PCR (Polymerase Chain Reaction) testing is a transformative innovation in diagnosing nail and skin disorders within podiatry. Introduced for podiatric medicine about 15 years ago, PCR enables the rapid amplification of specific DNA sequences, making it a powerful tool for identifying fungal and bacterial infectious agents that cause various dermatological conditions. This capability is also crucial for diagnosing infectious diseases, including viral infections like COVID-19, where timely and accurate detection can significantly impact public health responses.

In podiatry, PCR testing is especially valuable for accurately diagnosing fungal nail infections (onychomycosis) and skin infections, such as athlete's foot and cellulitis (Figure 4). Traditional KOH prep and fungal culture methods can be inaccurate and sometimes take several weeks for results, while PCR testing provides rapid and precise identification of pathogens (genus and species), with a higher sensitivity and specificity than older methods, allowing for individualized treatment plans that can improve patient outcomes. This is crucial in cases where timely diagnosis

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Figure 4. White superficial onychomycosis (WSO) or leukonychia trichophytica caused by Trichophyton rubrum. Mixed form of WSO with distal subungual onychomycosis; 63-year-old patient. From Nenoff P, Reinel D, Mayser P, et al. S1 guideline onychomycosis. JDDG: Journal der Deutschen Dermatologischen Gesellschaft. 2023;21:678–692. https://doi.org/10.1111/ddg.14988.

can prevent the spread of infection or more severe complications.

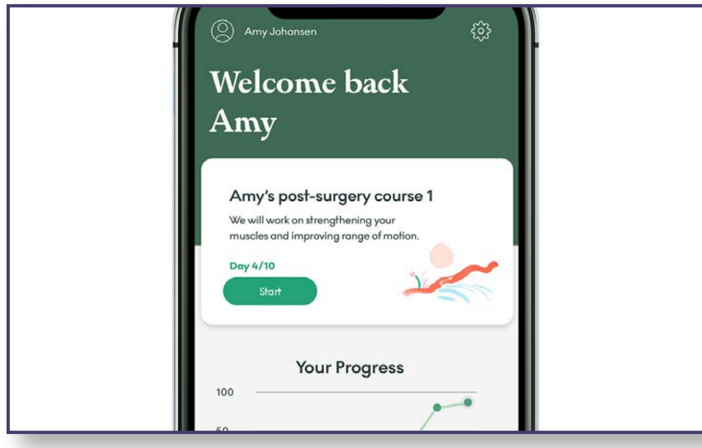
Additionally, PCR technology can help differentiate between different types of fungi (including Terbinafine-resistant strains) and bacteria, ensuring that patients receive the most effective antifungal or antibiotic therapies. This specificity reduces the risk of misdiagnosis and ineffective treatments, which can prolong suffering and lead to chronic conditions. This ensures that patients receive prompt diagnoses and appropriate care, particularly important for those with compromised health, such as geriatric patients with diabetes.

William P. Scherer, DPM, MS, is a Senior Podiatric Medical Advisor at Bako Diagnostics in Delray Beach, Florida. Before joining Bako, he had practiced podiatric medicine and surgery for more than 25 years in Delray Beach.

REDUCING FALLS WITH REMOTE MOTION ANALYSIS

By William Dieter, PT, DPT, GCS, FSOAE

Since we announced our partnership with OneStep in April 2023, FOX Rehabilitation has seen strong results for our residents, with their smartphones turned into clinical-grade motion analysis labs. OneStep's



The OneStep Smartphone interface.

innovative remote care platform has empowered our clinicians to extend patient care beyond in-person visits using remote therapeutic monitoring (RTM), improving clinical outcomes, increasing patient engagement, lowering healthcare costs, and continuing to grow FOX's reputation as a healthcare innovator.

The collaboration has delivered tangible results, including a 45% reduction in fall rates and a 58% improvement in residents' functional capabilities. FOX clinicians' workflows have even improved, with the amount of time spent triaging resident care was cut in half and a 97% success rate for resident RTM billing was achieved.

Recently, this partnership was honored with the Innovator of the Year Award (Silver) at the 2024 McKnight's Tech Awards. We're excited to continue scaling this forward-thinking technology across our senior living communities, building on our commitment to improving and extending the lives of our residents.

William Dieter, PT, DPT, GCS, FSOAE, is Senior Clinical Director at Fox Rehabilitation FOX Rehabilitation, a nationwide geriatric home-care provider, based in Cherry Hill, New Jersey.

ACCESSIBILITY OF TECHNOLOGY FOR REAL WORLD CARE

By Antonio Robustelli, MSc, SCS

The last 15 years have represented an exciting period of innovation in the field of sports medicine and sport science. We have witnessed the

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increased accessibility of advanced technologies that were previously available only in high-grade research-lab environments and top-level clinics and centers.

Practitioners in sports medicine and sport science have been able to gain a deeper understanding of an athlete's health and performance by assessing valuable metrics in real time directly on the field of play: wearables, cloud accessibility, and athlete management systems have completely revolutionized the way practitioners provide athletes with proper care and performance support.

However, from my perspective, the most important and relevant innovation has been related to a mind shift toward the athlete's care and the awareness of the necessity for a multifactorial team that is able to properly manage the complex nature of sports performance.

While wearables and technologies to monitor recovery, sleep, fatigue, and stress levels do represent innovations in and of themselves, to my mind they are the natural result of a more holistic approach to an athlete's performance and health.

Research has highlighted the importance of the interconnection among different elements (ie, physiology, chemistry, biomechanics, environment, behavior, social life, nutrition, etc.) toward the expression of an individual performance blueprint, and practitioners have become progressively accustomed to the complexity of human beings and the need of a comprehensive approach to sports and health phenomena.

Thus, it's the positive mind shift toward a synthesis approach versus a traditional analytical approach that has represented the most impactful innovation in the last 15 years. ler

Antonio Robustelli is a professional sports performance consultant and elite coach from Italy. He is also a member of the LER Editorial Advisory Board and can be reached at Antonio.Robustelli@omni-athlete.com.

TECHNOLOGY ADVANCES IN ENVIRONMENT OF CONTINUOUS QUALITY IMPROVEMENT

By Wade Bader, CPO

The Noodle Classic AFO from Kinetic Research

Technology stems from the inherent human desire to improve on what we already know. As our pool of knowledge grows, new bases are formed that set the stage for the next innovation.

The desire to find better, cheaper, faster solutions transcends every field. People sometimes notice the big changes and reflect on how crude it was before, not always realizing how many steps it took to make that change happen. We remember the monumental achievement of landing a man on the moon in 1969, but that 1 event was the culmination of over 1,000 new technologies brought together to make the mission possible. Thirty-three years later, Space-X was born, and 20 years thereafter, with some failures along the way, they have revolutionized how we work in space. SpaceX didn't invent the rocket, but they made it efficient and reliable. Over the years, the company's expanding understanding and mastery of their work allowed them to address even more complex needs of their customers. SpaceX continues to innovate and expand with the Starlink system that was only made possible through the milestones achieved at SpaceX.

When I relate this to my experience at Kinetic Research, we started in the early 1990s using our knowledge of that time to create composite ankle-foot-orthoses (AFOs). As our understanding and mastery expanded, our ability to address complex deformities expanded. In 2009, we introduced the Noodle AFO, a dynamic, energy-storing AFO that was

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reliable, durable, and efficient. Expanding on the Noodle, in 2015 we introduced the SOTO design, which has at its core a Noodle AFO, but then we integrate a flexible hemi-supramalleolar orthosis (SMO) into the AFO, making it a game changer for medio/lateral control. Could we have skipped the first 20 years and jumped straight to the SOTO? The answer is obviously no. To get where we are today, we needed those years of experience and an environment of continuous quality improvement.

Wade Bader, CPO, is President of Kinetic Research in Tampa, Florida.

WHEN SNEAKERS AND SCIENCE COLLIDE: GAME-CHANGING TECH AT THE 2024 OLYMPICS

By Sarah Clark, MS, ATC

The 2024 Paris Olympics were nothing short of thrilling. Snoop Dogg and Martha Stewart hilariously guided us through the City of Lights with their unique blend of humor and charm. Athletes swam in the Seine, volleyball matches unfolded under the shadow of the Eiffel Tower, and breakdancing made its Olympic debut. The excitement was palpable, both for those in attendance and those watching at home. Reflecting on past Olympics and seeing how technology has evolved across sports is fascinating, but this year, something truly groundbreaking stole the spotlight.

Hellen Obiri, the phenomenal Kenyan distance runner and 2-time Olympic silver medalist, made history—not just with her incredible performance but with her choice of footwear. Hellen sported the Cloudboom Strike LS from On, a sportswear company known for pushing the envelope. But here's the twist: this wasn't your typical sneaker. It was a spray-on shoe! Yes, you read that right. On has developed a revolutionary technology called LightSpray (LS), and it's as fascinating as it sounds. Imagine a robot placing a foot form on its arm, then spraying on the entire upper part of the shoe in 1 continuous filament. The whole process takes just 3 minutes! Fast Company recently highlighted this game-changing technology, and it's set to transform the world of sportswear.

So, what does this mean for athletes like Hellen Obiri? First and foremost, it promises a perfectly customized fit, crucial for comfort and peak performance. The efficiency and precision of the spray-on method could also revolutionize sportswear manufacturing, making it more sustainable by reducing waste and conserving resources.

Hellen's decision to wear the Cloudboom Strike LS at the Olympics

Cloudboom Strike LS

is more than just a fashion statement; it's a bold move that showcases how technology can reshape athletics. She wasn't just running for gold—she was running for innovation, making this a truly historic moment. And what a race it was! Hellen won the bronze medal in the Women's Marathon for Kenya, setting a personal best with a time of 2 hours, 23 minutes, and 10 seconds—just 15 seconds shy of the gold medal! Hellen also secured back-to-back victories at the Boston Marathon (2023 and 2024) and triumphed at the New York Marathon (2023). Impressively, she became the first woman since 1989 to win both the Boston and New York Marathons in the same year. It should be noted that she did wear the spray-on shoe in the 2024 Boston Marathon.

Hellen Obiri's spray-on shoes are a perfect example of how technology can shake things up—not just in sports, but in so many areas, like medicine. When we step outside the box and challenge what's considered normal, we open the door to incredible possibilities that can change the game. Whether it's improving athletic performance or transforming patient care, innovation is the key to progress.

So, let's take a page from On's playbook and start thinking about how we can bring that same forward-thinking mindset into our own fields. How are you disrupting the norm and making an impact? The future is wide open, and it's up to us to shape it. Let's get to work!

Sarah Clark, MS, ATC, is a healthcare consultant who helps independent medical practices transform chaos into calm. With over two decades of experience, she uses her "4 Ps to Success" framework—People, Patients, Paperwork, and Processes—to optimize practice efficiency. As a Fractional Practice Administrator, Sarah provides hands-on support to improve patient care, boost staff morale, and increase profitability. Her workshops and keynotes cover topics from Process Improvement to enhancing patient experience. Ms. Clark's entry is an edited version of a a recent blog post which can be found at sarahclarkconsulting.com.