

# ler

LOWER EXTREMITY REVIEW

October 21 / volume 13 / number 10

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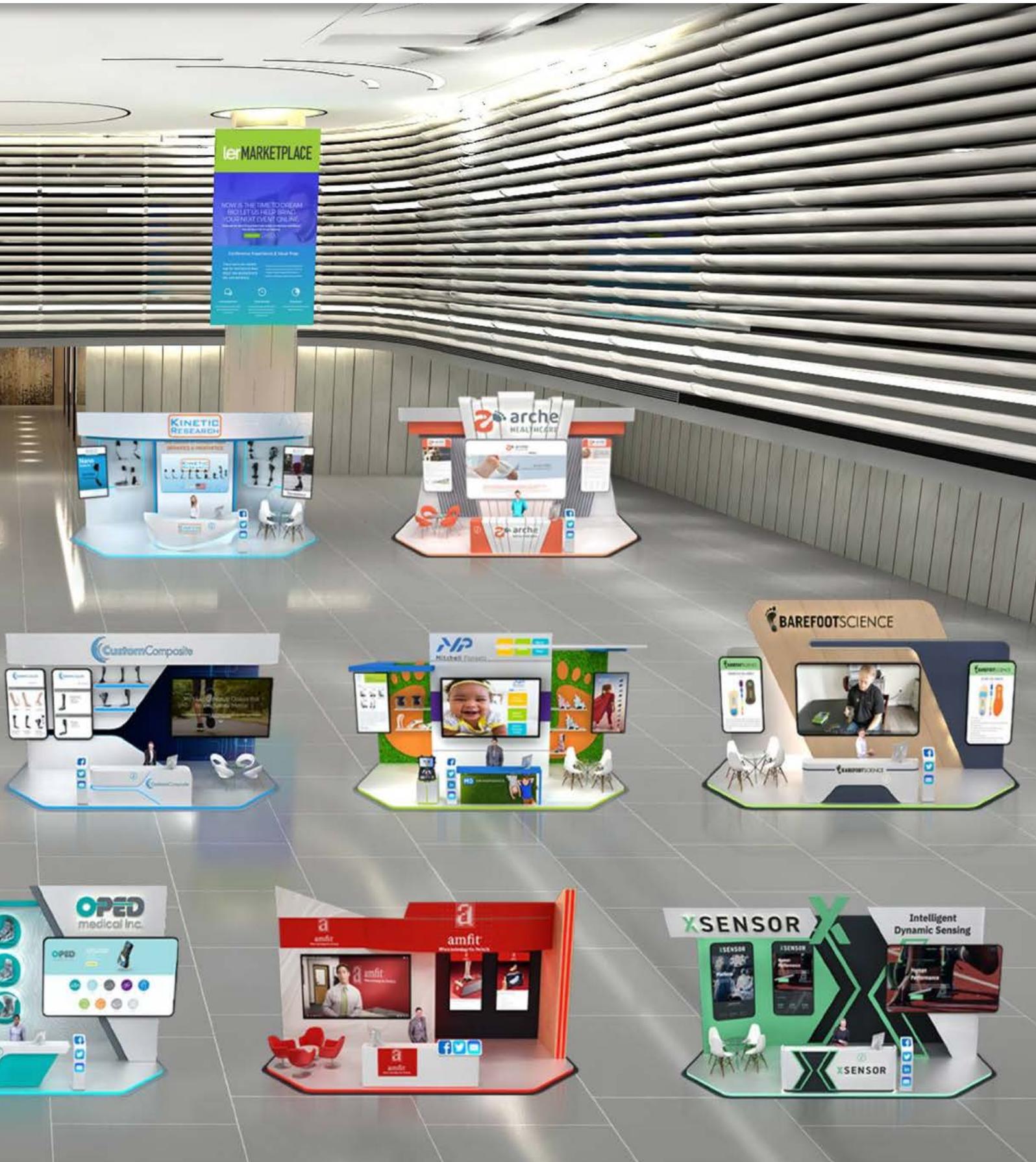
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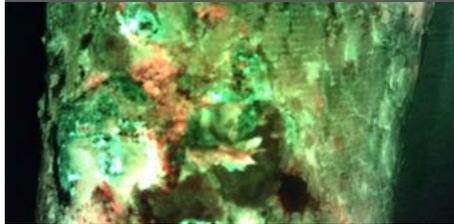
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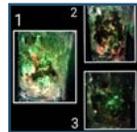
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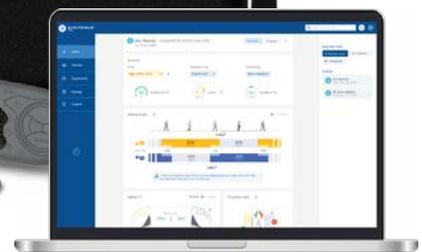


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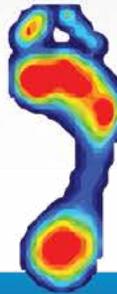


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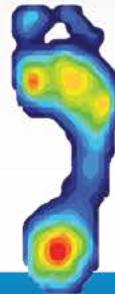
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## Is Weight Loss or Physical Activity More Important for Preventing Type 2 Diabetes?

BY SHERI COLBERG, PHD

Ever since the U.S. Diabetes Prevention Program (DPP) multicenter trial was completed nearly 2 decades ago,<sup>1</sup> we have known that it is possible to prevent, or at least delay, prediabetes (an insulin resistant state) from progressing into full-blown type 2 diabetes. Why? In the study, diabetes risk was reduced by 58% in the “intensive lifestyle” (ILS) participant group and by 31% in the metformin (an oral glucose-lowering medication) participants compared to no intervention (“placebo” group). For participants who were 60 years or older, lifestyle changes worked much better to prevent diabetes than taking metformin.<sup>1,2</sup>

As an exercise physiologist, what I have always disagreed with about the DPP trial is its greater emphasis on weight loss than on physical activity. Admittedly, ILS consisted of a goal of losing 7% of body weight (only 14 pounds if you weigh 200) by following a low-calorie, low-fat, high-fiber diet and doing at least 150 minutes per week of a moderate physical activity (like brisk walking). In a follow-up report,<sup>2</sup> for every kilogram (2.2 pounds) of weight loss, type 2 diabetes risk was reduced by 16%.

However, in the DPP, both a lower percent of calories from fat and increased physical activity predicted weight loss. Typically, it is easier for people to lose some weight than to keep it off afterwards, and that study reported that increased physical activity was critical to maintaining a lower weight. Even among the 495 participants who failed to meet the weight loss goal of 7% loss the first year, those who exercised regularly still had a 44% lower diabetes incidence (without weight loss!), and only the regular exercisers kept the weight off.<sup>2</sup> In my mind, that means that physical activity is likely more important.

For the 10-year DPP Outcomes Study (DPPOS) and the 15-year follow-up, all original DPP participants were offered intensive lifestyle management training.<sup>3,4</sup> During the first 7 years,

diabetes incidence rates decreased by 42% in those who had not been doing ILS or taking metformin previously (DPP placebo group) and by 25% in the DPP metformin participants (who had the option to keep taking metformin); by way of comparison, those in ILS during the DPP increased diabetes rates by 31% during follow-up.<sup>5</sup> That seems like a horrible outcome for the DPP ILS participants who only had to keep up their lifestyle changes.

On further analysis, no combination of changes in weight, physical activity, diet, smoking, and antidepressant or statin use explained the DPPOS lower rates of diabetes progression in placebo and metformin groups, but...weight gain was associated with higher rates in the ILS group. That also seems like a bad outcome. Did these participants stop exercising or become less active during the follow-up study? Statistically speaking, physical activity was not a factor that accounted for their increased diabetes rates, but in practical terms, even small changes in activity can make a big difference in blood glucose and body weight management. It's also important to note that the ILS group still had the overall lowest rates of diabetes incidence at the 15-year mark, even though they rose closer to the other groups.<sup>4</sup>

Although the DPP established combined lifestyle improvements (diet, activity, and weight loss) as the best way to prevent type 2 diabetes, a more recent study attempted to determine how much exercise alone contributes, along with the optimal intensity of exercise since most DPP participants did brisk walking.<sup>6</sup> Three study groups did varying amounts and intensities of exercise while a fourth group followed diet and exercise strategies like the DPP to lose 7% of body weight. Interestingly, a higher amount of moderate-intensity exercise by itself (the equivalent of walking about 13.8 miles weekly) was very effective at improving how well people responded to consuming a large amount of glucose (via an oral



glucose tolerance test) despite a relatively modest 2-kilogram (4.4-pound) loss of body fat, which suggests that a higher amount of moderate-intensity walking may work as well as combined approaches for preventing the progression to type 2 diabetes. It should be noted, however, that only the diet and exercise group experienced a decrease in fasting blood glucose levels in that study.<sup>6</sup>

So, does physical activity matter? I still maintain that it is as important as—if not more important than—losing weight when it comes to preventing diabetes and managing insulin resistance (even if you have type 1 diabetes), especially since most people have trouble keeping the weight off and only regular physical activity is guaranteed to help you do that. Importantly, the latest follow-up study coming from the DPP just confirmed that I (and others) were right all along.<sup>7</sup> In that study, cumulative diabetes incidence remained lower in the lifestyle compared with the placebo and metformin randomized groups and this difference could not be explained by changes in body weight. Examining the self-reported physical activity overall revealed that physical activity was inversely related to diabetes, meaning that the more active people were over time, the less likely they were to develop it, regardless of their body weight. Eureka!

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Losing the right type of weight matters as well (that is, mostly fat and not much muscle), so if your patients are dieting, remind them to include regular activity (particularly resistance exercise) to retain more of insulin-sensitive muscle mass.<sup>8</sup>

*Sheri R. Colberg, PhD, is the author of The Athlete's Guide to Diabetes: Expert Advice for 165 Sports and Activities (the newest edition of Diabetic Athlete's Handbook). She is also the author of Diabetes & Keeping Fit for Dummies, co-published by Wiley and the American Diabetes Association. A professor emerita of exercise science from Old Dominion University and an internationally recognized diabetes motion expert, she is the author of 12 books, 34 book chapters, and over 420 articles. She was honored with the 2016 American Diabetes Association Outstanding Educator in Diabetes Award. Contact her via her websites (SheriColberg.com and DiabetesMotion.com). She is also a member of MedFitNetwork, one of LER's partners.*

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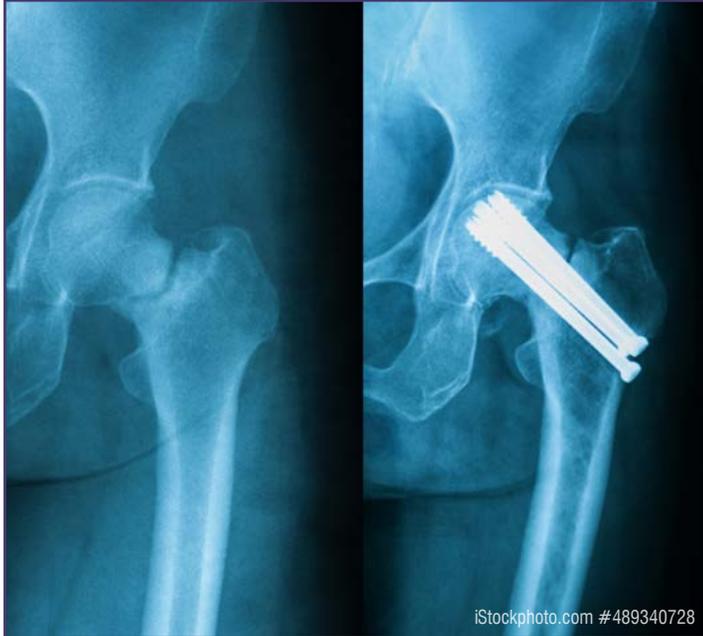
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## RISK OF PROLONGED OPIOID USE IN OLDER PATIENTS AFTER HIP FRACTURE SURGERY



There is a notable risk of prolonged opioid use in older patient populations following musculoskeletal injury according to a new study presented at the 2021 Annual Meeting of the American Academy of Orthopaedic Surgeons. While numerous studies have analyzed opioid dependence in younger patient cohorts, relatively few studies have examined the risk factors and prevalence associated with long-term opioid usage in patients age 60 and older, who, despite their age, remain at risk for opioid dependence.

The retrospective cohort study, “Prolonged Opioid Usage Following Hip Fracture Surgery in Opioid-Naïve Older Patients,” followed 29,618 opioid-naïve patients (not filling an opioid prescription 3 months prior to the hip fracture), age 60 and older, who underwent surgical treatment of a hip fracture between 2009 and 2018. The research team, led by Kanu Okike, MD, MPH, FAAOS, used Kaiser Permanente’s Hip Fracture Registry for the study. Because the registry uses a patient’s electronic medical records, the research team was also able to capture relevant factors such as demographics, preexisting comorbidities, and opioid use before, during, and after surgery.

With these data, the study looked at outpatient opioid use during 3 time periods — 0 to 30 days post-surgery (P1), 31 to 90 days post-surgery (P2), and 91 to 180 days post-surgery (P3) — to analyze prolonged outpatient opioid use, defined as filling one or more opioid prescriptions in all 3 time periods.

“Hip fractures stand alone not only in their frequency among older adults, but because they increase the risk of morbidity and mortality,” said Okike, lead researcher and orthopaedic trauma surgeon at Hawaii Permanente Medical Group in Honolulu. “Given that hip fractures are a severe injury in an already frail patient population, it would be problematic if some patients were also developing opioid dependence following their injury.”

Of patients who remained alive for the entire study, the proportion of outpatient opioid usage was 83.7% (24,776/29,618) in P1, 69% (19,380/28,068) in P2, and 16.7% (4,435/26,481) in P3. Of note, the team found that that 1 in 6 elderly hip fracture patients were still taking opioid pain medications at 3 to 6 months following hip fracture surgery.

Additional findings include:

- Prolonged opioid usage was less commonly observed among patients who were either Asian, had an annual income of \$150,000 or greater, or had undergone regional anesthesia.
- The most common types of opioid prescriptions filled in the 6 months following hip fracture surgery were hydrocodone (53.9%), oxycodone (22.4%), and morphine (6.8%).
- Prolonged opioid usage was more common following fracture fixation and less common following total hip arthroplasty (both in comparison to hemiarthroplasty).

“While most of the concerns and opioid usage research in elderly individuals have centered on short term risks, such as oversedation and delirium, our findings suggest that prolonged opioid usage is an important concern in this older population, just as in the younger trauma populations,” said Okike. “Our hope is that by uncovering more data and continuing to educate patients of all ages, the orthopaedic community will be able to better aid efforts to decrease long-term opioid dependence in their patients.” 

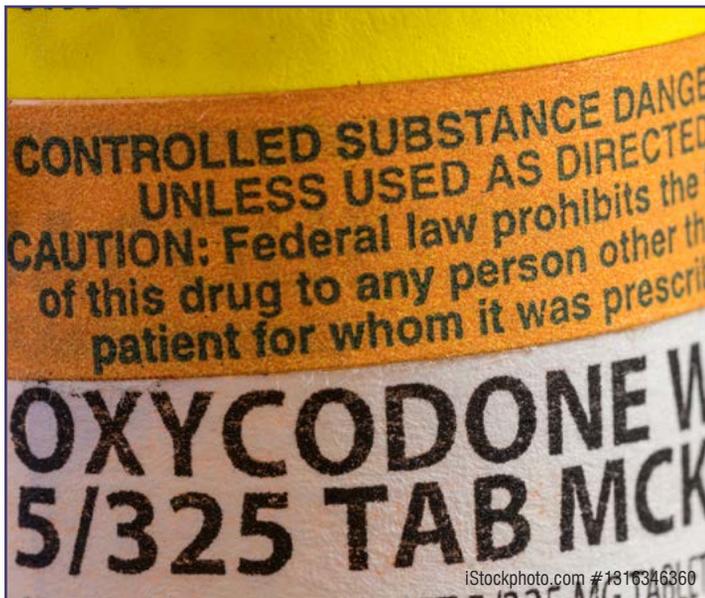
## OPIOIDS OVERPRESCRIBED TO CHILDREN, ADOLESCENTS FOR COMMON ORTHOPAEDIC PROCEDURES

While pain control is an important component of orthopaedic surgery postoperative care, the practice of overprescribing opioid medications has become a contributing factor to the misuse of narcotics in the United States. A new study presented at the 2021 AAOS Annual Meeting analyzed opioid prescribing behaviors for children and adolescents undergoing common orthopaedic surgical procedures and found that patients used significantly less opioids than the quantity prescribed, with 56% of the medication remaining unused in the postoperative period.

*Continued on page 14*

Lead researcher Cliff Willimon, MD, FAAOS, and colleagues conducted the study to describe the average opioid use among adolescents. They looked at 7 common orthopaedic surgeries:

- Posterior spinal fusion for adolescent idiopathic scoliosis
- Epiphysiodesis (guided growth procedure to fix crooked legs or severe bowing)
- Closed reduction and percutaneous pinning of supracondylar humerus fracture (most common elbow fracture in children)
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“We previously conducted a study determining the average time for return to school for children following these surgeries to manage expectations and help families plan for the recovery process,” said Willimon, orthopaedic surgeon and practice director of Children’s Orthopaedics and Sports Medicine at Children’s Healthcare of Atlanta. “Our recent study on opioid use was another way for us to improve outcomes by helping patients and families best understand the amount of opioids needed to control pain.”

A total of 340 patients (172 female, 162 male) completed a medication logbook to track which medications they were taking (prescription and over the counter) and when they took the medicine; and a questionnaire to determine how well their pain was controlled. Patients ranged in age from 5 to 21 with a mean age of 14 years. The patients were prescribed a total of 9,796 tablets and liquid doses of either hydrocodone-acetaminophen 5-325 mg tablets or hydrocodone-acetaminophen 7.5-325 mg/15 mL elixir for postoperative pain control, with an average of 28 tablets or liquid doses per person. The prescription was filled by 98% of patients.

The findings of the study reveal:

- Patients consumed a total of 4,351 tablets or liquid doses of the narcotic medication; however, approximately 5,500 doses (56%) of the prescribed medication remained unused.
- 92% of patients were either very satisfied or satisfied with their pain control.
- 60% of patients reported one or more side effects from the hydrocodone, with the most common being drowsiness and constipation.
- For prescribing habits and consumption by procedure, hip arthroscopy reported 74% unused doses (7 doses consumed, 28 prescribed), followed by epiphysiodesis at 62% (7 doses consumed, 28 prescribed), and knee arthroscopy at 61% (8 doses consumed, 21 prescribed).
- There were no significant differences in the amounts of narcotics consumed between age, sex, or ethnicities.
- Non-steroidal anti-inflammatory drug usage significantly decreased the total number of narcotics consumed by 5.1 tablets and reduced the duration of narcotics use by 1.7 days.

“The results of the study and the information we gleaned from the questionnaire provide great education opportunities for patients, families, and the entire healthcare team,” said Willimon. “For example, some patients thought they needed to finish the entire prescription, similar to an antibiotic, despite the medication not being prescribed or instructed to be taken in that manner. Knowing this helped us improve how we educate patients and families, and based on our data, we can give general recommendations on how many doses patients can expect to need so surgeons can prescribe more accurately. Patients who get off to a good start in their recovery typically have an easier recovery process, so it is important that everyone is on the same page when it comes to pain management.” 

## EFFECTS OF COVID-19 ON YOUTH ATHLETES DIFFERS BY SPORT, AGE

When single sport youth athletes have their routine disrupted, as occurred during the COVID-19 pandemic, they may be at greater risk for depression, demonstrating the need for increased education and research in mental health for adolescent athletes. The results of a new survey, “Sidelined due to COVID-19: Youth Athletes Sleep More, Practice Less, and May Lose Interest in Playing Sports Due to Social Distancing Mandates,” presented at the 2021 AAOS Annual Meeting also found that females who played fewer years of sports were at greater risk for anxiety symptoms during the shutdown. There were a few positive effects of COVID-19 restrictions as well, including increased sleep quality and younger athletes spending more time outdoors.

Approximately 60 million children ages 6 to 18 participate in

Continued on page 16



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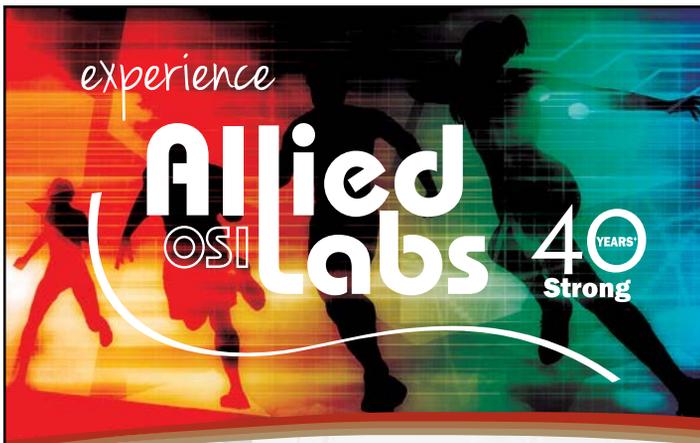
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Continued from page 14

organized sports in the United States. But COVID-19 social distancing guidelines shut down or severely curtailed some sports participation in spring 2020, potentially increasing the risk for anxiety in young athletes.

“Mental health needs to be at the forefront for orthopaedic surgeons, primary care physicians, and any health professionals working with youth athletes,” said Henry B. Ellis, MD, pediatric orthopaedic surgeon and associate director of clinical research – Frisco campus, Scottish Rite for Children in Dallas. “When athletes sustain an injury, they lose their ability to participate in sports. For some of those youth athletes, their identity is wrapped up in being a player for that particular sport (like a soccer player or a dancer). If they are out for a long period of time or



have a sudden change in events, like they did during the pandemic, it can be challenging for them to cope.”

The researchers set out to evaluate how young athletes are affected when their daily sports routine is altered, increasing the understanding of how sports participation impacts physical and mental well-being. Through an anonymous self-reported questionnaire, the survey included 60 questions in 6 areas: demographics; sport participation/training before and during COVID-19; changes in sport-related goals and aspirations; changes in sleep habits; and Patient-Reported Outcomes Measurement System (PROMIS®) Emotional Distress depression and PROMIS® anxiety.

The study targeted athletes ages 6 to 19 across the United States who participated in one or more sport. The data were collected from April 24, 2020, through May 12, 2020, when social distancing measures began to lift. A total of 575 survey responses met the inclusion criteria. The responses were grouped by age (group one, 6 to 9 years old; group two, 10 to 14 years old; group three, 15 to 19 years old) and depression and anxiety scores (none to slight, mild, and moderate/severe).

Most respondents had played sports for multiple years, reporting participation 42.1 weeks per year, and 83.1% were considered high-level

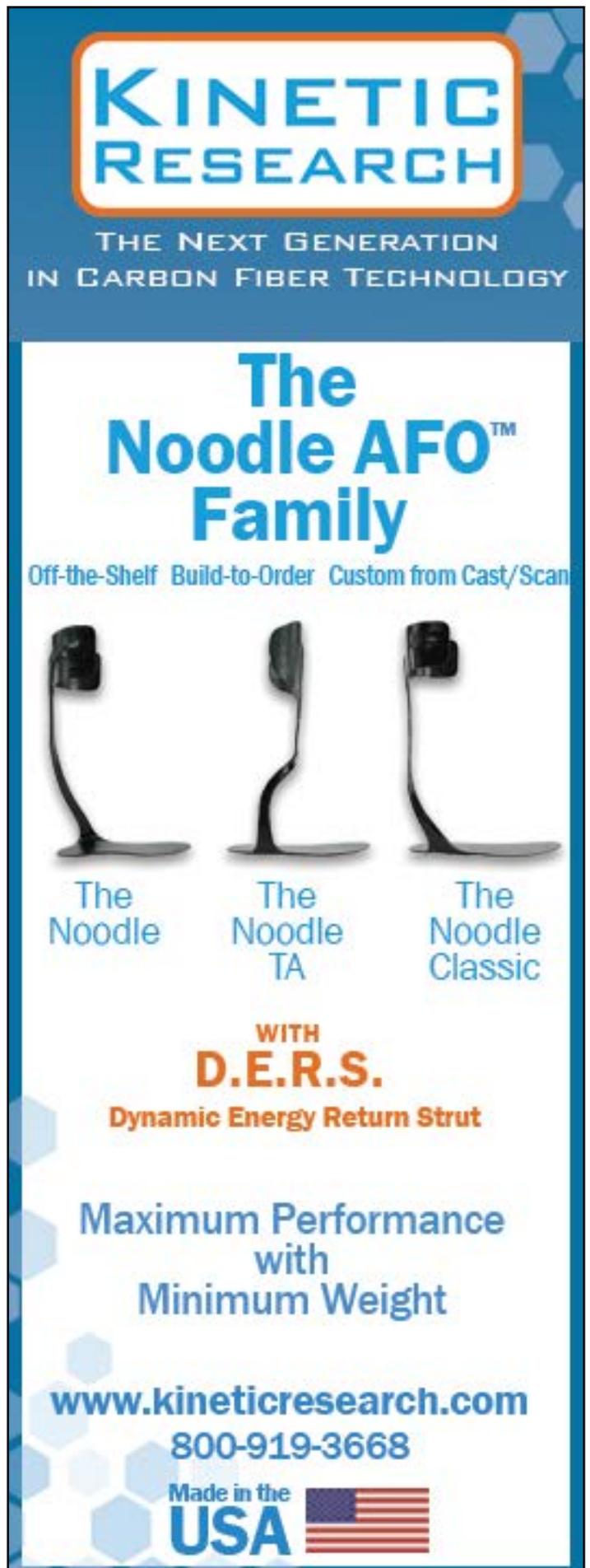
athletes, meaning they competed at a level above recreational or school sports. Of all participants, 61.7% were single sport athletes, with more than 50% of elementary and middle schoolkids playing a single sport, indicating a high rate of early sports specialization. Most experts recommend avoiding sports specialization until at least age 14. (Early sports specialization — playing only 1 sport more than 8 months of the year — can lead to burnout and negative impacts on physical and mental health.)

The survey results revealed:

- Prior to COVID-19, participants trained 9.75 hours per week on average. During the pandemic, training decreased significantly to 6.52 hours per week. Most participants continued to train while social distancing (86.2%) and maintained communication with their sports teams (76%).
- During the pandemic, 47.1% of participants spent more time outside. Groups one and two reported “more” or “a lot more” time spent outside (53.7% and 52.8%, respectively), while the majority of group three (64.6%) spent less or the same amount of time outside.
- The average hours of sleep per night significantly increased overall, from 7.86 hours pre-COVID to 9.12 hours during the pandemic. An increase in sleep was most reported by older athletes.
- Approximately one-fourth of respondents reported elevated depression scores during the pandemic — 28.3% identified as mild, moderate, or severe, while 22.2% reported some degree of anxiety. The analysis showed that elevated depression scores were significantly associated with increasing age, fewer years played, decreased hours of sleep, and sport specialization.
- Regarding goals and aspirations, 13.3% reported a change due to the pandemic, with the majority of those feeling they lost opportunities to compete at a higher level (52.8%) or lost interest in intense training (41.7%). Group three was most likely to report changes in sport-related goals and aspirations.
- Any change in sleep quality, whether worsened or improved during the pandemic, was associated with elevated anxiety scores. Females disproportionately were the largest group of the moderate/severe (73.6%) and mild (60.9%) groups reporting anxiety.

“We were really surprised by how many single sport athletes responded and their increase in depression scores,” said Dr. Ellis. “We had not seen that in our own practice, but we’ve since used these results to implement a stronger look at the mental health of athletes when they have an injury, paying particular attention to single sport athletes. They may not have the adaptability when a disruption keeps them out of sports for a long period of time.”

The survey results also pointed to the need to implement changes to reduce burnout in student athletes. An estimated 70% of kids quit organized sports in middle school, potentially due to intense practices, travel, and the over-emphasis on winning. 



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## FEED YOUR BODY, HEAL YOUR WOUND

BY WINDY COLE, DPM, CWSP, FAPWH



Macronutrients have been shown to play a vital role in wound healing. Proper nutrition is something that every wound care clinician should discuss with their patients. Caloric needs increase during wound healing and it is estimated that patients should consume 30-35kcal/kg daily. Recent reporting details daily recommended values of macronutrients in persons with open wounds as well as provides guidance on commonly available food sources.

### Protein

Protein acts as an essential building block for tissue repair. Dietary protein provides amino acids that are essential in cellular metabolism. The body is in constant need of protein to support new cell growth. Therefore, sufficient protein intake is vital in patients with open wounds. Patients should be encouraged to include a high protein food source at every meal. It has been estimated that patients with wounds should consume roughly 1.2 – 1.5kg of protein per kg body weight daily. Food sources high in protein include eggs, meat, dairy, legumes, nuts, soy, seeds, and tofu.

### Fat

Fats provide vital fuel necessary for wound healing. Dietary fats are broken down to produce ATP to provide energy to support cellular function therefore sparing protein for wound healing. Fat intake also assists in absorption of fat-soluble nutrients such as vitamin A and Omega-6 and Omega-3 fatty acids. Fatty acids are needed to synthesize prostaglandins. Without adequate quantities of two essential fatty Omega-6 fatty

acids, linoleic and arachidonic, prostaglandin synthesis will be negatively affected and decrease the body's ability to mount an immune response to bacteria and other antigens. Common food sources include olive oil, nuts, avocados, peanut butter, peanut oil, salmon, tuna, tofu, and eggs.

### Carbohydrates

Carbohydrates provide an abundant energy source necessary for cellular proliferation, fibroblast migration, and leukocyte activity. Carbohydrates stimulate insulin production needed for anabolic activities during the proliferative phase of wound healing. But carbohydrate intake should be monitored closely in persons with diabetes since increased intake can result in hyperglycemia leading to a reduction in granulocyte function. Food sources high in carbohydrates include whole grains, pasta, brown rice, quinoa, green peas, potatoes, squash, legumes, oats, and beans.

Recognizing nutritional deficiencies in our at-risk patient population can be a simple, yet powerful way to support our patients along their journey to healing. 

*Source: Quain A, Khardori N. Nutrition in Wound Care Management: A Comprehensive Overview. Wounds. 2015;27(12):327-335.*

## ACSM RELEASES CONSENSUS STATEMENT ON ANABOLIC-ANDROGENIC STEROID USE

The American College of Sports Medicine has updated its 1987 consensus statement on the use of anabolic-androgenic steroid (AAS) use, synthesizing more than 30 years of research on the topic.<sup>1</sup> The College acknowledged that lawful and ethical therapeutic use of AAS is a mainstream treatment for several clinical disorders, but also recognized that illicit use by athletes to enhance performance remains antithetical to competitive sport and called the illicit use deplorable.

In a blog<sup>2</sup> accompanying the release, Michele Labotz, MD, one the authors, noted that the average AAS user spends 268 hours – that's nearly 7 full-time work weeks – learning about the products and their effects before ever beginning use. While she acknowledged that the average sports medicine clinician can't come close to this level of knowledge about these products, she did identify 4 basic patterns to understand about AAS:

1. Most AAS users are males who are focused on increased muscle size, not improving athletic performance. "Muscle dysmorphia (aka 'megarexia') is a dominant risk factor for AAS misuse."
2. More than 99% of AAS users inject the drugs and 80% "stack" several different compounds; ancillary drugs to blunt side effects are used by 40%.

Continued on page 20

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- Anabolic-androgenic steroids are Schedule III drugs that place users at risk for physical and psychological dependence, but their increasing clinical use (eg, testosterone therapy for aging men or as part of gender affirming treatment for transgender males) will place more households at greater risk for diversion of these drugs for non-medical uses.
- Long-term data regarding muscle-related effects of AAS is highly variable and needs additional work with reasoned debate about the findings.

Importantly, LaBotz reported that less than 10% of AAS users perceive physicians or pharmacists as knowledgeable about these products and explains how this statement seeks to regain credibility in this topic area. 

The consensus statement is available for free at: [journals.lww.com/acsm-msspe/pages/articleviewer.aspx?year=2021&issue=08000&article=00026&type=Fulltext](https://journals.lww.com/acsm-msspe/pages/articleviewer.aspx?year=2021&issue=08000&article=00026&type=Fulltext)

- Bhasin S, Hatfield DL, Hoffman JR, Kraemer WJ, et al. Anabolic-androgenic steroid use in sports, health, and society. *Med Sci Sports Exerc.* 2021;53(8):1778-1794.
- LaBotz M. Anabolic-androgenic steroid use in sports, health and society | A New Consensus Statement from ACSM. Blog posted Aug. 31, 2021. Available at <https://www.acsm.org/home/featured-blogs---homepage/acsm-blog/2021/08/31/anabolic-androgenic-steroid-use-sports-health-acsm-consensus-statement>. Accessed Oct. 18, 2021.

## AAOS UPDATES CLINICAL PRACTICE GUIDELINE FOR OSTEOARTHRITIS OF THE KNEE



The American Academy of Orthopaedic Surgeons (AAOS) issued an update to the Clinical Practice Guideline (CPG) for Management of Osteoarthritis of the Knee (Non-Arthroplasty), which replaces the 2nd edition released from 2013. This 3rd edition of the CPG provides updates to 19 of the 29 evidence-based recommendations included in the previous guideline. The guidelines were developed to include only treatments which are less invasive than knee replacement surgery to provide pain relief and improve the patient's functioning.

Continued on page 22



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Approximately 33 million Americans are affected by osteoarthritis (OA), a common condition that occurs when the cartilage that cushions and protects the ends of the bones gradually wears away. OA, also known as “wear and tear” arthritis can affect any joint in the body but is prevalent in the knee and commonly occurs in people who are 50 years of age or older. Knee OA can be a leading cause of physical disability.

“Knee osteoarthritis is a highly prevalent, disabling joint disease commonly associated with aging and obesity,” said Robert Brophy, MD, FAAOS, co-chair of the clinical practice guideline workgroup and member of the AAOS Committee on Evidence-Based Quality and Value. “Considering the rising prevalence of knee osteoarthritis in the U.S. population, the AAOS felt it was important to update the guidelines in terms of the best evidence on how to manage these patients, particularly when they have early stages of the disease. The update represents a substantial investment by the AAOS over nearly 3 years to develop consensus around the latest research and offer recommendations regarding various treatment options for patients with knee osteoarthritis.”

Consistent with the previous edition, the guideline suggests that patients with symptomatic OA of the knee receive one of the following analgesics for pain (unless there are contraindications to this treatment):

- Acetaminophen (not to exceed 3,000 mg per day)
- For short-term pain relief, intra-articular corticosteroids
- Oral anti-inflammatory drugs (NSAIDs)

It does not recommend the following treatments or reports that evidence is inconsistent/limited:

- Custom-made lateral wedge insoles
- Glucosamine and/or chondroitin sulfate or hydrochloride
- Needle lavage (aspiration of the joint with injection of saline) and/or debridement

“We know that treatment for osteoarthritis is not a one-size-fits-all approach, and fortunately there are a number of treatment options for orthopaedic surgeons to consider with their patients to help alleviate pain and increase mobility,” added Brophy. “The updated guideline includes recommendations for patients across the spectrum of disease severity, regarding a variety of nonsurgical treatments based on the current evidence. It is important for both surgeons and patients to remember that these are guiding principles, not prescriptions, on how to care for symptomatic knee osteoarthritis.”

Development of this CPG was a collaborative effort between representatives from the American Association of Hip and Knee Surgeons, The Knee Society, the American Academy of Family Physicians, the American Physical Therapy Association, the Arthroscopy Association of North America, the International Cartilage Repair Society, the American Medical Society for Sports Medicine, and the American Society of Regional Anesthesia and Pain Medicine. 

*The full Clinical Practice Guideline for Management of Osteoarthritis of the Knee (Non-Arthroplasty) is intended for reference by orthopaedic*

surgeons and other physicians, and available through AAOS' OrthoGuidelines website and free mobile app. For more information, visit [aaos.org](http://aaos.org).

## ISOMETRIC EXERCISE DURING IMMOBILIZATION REDUCES RETURN-TO-PLAY TIME AFTER LAS



- Increased side-to-side difference in ankle ROM leads to a longer time to RTP after a lateral ankle sprain.
- Isometric exercise combined with EMS during immobilization increased the total ankle ROM at the time of cast removal.
- Less side-to-side difference after ankle immobilization due to active isometric exercise and EMS intervention led to a shorter time to RTP.

Researchers from Japan reported that immobilization reduces symptoms after lateral ankle sprain (LAS) but may worsen the range of motion (ROM) of the ankle and delay return to play (RTP). They sought to understand the correlation between ankle ROM and time to RTP following immobilization for LAS and studied whether isometric exercise during immobilization would increase ROM and shorten the time to RTP. Their study looked at 82 patients with acute LAS who were treated by a short-leg cast with or without isometric exercise and electrical muscle stimulation (EMS); intervention group or control group, respectively. The correlation between ankle ROM at cast removal and time to RTP was analyzed. The total and side-to-side ankle ROM and the time to RTP were compared between the two groups. Their results show side-to-side difference in total ankle ROM was significantly correlated with time to RTP ( $r = 0.38, P = 0.02$ ). The intervention reduced the side-to-side difference in total ROM ( $20^\circ$  versus  $31^\circ, P = 0.01$ ) and time to RTP (46 vs 65 days,  $P = 0.01$ ) compared to the control group. They concluded that increased deficiency in ankle ROM led to a longer time to RTP, and that isometric exercise combined with EMS during immobilization increased the total ankle ROM and shortened the time to RTP. 

**Source:** Toyoshima Y, Akagi R, Nabeshima K. Isometric exercise during immobilization reduces the time to return to play after lateral ankle sprain. *Phys Ther Sport*. 2021;52:168-172.



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# Talocrural Joint Laxity and Range-of-Motion Following an Acute Lateral Ankle Sprain

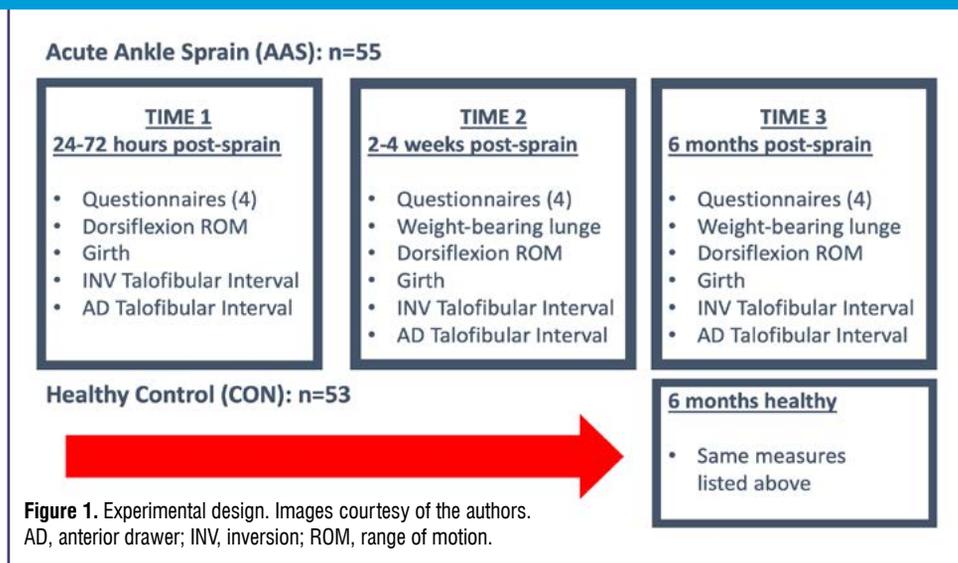
BY BETHANY A. WISTHOFF, PHD, ATC;  
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KAMINSKI, PHD, ATC, FNATA, FACSM

The many articulations of the human ankle joint can be easily disrupted by “a mere sprain.” This research examines 2 specific deficits and their impact in the 6 months after an initial sprain.

Ankle sprains account for a large number of acute sport-related injuries presenting to the emergency department with a cost of over \$1,000 per lateral ankle sprain.<sup>1</sup> The ankle joint is the most common injured body site in an athletic population. The sports with the highest prevalence of ankle sprains have been reported as men’s and women’s basketball, as well as women’s track, women’s soccer, and women’s field hockey. The amount of time to return to full activity has been previously reported with 44% returning less than 24 hours from the injury and only 3.6% requiring more than 21 days before returning to play.<sup>2</sup>

In a general clinic-based population, approximately 72% of patients following an ankle sprain reported residual symptoms 6 to 18 months later.<sup>3</sup> Of those that reported residual symptoms, 40% reported at least one moderate to severe symptom, which included: perceived ankle weakness, perceived ankle instability, pain, and swelling. Factors that were associated with moderate to severe symptoms were re-injury of the ankle, activity restriction longer than one week, and limited weight bearing longer than 28 days.<sup>3</sup>

A reduction in dorsiflexion range-of-mo-



tion (DFROM) after an ankle sprain has been identified as a strong injury predictor, leading to a subsequent ankle sprain.<sup>4</sup> Previous research has determined that this deficit may result from an anterior displacement of the talus or loss of posterior talar glide.<sup>5</sup> As deficits in range-of-motion occur after an ankle sprain, deficits in talocrural joint laxity also occur.<sup>6</sup>

Laxity, or the amount of mechanical instability within the joint, has been previously identified as an indicator of subsequent injury to the ankle ligaments.<sup>7</sup> After an initial evaluation of the injury occurs, the clinician will grade the injury (I, II, III) depending upon the severity of the injury and the symptoms presented. Grading, typically, will occur following manual stress tests, such as the anterior drawer test and talar tilt test.<sup>8</sup> Manual stress tests have been shown to be less reliable in determining laxity within the joint, thus making the grading of injury severity less accurate.<sup>9</sup> This can be problematic, since understanding the severity of an ankle sprain plays a significant role in the clinician’s reasoning for specific rehabilitation protocols and time to return-to-play. Therefore, the purpose of recent research—*Identifying range-of-motion deficits and talocrural joint laxity after an acute lateral ankle sprain* published by our group in the *Journal of Athletic Training*—was to compare mechanical laxity of the talocrural joint

and dorsiflexion range-of-motion in an athletic college-aged population over time after an acute ankle sprain.<sup>10</sup>

## Methods

This cross-sectional study recruited 108 volunteers who were divided into 2 groups: those who sustained an acute ankle sprain (AAS= 55) and a control group of those who had had no ankle sprain (CON= 53). Ankle sprain was defined per the International Ankle Consortium endorsed definition: *An acute traumatic injury to the lateral ligament complex of the ankle joint as a result of excessive inversion of the rear foot or a combined plantar flexion and adduction of the foot that usually results in some initial deficits of function and disability.*

Ankle laxity and ROM were assessed for the AAS group at 24–72 hours, 2–4 weeks, and 6-months post-ankle sprain (see Figure 1 for details). The CON group was assessed in all outcome measures once to compare to the AAS group. Within the AAS group, 44 of the 55 (80%) were Division I or II competitive athletes that received initial treatment within 24–72 hours and progressive rehabilitation by a certified athletic trainer (AT). The remaining 20% were recreational non-competitive athletes that received initial evaluation by a physician within 24–72

Continued on page 26

hours but did not have progressive rehabilitation by an AT; however, these athletes still returned to physical activity following the ankle sprain.

## Results

Of those who sustained an acute lateral ankle sprain, 21 of 55 (38%) were Grade I, 27 (49%) were Grade II, and 7 (13%) were Grade III. While DFROM improved over time, a more significant improvement was seen between the first and second visits, with a smaller improvement noted at 6-months. In Grade III ankle sprains, DFROM was more severely compromised compared to Grade I within the first 24–72 hours. Laxity using an inversion length measurement (Figure 2) showed a significant difference between 2–4 weeks and 6 months. Laxity improved in inversion at 2–4 weeks; however, when compared with the CON group, an increase in inversion length was noted at 6-months post-sprain. Similar differences were noted in anterior drawer direction as well. As sprain severity increased from I to III, inversion length increased sequentially as well. The largest differences between the severity groups were seen at 24–72 hours post-sprain.

The weight-bearing lunge test (WBLT; Figure 3) was not conducted at 24–72 hours. At 2–4 weeks, the WBLT results in degrees approached differences by severity, yet the centimeter measure did not differ. Conversely, at 6 months, the WBLT result in centimeters approached differences by severity, yet the result in degrees did not differ.

## Discussion

The long-term effects of an acute lateral ankle sprain on ankle joint laxity and ankle joint function have not been previously identified in a college-age population compared to a healthy uninjured cohort. This study sought to compare mechanical laxity of the talocrural joint in this population over time after an acute ankle sprain. The primary findings showed that, at 6 months following an acute ankle sprain, significant differences in laxity do exist when compared to a healthy control group.

Previous research is limited on the differences observed in the WBLT and DFROM results



Figure 3. Weight-Bearing Lunge Test (WBLT)

across severity of ankle sprain.<sup>11</sup> As DFROM improves over time in those with an AAS, it may be important to consider the difference between the injured and uninjured limb as well over time. In a Grade II or III ankle sprain, the structure of the anterior talofibular ligament (ATFL) has been disrupted and during the remodeling phase, scar tissue is built up around the repairing ligament.<sup>12</sup> This scar tissue is less mobile than an intact ligament. Previous work concluded that this may cause a shift in the position of the talus such that it may sit more anteriorly, causing a decrease in DFROM of the ankle.<sup>5</sup> We postulate this to be the reason for a decrease in the WBLT found in those with a Grade II or III ankle sprain. The WBLT measures DFROM in a weight-bearing position and has previously been accepted as a reliable method of measuring DFROM over a goniometric measurement in a non-weight-

bearing position.<sup>13</sup> We contend that the WBLT is important to utilize and monitor in those who sustain a Grade II or III ankle sprain to make sure differences do not exist over time.

Similar to previous research, in the present study, talofibular interval (difference of the stressed to static position on the ultrasound image) significantly reduced from 24–72 hours to 2–4 weeks following the injury. However, the interval at 6 months was closer to 24–72 hours post-sprain, meaning that the improvement of the stability of the ankle joint may not sustain to 6 months or longer. This previous research, however, did not use a control or healthy group for comparison. They used the opposite, uninvolved ankle for comparison. The time points used also extended the time at baseline which was less than 7 days from injury and up to 6 weeks from the injury. In our study, a 6-month time point was used to determine long-term effects of ankle laxity noted via stress ultrasonography.

The International Ankle Consortium has developed recommendations for clinical assessment of acute lateral ankle sprain injuries, based on expert consensus. The Rehabilitation-Oriented ASsessment (ROAST) includes assessment of the patient's ankle in multiple areas: joint pain, magnitude of joint swelling, range-of-motion, arthrokinematics, strength, static and dynamic postural balance, gait, level of physical activity, and self-reported joint function.<sup>14</sup> Along with

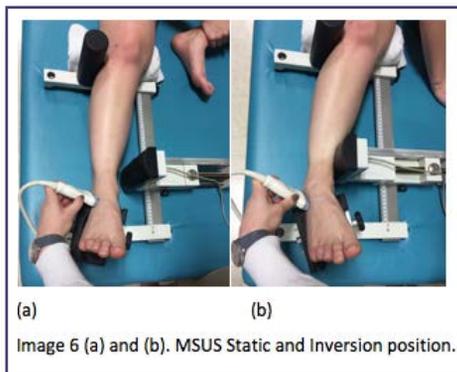


Figure 2. Inversion Talofibular Interval (a) Static position (b) Stressed position.



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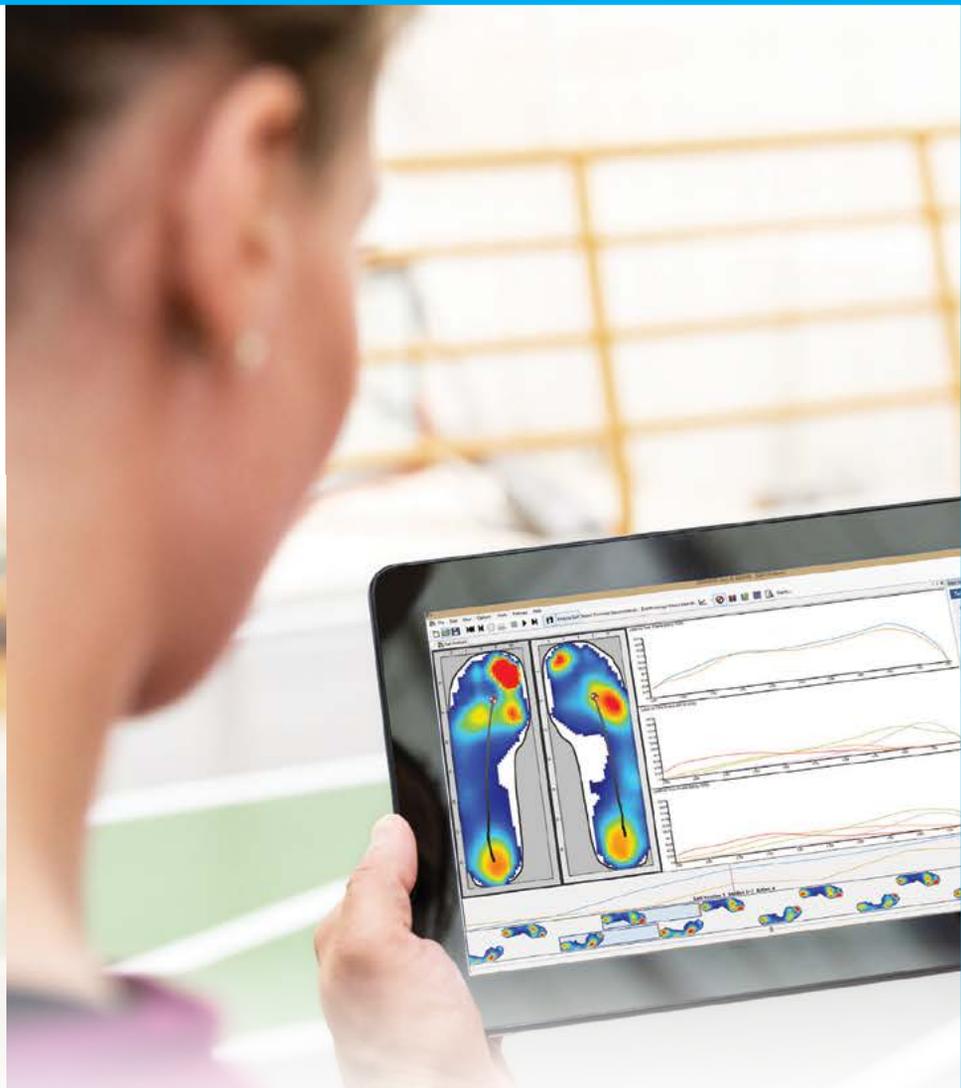


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establishing the mechanism of injury and assessment of ankle joint bones and ligaments through stress tests, clinicians need to be able to incorporate all previous areas into their assessment of acute lateral ankle sprain injuries.

## Conclusions

- Deficits can be noted in those that sustain an AAS at least 6 months following the injury.
- Each sprain may have different impairments that need to be addressed and must be reevaluated after return to full function. Ultimately, in an athletic population, current research is showing that these patients may be returning back to full participation too early, without any follow-up or maintenance rehabilitation, which may lead to incomplete recovery.<sup>15</sup>
- We believe that the use of musculoskeletal ultrasound to obtain subjective information can be important to clinicians early in those with a LAS.
- A significant increase in anterior drawer and inversion/talar tilt was noted between the groups 6 months following an acute ankle sprain.
- Between severity, at 24–72 hours, Grade II and III ankle sprains have greater anterior drawer and inversion ATFL length.
- At 2–4 weeks, Grade II ankle sprains have increased inversion length compared to Grade I ankle sprains. Interestingly, this difference at 2–4 weeks may indicate the long-term effects seen between the severity of ankle sprains. 

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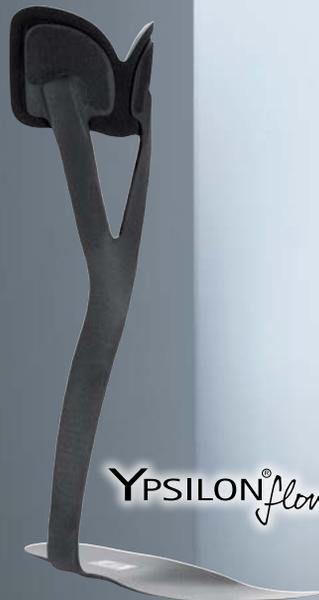
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## WOUND CARE UPDATE

# The Importance of Antimicrobial Stewardship in Wound Care

BY WINDY COLE, DPM, CWSP, FAPWH

Despite advances in wound dressings and best practices, hard-to-heal wounds still remain. Increases in the number of chronic wounds have led to greater antibiotic usage, more hospitalizations, and increased amputations.<sup>1</sup> It is therefore necessary to understand the continuum of wound contamination and effectively address bioburden and biofilm. Practicing good wound hygiene and performing regular wound debridement is a key component in achieving better patient outcomes.

Although all chronic wounds exhibit some level of bioburden, most do not need treatment with oral antibiotics. It has been estimated that 80% of chronic wounds contain biofilm.<sup>1</sup> What exactly is biofilm? Biofilm consists of a colony of tenacious polymicrobial organisms that form on the wound surface. While these biofilm bacteria are senescent and typically encased in an extra polymeric glycoalyx, the number and complexity of the microbes present can increase the risk for infection.<sup>1</sup> The presence of biofilm also contributes to inflammation and wound chronicity.

To support wound healing, biofilm must be removed. Integration of a well-planned and systematic approach to wound hygiene is key. Components of a successful wound hygiene strategy include:<sup>2</sup>

1. Wound Cleansing using antimicrobial washes or surfactants to loosen devitalized tissue, debris, and biofilm.
2. Debridement by means of mechanical, sharp, enzymatic, or biologic methods.
3. Appropriate wound dressings that manage exudate with or without antimicrobial agents.

The hallmark of good wound hygiene is repetition – Every Wound, Every Visit.

### Case Example

Photo 1 shows a baseline fluorescence image of a chronic wound with an abundance of devitalized tissue and surface bacteria present.

Photo 2 is the same wound after cleaning

and debridement. The fluorescent red areas indicate remaining bacterial contamination.

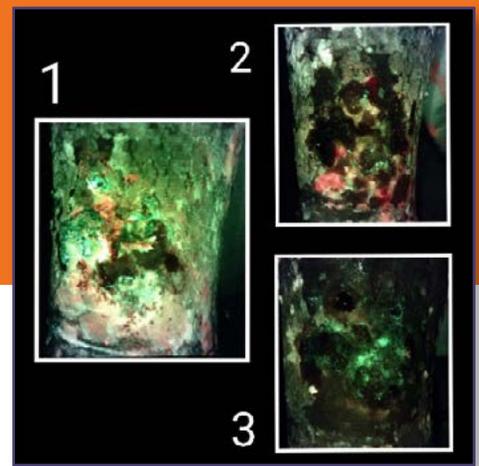
Photo 3 is that same wound after 2 weeks treatment with debridement and collagen matrix containing PHMB. Bacterial contamination has resolved without the use of oral antibiotics. (Polyhexamethylene biguanide [PHMB; polyhexanide] is a broad-spectrum antimicrobial biocide that has been in use for more than 70 years.)

The world is facing a crisis due to the rising rate of bacterial resistance to antimicrobial agents. This resistance is directly related to the increasing utilization of antibiotics.<sup>3</sup> Prior treatments with commonly used antibiotics increases a person's risk for infection, morbidity, length of hospital stay, and overall healthcare costs.<sup>3</sup> It has been estimated that 50% of all antibiotic prescriptions are unnecessary or inappropriate.<sup>3</sup>

Key factors contributing to antimicrobial misuse in patients with wounds include: diagnostic uncertainty, clinical ignorance, clinician fear, and patient demands.<sup>3</sup> Possible solutions consist of incorporating rapid point-of-care testing or imaging to detect bacterial contamination and implementing a dedicated antimicrobial stewardship program along with patient education.

Steps to an antimicrobial stewardship program should include the following:

1. Avoiding antibiotics when not indicated – wound infections should be diagnosed through clinical signs and symptoms. Uninfected wounds should not be treated with systemic antibiotics.
2. Prescribing appropriate antibiotic regimens – use the narrowest spectrum for likely bacteria present initially and then tailor to culture results.
3. Ordering antibiotic therapy for the correct duration – treatment should be just long enough to achieve symptom resolution. Consider switching to topical antimicrobial therapy sooner. Typically, 1–2 weeks for soft tissue infections and 6 weeks for bone infection is



adequate.

4. Always using agents with the least risks and side effects.

Implementing an antimicrobial stewardship program has been associated with a reduction in antimicrobial resistance, better clinical outcomes, and lower costs of care.<sup>3</sup> 

*Windy Cole, DPM, CWSP, FAPWH, serves as Adjunct Professor and Director of Wound Care Research at Kent State University College of Podiatric Medicine and Student Rotation Coordinator, UH Richmond Medical Wound Center, both in Cleveland, Ohio. She is a dedicated healthcare advocate with interests focused on medical education, diabetic foot care, wound care, limb salvage, clinical research, and humanitarian efforts. Dr. Cole has published extensively on these topics and is a sought-after speaker both nationally and internationally. Dr. Cole also serves as a member of the Editorial Advisory Board for LER.*

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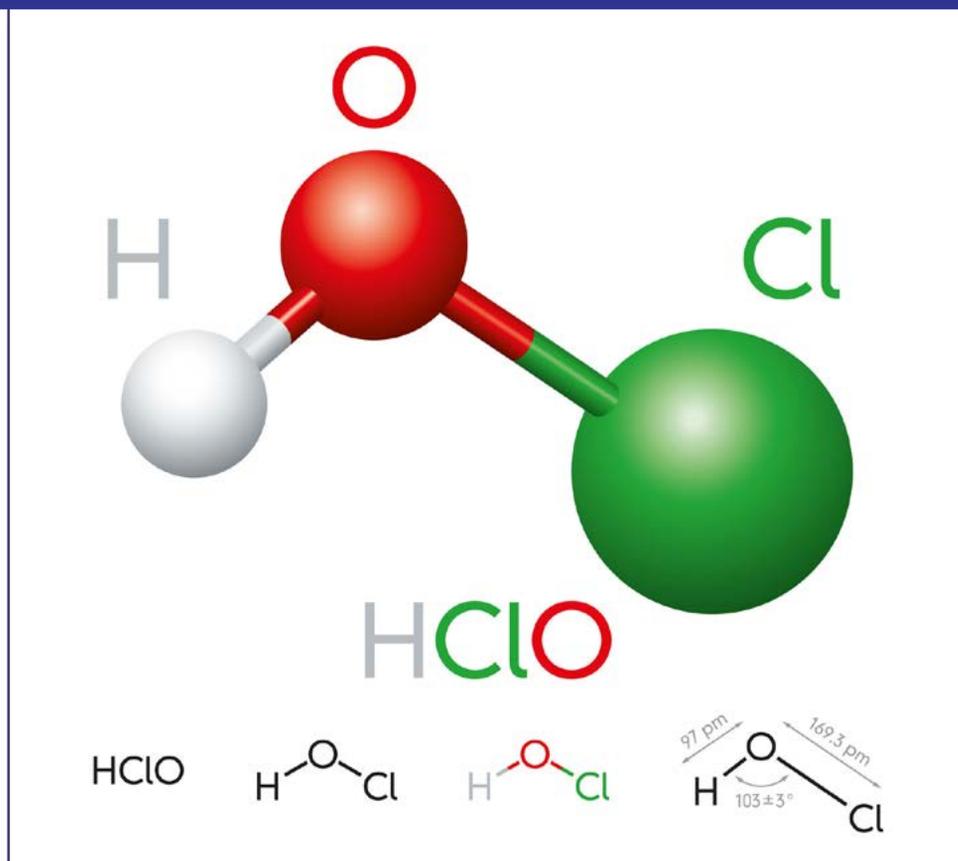
# A Case for Hypochlorous Acid Solution as a Replacement for NSS in Wound Hygiene: A Review

BY JAMES MCGUIRE DPM, LPT, LPED, FAPWHC; MADELINE HOBBS, BA, AND YUNKYUNG JESSICA HO, BA

Given its lack of efficaciousness in decreasing bioburden, normal sterile saline may not be the best solution for this important task.

Chronic hard-to-heal wounds pose a significant burden on both patients and the health care system. Chronic wounds, whether pressure, arterial, venous, or wounds from multiple causes, share certain characteristics, including the presence of biofilms, prolonged inflammation, secondary infection, and delayed healing.<sup>1</sup> Patients with chronic wounds have been shown to have a decreased quality of life due to pain, decreased mobility, and withdrawal from social settings due to the presence of odor or exudate.<sup>2</sup> The economic burden of these wounds accounted for 1% – 3% of total health care expenditure in 2017, with these costs including, but not limited to, increased wound care materials used, increased consumption of analgesics and antibiotics, outpatient therapy costs, and subsequent amputations.<sup>3</sup> Any approach to lessen the psychological and financial burdens of chronic wounds, and decrease wound healing time through the utilization of optimal wound care therapies is welcome.

Normal sterile saline (NSS) cleansing and irrigation have been a staple of wound management for many years. However, a case can be made that NSS is not very efficacious in decreasing wound bioburden or improving healing time, as compared to other wound hygiene solutions.<sup>4</sup> This raises the question of whether it would be advantageous to stop using NSS for chronic wounds all together, and whether



to replace it with a more effective solution. While there are a multitude of commonly used products on the market currently, hypochlorous acid (HOCl) stands out not only for its antimicrobial properties, but for its success in biofilm reduction and its lack of cytotoxicity to healthy tissue.<sup>5-7</sup> This article will review literature discussing the efficacy of NSS versus HOCl in treating wounds, as well as the properties of HOCl that make it an ideal wound hygiene product compared to its competitors, and the differences between various preparations of the solutions.

## Wound Hygiene Today

“Wound hygiene” is a term commonly used by health professionals, but there are various interpretations of what this practice embodies. In its commonly used form, “hygiene” is a standard of maintaining daily routines to keep the body free of unwanted germs. For instance,

we practice oral hygiene by regularly brushing our teeth to prevent gum disease and cavities, and hand hygiene by washing our hands with an antibacterial soap or hand sanitizer to stop the spread of communicable diseases. These repetitive activities are considered necessary to maintain an enhanced healthy life. The standard practice of our personal hygiene is analogous to “wound hygiene” in a clinical setting. To recognize the need for preventative hygiene for wounds before they progress to the chronic stage is essential. Early hygienic intervention prevents progression along the wound infection continuum, preventing species accumulation and biofilm formation, reducing the chance of local or systemic infection, and inhibiting the generation of resistant species.

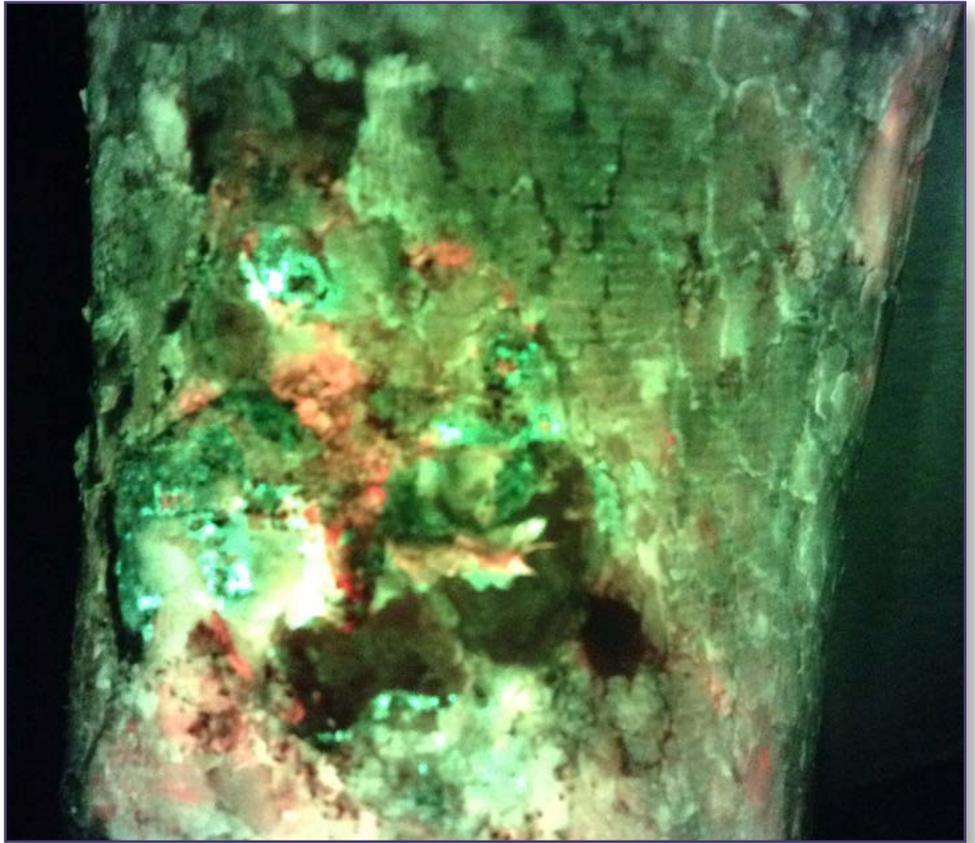
Wound cleansing, along with thorough debridement, is essential for bacterial clearance and is a prerequisite for proper wound healing.<sup>8,9</sup> The use of wound irrigation rapidly

*Continued on page 34*

decontaminates the wound, removes necrotic tissues, enhances effectiveness of other advanced healing modalities, and prevents the accumulation of competing biofilms.<sup>10</sup> The standard for wound hygiene, what is now referred to as biofilm-based wound care, consists of appropriate wound debridement of nonviable or necrotic tissue, foreign debris, bacterial biofilms, and excess exudate to remove barriers to healing and convert the wound from a chronic to an acute wound surface.<sup>11</sup>

Bacteria, whether single or multiple species, produce biofilms to increase their chances of survival. Chronic wound biofilms consist of a polymicrobial community of microorganisms that produce a protective polysaccharide extracellular matrix (ECM) to facilitate inter-organism communication and protect the community from environmental stresses and the host's immune system. Wound debridement and regular hygiene should be performed to remove biofilms that quickly reform within 24 hours after removal.<sup>4,11</sup> Leaving biofilms alone allows them to develop pathogenic characteristics due to horizontal gene transfer within the biofilm.<sup>12</sup> Frequent debridement allows for the natural healing process to continue uninterrupted and hastens wound closure.<sup>8</sup>

It is common practice to cleanse the area to be debrided, rinse the area frequently during debridement, and apply a moist wound dressing upon completion. The solution of choice for most clinics is NSS. In wounds with observable secondary signs of biofilm accumulation, an antimicrobial topical or dressing may be applied to prevent reformation of the biofilm. With the advent of biofilm-based wound care and the renewed concept of wound hygiene, clinicians are using more antimicrobial solutions in their protocols. Choices for these solutions and cleansers are based on microbial effectiveness and lack of tissue toxicity. Solution choices include Dakin's Solution (sodium hypochlorite – NaOCl), polyhexadine/betaine (PHMB), povidone-iodine (PVI), hydrogen peroxide (H<sub>2</sub>O<sub>2</sub>), chlorhexidine, surfactants, and hypochlorous acid (HOCl).



## Saline Efficacy

The use of NSS as the primary cleansing agent in wound care is one of convention and economics, but new information demonstrates not only the clinical advantages, but the cost-effectiveness, of other solutions. Several sources highlight the efficacy of other various products in comparison to NSS for wound hygiene. Lindfors<sup>13</sup> compared the efficacy of NaOCl versus NSS in decreasing bioburden and wound size over 2 months of treatment. After 2 months, wounds treated with NaOCl showed 100% reduction in aerobic bioburden, 86% reduction in anaerobic bioburden, and 33% of the wounds decreased in size. Those treated with NSS showed 33% reduction in aerobic bioburden, 0% reduction in anaerobic bioburden, and 11% of the wounds decreased in size. It is worth noting that 56% of NSS-treated wounds actually increased in size.

Wilkins and Unverdorben<sup>5</sup> reviewed several wound care agents in relation to NSS. They highlighted multiple cases showing the inefficacy of NSS in reducing bioburden

compared to agents such as PHMB and PVI. PHMB proved to be more effective in removing coagulated plasma protein deposits, reducing wound odor, pain, exudate, size, and healing times in comparison to NSS. When healing open wounds, NSS proved inferior to PVI. Assadian et al<sup>14</sup> showed similar results in that hypochlorite/hypochlorous acid, polyhexanide, and PVI solutions showed greater reduction in biofilm burden when compared to 0.9% NSS.

Landmans et al<sup>15</sup> discusses the clinical outcome of wound healing with HOCl alone, HOCl plus levofloxacin, and NSS plus levofloxacin. The outcome showed HOCl alone had the highest percentages of success and improvement with wound healing but was not statistically significant compared to HOCl plus levofloxacin. HOCl plus levofloxacin showed a greater reduction in microbial species compared to HOCl alone. Both treatment modalities with HOCl overall showed higher success, cure rate, and lower microbial species than NSS plus levofloxacin. Overall, the authors state that HOCl is an effective adjunct in treatment of diabetic foot ulcers.

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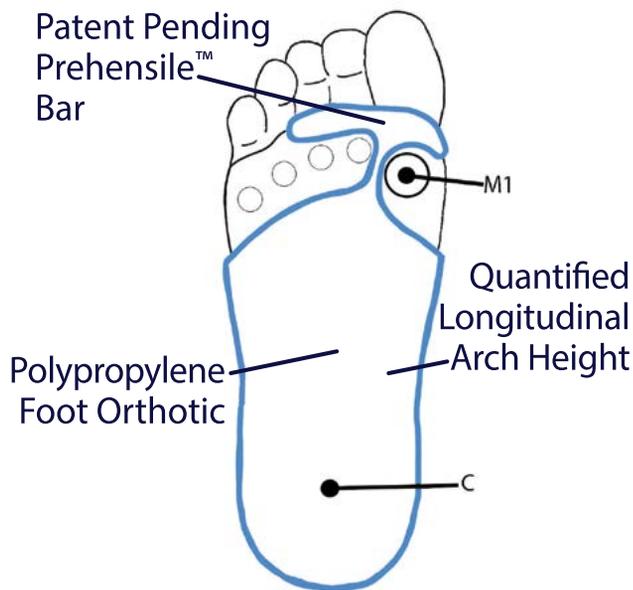
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NSS has not even shown superiority over regular tap water.<sup>16</sup> Data collected on 634 infected wounds that were irrigated with either NSS or tap water showed no significant difference in reduction between the 2 irrigants. Considering these findings, it appears that we would be advised to reevaluate the commonplace use of NSS and that it be replaced with a more efficacious product that is safe and provides greater benefit to the patient.

The efficacy of HOCl has been shown in various settings beyond just diabetic foot ulcers. A literature review by Joachim that compared the use of HOCl versus NSS in various wound care scenarios showed HOCl to be superior in decreasing bacterial burden, odor, pain, local erythema or cellulitis, and reducing hospital stay.<sup>17</sup> In another study, patients treated with HOCl-irrigated wounds had a 25% post-operative closure failure and  $10^2$  bacterial counts, compared to those with NSS-irrigated wounds, who showed 80% post-operative closure failure and  $10^5$  bacterial counts.<sup>18</sup>

Overall, the ideal wound irrigant should not harm local tissue, should not impede the wound healing process and should effectively reduce microbial infection.<sup>4</sup> While HOCl exhibits all of these qualities, NSS exhibits none. Given these characteristics, it is suggested that NSS is not appropriate for wounds that are diagnosed with infection or biofilm formation, or even for wounds at risk of infection.

### Tissue Toxicity

HOCl is an ideal wound hygiene agent due to its minimal tissue toxicity. Based on in vitro studies, HOCl exhibits low risk for collateral damage on healthy tissue as compared to alternative agents.<sup>19</sup> Wang<sup>6</sup> discussed that 0.1% NaOCl has been shown to increase epidermal hyperplasia and inflammatory influx, thus indicating “thermal injury.” Even at doses as low as 0.0025%, NaOCl has been shown to have direct cytotoxicity on wound healing cells such as keratinocytes, fibroblasts, and macrophages, whereas HOCl has not.<sup>7</sup> HOCl also proves to have the strongest antimicrobial activity at safe, low doses in comparison to NaOCl and  $H_2O_2$ .<sup>6</sup> There have also been no proven signs of HOCl systemic toxicity.<sup>6</sup>

It has been argued that the literature regarding cytotoxicity of PVI has been deemed low quality, conflicting, and rendered as weak recommendations.<sup>5,7</sup> This may lead one to believe that PVI may be a safe alternative as a wound hygiene product. Recent literature though has highlighted PVI toxicity to human cells and most clinicians now avoid prolonged application of the solution. In vitro, PVI has been shown to disrupt migration of skin fibroblasts and keratinocytes in a wound healing assay, whereas HOCl encouraged migration.<sup>20</sup> In addition to fibroblasts, PVI has decreased cell survival and migration in human myoblasts and osteoblasts.<sup>21</sup> It also has been noted in several studies that wounds treated with HOCl showed greater reduction in periwound erythema, wound size, healing time, and pain compared to those treated with PVI.<sup>16,22</sup>

PHMB has recently gained acceptance as a wound cleanser. Howev-

er, in higher concentrations it has been shown to be cytotoxic to human cells.<sup>23-25</sup> PHMB was also deemed carcinogenic in 2015 by the Scientific Committee on Consumer Safety (SCCS).<sup>26</sup> It is worth noting though that the SCCS stated lower concentrations of the agent are likely safe, and that additional data was needed regarding PHMB's use outside of cosmetic preservatives.

## Microbiocidal Characteristics

Diabetic foot ulcers (DFUs), pressure ulcers (PU), venous leg ulcers (VLU), and surgical site infections (SSIs) are all general classes of chronic wounds.<sup>12</sup> Utilization of HOCl in wound therapy as a cleansing agent can decrease the rate of bacterial accumulation and hence biofilm formation by killing off microorganisms that are frequently seen in in these polymicrobial wounds. After being cultured, studies have shown that pathogens identified from these chronic wounds include gram-positive cocci, *Staphylococcus aureus* being the most common (25.5%), 8% of which were methicillin-resistant *Staphylococcus aureus* (MRSA) strains. Gram-negative bacteria included 16.3% *Enterococcus* spp., 17.7% *Proteus mirabilis*, 14.3% *Pseudomonas aeruginosa*, and *Escherichia coli* 9.5%.<sup>13</sup> It is estimated that about 60% of DFUs are already infected upon presentation, and that the prevalence of colonization with MRSA is high within diabetic patients due to the incidence of repetitive use of antibiotics.<sup>27,28</sup>

Regular use of antimicrobial cleansers decreases the risk of biofilm formation due to their ability to kill particularly difficult pathogens such as MRSA, as well as vancomycin-resistant *E. faecium* and *Bacillus anthracis* spores.<sup>6</sup> HOCl has shown superior kill time compared to other agents by effectively killing *E. coli*, *P. aeruginosa*, and *S. aureus* in under 1 minute, whereas NaOCl and H<sub>2</sub>O<sub>2</sub> were 5 – 15 and 10 minutes, respectively.<sup>6</sup> In patients with VLUs, debridement with HOCl-soaked cotton gauze at a maximum of every 36 hours showed decreased bioburden and biofilm formation throughout the healing process.<sup>29</sup> In patients with infected DFUs, HOCl application had wounds infection-free after 15 days of treatment when compared to H<sub>2</sub>O<sub>2</sub> and PVI solution. It was noted that HOCl had the ability to kill *Candida*, *Proteus* species, and *Klebsiella* in this 15-day period as well.<sup>21</sup> HOCl overall has been recommended as a primary agent for treatment of DFUs due to its strong capability of controlling and decreasing infection.<sup>18</sup>

HOCl has been highly effective in killing fungal and viral human pathologies, in addition to bacterial challenges.<sup>29</sup> Block et al<sup>30</sup> highlighted HOCl as a strongly recommended choice of disinfectant against the COVID-19 virus, in addition to a wide range of other microorganisms. Studies have shown HOCl inactivating coronaviruses within 1 – 10 minutes depending on the concentration used.<sup>31</sup> HOCl has also been recommended as a fungal prophylaxis agent due its 1 minute, in vitro, 99% kill rate for an array of mold and yeast species.<sup>32</sup>

## Wound Debridement and Healing

HOCl's characteristics allow it to have a direct increase in wound bed

*Continued on page 39*

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healing. Bongiovanni<sup>28</sup> showed that after 15 – 30 seconds of exposure to HOCl, a VLU wound bed would show increased transcutaneous oxygen pressure (T<sub>cp</sub>O<sub>2</sub>), signifying capillary dilation and increased perfusion. A review of several trials utilizing HOCl in ulcers showed overall reduction in size, periwound erythema, pain, and an increase in healthy granulation when compared to various other agents, such as PVI.<sup>10</sup>

The biofilm produced by bacteria impedes wound healing, and thus it is imperative that a successful wound hygiene agent penetrates and eradicates biofilms. It has been shown that prolonged contact time with the wound surface with HOCl increases its effectiveness against biofilms.<sup>33,34</sup> Robson<sup>33</sup> demonstrated the efficacy of HOCl on dismantling *Staphylococcus aureus* biofilm with 70% of biofilm polysaccharide and over 90% of biofilm protein removed after 5, 7, and 10 minutes of contact time of HOCl. The *Staphylococcus aureus* bacteria itself showed a reduction of log<sub>6</sub> CFU/cm<sup>3</sup> (indicating complete biofilm eradication) after 3, 5, 7, and 10 minutes of exposure to HOCl. Similar results were obtained with an HOCl gel solution in the presence of *Pseudomonas aeruginosa* biofilm.<sup>34</sup>

## pH of HOCl

Various companies have produced HOCl with different stability and shelf life which appear to be based on proprietary buffering and maintenance of pH. While past literature recommends a more acidic pH for HOCl, recent research leans toward solutions slightly higher on the pH scale. Studies from 2007 have insisted that the ideal pH for maximal HOCl efficacy lies around 3.5 – 5.0.<sup>6,35</sup> It was even shown that HOCl, when raised to pH of 4.5, started lacking some of its antimicrobial activity.<sup>35</sup> Recent literature, however, states the ideal HOCl pH for bactericidal effects lies between approximately 5.5 – 6.0.<sup>7,36,37</sup> It was also noted that a pH of 5.5 for HOCl is more skin-compatible than other chlorinated competitors, such as Dakin's solution, which is known to irritate the skin with its more alkaline pH (~10.0).<sup>7</sup>

## Cost-Benefit

Hypochlorous acid has also been shown to be a cost-effective wound cleansing alternative. In a study that compared the use of a silver impregnated collagen to the use of hypochlorous on chronic wounds, an 11% reduction in quarterly wound care product cost was seen, along with a 38% reduction in utilization of wound cultures and tests.<sup>38</sup> In another study, a wound care regimen that implemented a 5-minute hypochlorous acid soak prior to treatment resulted in a projected annual 85% reduction in cost of wound care products for infection and debridement. Cost savings, based on the findings of the study, were estimated to be \$87,696 per year.<sup>39</sup> In another study, treating wounds with Santyl™ (Collagenase Santyl, Smith & Nephew, Inc., Fort Worth, TX) alone was compared to wounds cleansed with HOCl and soaked for a short time prior to application before Santyl was applied. A \$1,096 decrease in the amount of Santyl purchased per patient, or \$420 per wound, was observed.<sup>40</sup>

## Conclusion

Wound hygiene is an essential component in the management of chronic wounds and involves much more than simply cleansing a wound with a non-toxic solution. Hygiene is an entire process of wound bed prep including careful debridement of non-viable materials and biofilm from the wound, as well as proper application of a dressing selected to maintain an optimal wound environment, and facilitate wound healing.<sup>41</sup> For many years, NSS has been the solution of choice for this process. After review of the recent literature, it can be said with confidence that utilization of HOCl as a replacement for NSS is of considerable benefit to both the patient and the facilities administering wound care. Stabilized HOCl is a non-toxic, cost-effective wound cleanser with the ability to significantly reduce high tissue bacterial burden on wounds. It has been shown to decrease healing time for chronic wounds such as DFUs, VLUs, and traumatic wounds and be an effective intraoperative irrigant. Aside from its obvious benefits in wound care, the solution has shown

several other considerable uses, including, but not limited to, viral disinfectant, antiseptic hand sanitizer, pruritic eye treatment, and skin graft treatment.<sup>42</sup> An agent with such a versatile application and clinically proven benefits should be considered for all patients and practices, but specifically for the treatment of hard-to-heal wounds. Future research should include randomized, controlled trials of HOCl use, HOCl effect on bacterial colonization and biofilms, and other chronic wound complications. 

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### Disclosures

*James McGuire reports that he serves as a speaker for Smith & Nephew, Imbed, 3-M, Pure & Clean; receives research support for RedDress, Drexel University; receives product support for Reaplix; and serves as a consultant for NueEsse.*

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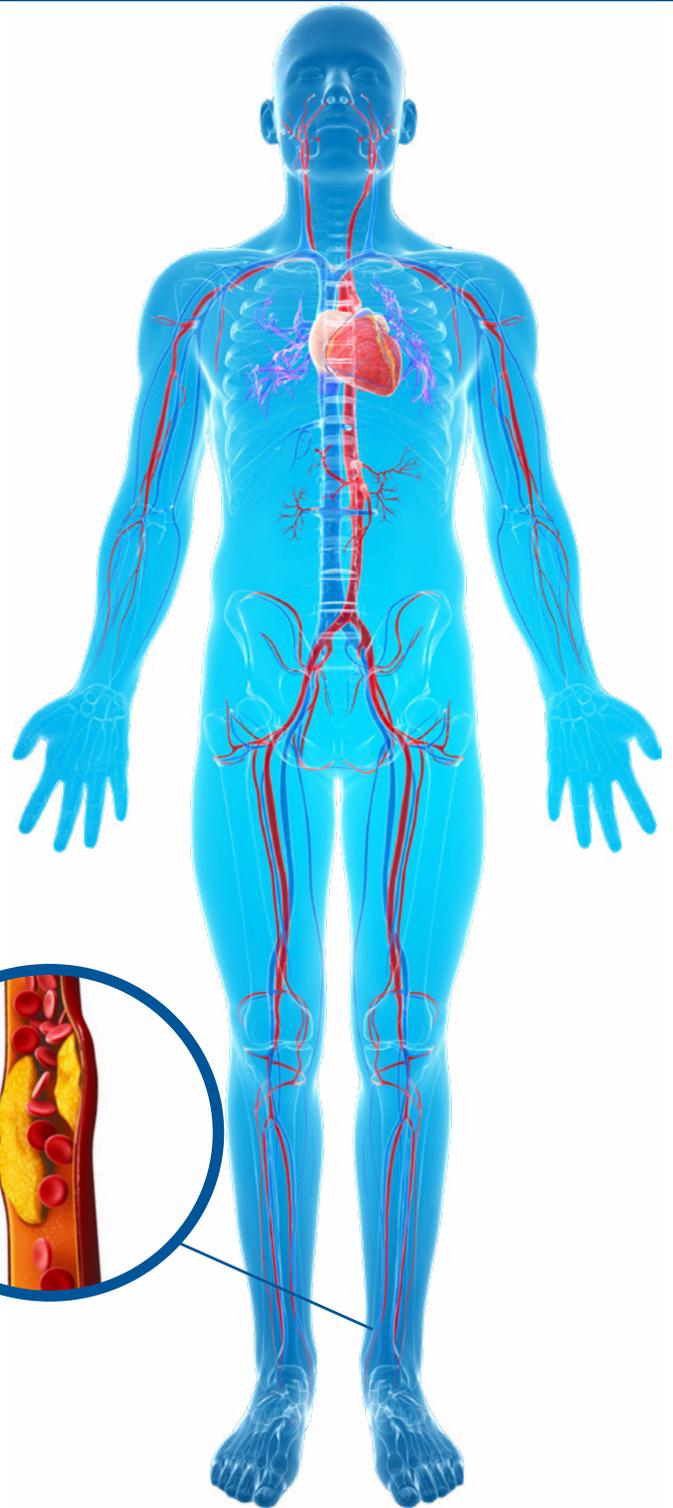
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# Are Static and Dynamic Postural Balance Assessments Two Sides of the Same Coin? A Cross-Sectional Study in the Older Adults

BY ALEX RIZZATO, ANTONIO PAOLI, MARTA ANDRETTA, FRANCESCA VIDORIN, AND GIUSEPPE MARCOLIN

These authors investigate the impact of static and dynamic postural balance assessments and the effects of a cognitive-interference task on balance control performance in older adults.

Postural balance control has been defined as the ability of a subject to maintain the center of pressure (CoP) within the base of support to prevent falling. Traditionally, literature differentiates between static and dynamic balance conditions. The static condition is referred to balance under unperturbed environments such as quiet standing, while the dynamic condition is connected to the ability of the subject to react efficiently to the base of support displacements or to external mechanical stimuli. The CoP displacement, derived from force platforms, is considered the most reliable output for postural balance control assessment under static conditions. Nevertheless, both static and dynamic postural control are crucial for the activities of daily living and are implicated in multiple scenarios of everyday life. Hence, the evaluation of the dynamic postural balance control is necessary besides the static one. Since the interaction of the postural control systems is complex, the assessment of postural



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balance control in a concise and holistic approach is demanding as well. On this point, Ringhof and Stein extended the traditional perspective considering balance as a general ability and reinforced the idea that dynamic balance tests are necessary and not interchangeable.

Consequently, the efficiency of the systems involved in postural balance control (ie, visual, vestibular, and proprioceptive systems) is crucial for people of different ages. Since the mid-seventies, an increased postural sway in the older adults has been recognized, in association with a higher risk of falling. Indeed, more than one-third of persons over 65 falls each year, and in half of such cases, falls are recurrent.

Hageman et al found a larger area of sway in healthy older adults than in a younger group for all the studied conditions: eyes open, eyes closed, and with visual feedback. Similarly, Fernie et al demonstrated a greater sway path velocity in older adults who had fallen once or several times in a year with respect to non-fallers. However, a review by Rubenstein reported that the fall-risk is more tightly associated with dynamic than static conditions. Moreover, Blake et al identified tripping as the most recurrent fall-related event after a community survey on 1,042 individuals age 65 and over. This age-dependent decrease in postural balance control has been interpreted as deterioration of sensory, motor, or cognitive sys-

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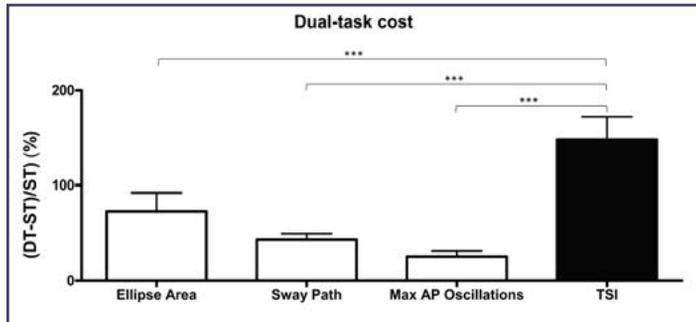
Continued on page 46

**TABLE 1** | Results of the postural balance parameters in the single and dual-task condition.

	Single-task (ST)	Dual-task (DT)
Ellipse area (mm <sup>2</sup> )	135.00 ± 10.65	211.20 ± 23.07 <sup>§</sup>
Sway path (mm/s)	11.70 ± 0.57	16.52 ± 1.07 <sup>§</sup>
AP oscillations (mm)	21.23 ± 0.74	25.86 ± 1.23 <sup>§</sup>
Total stability index	1.37 ± 0.16	3.02 ± 0.34 <sup>§</sup>

<sup>§</sup>Statistically significant ( $p < 0.001$ ).

Data are presented as mean ± standard error of the mean (SEM).

**TABLE 2** | Pearson's correlations among parameters obtained from static postural balance test, dynamic postural balance test, and handgrip strength test.

Single-task	Ellipse area (mm <sup>2</sup> )	Sway path (mm/s)	AP oscillations (mm)	TSI
TSI	$r = 0.169$	$r = 0.135$	$r = 0.202$	
Handgrip strength (kg)	$r = -0.006$	$r = 0.261$	$r = 0.120$	$r = -0.264^*$
Dual-task	Ellipse area (mm <sup>2</sup> )	Sway path (mm/s)	AP oscillations (mm)	TSI
TSI	$r = -0.099$	$r = -0.008$	$r = -0.054$	
Handgrip strength (kg)	$r = -0.074$	$r = 0.198$	$r = 0.050$	$r = -0.302^*$

\*Statistically significant ( $p < 0.05$ ).

TSI, total stability index.

**Figure 1.** Dual-task cost for static and dynamic postural balance parameters. Black histogram represents the dynamic parameter (TSI, total stability index) while white histograms represent static parameters. DT, dual-task condition; ST, single-task condition. Data are presented as mean + standard error of the mean (SEM). \*\*\*Significantly different ( $p < 0.001$ ).

tems. Moreover, the reduced rate of force development in older adults has been associated with a lower capacity for neuromuscular response to control body balance. Older fallers demonstrated a reduced contractile rate of force development than non-fallers. Similarly, Paillard hypothesized a relationship between lower extremity strength and postural performance (ie, the stronger the muscles the better the postural performance), confirming the role of strength on postural balance control. A final aspect to consider is that many falls in older adults occurred when a secondary cognitive or motor task (ie, dual-tasking) was performed. Thus, the use of dual-task (DT) paradigms to predict falls among older adults is encouraged for its superiority over the employment of single-tasks (STs). The secondary task can be manual, discrimination and decision-making, mental tracking, verbal fluency, and working memory. Indeed, during dual-tasking, the 2 tasks reciprocally interfere with the performer's attention overloading the cognitive sources. Therefore, the introduction of a secondary cognitive task over the motor one (ie, postural balance control) may help to understand the cognitive contribution involved in postural regulation both in static and dynamic conditions.

On the relevance of these previous investigations and considering that dynamic postural control has been recognized as important as the static postural control, the first aim of the present cross-sectional study was to investigate whether there was a relationship between static and dynamic postural balance performance in a group of healthy older adults. Moreover, considering the greater exposure to fall-risk of the older adults under dual-tasking condition, our second aim was to study if the addition of a cognitive-demanding task could equally affect static and dynamic postural balance control.

## Materials and Methods

We outlined a cross-sectional design in which two balance conditions, bipedal static (BS) and bipedal dynamic (BD) were tested both in ST and DT modality. Fifty-seven healthy older adults (age =  $73.2 \pm 5.0$  years, height =  $1.66 \pm 0.08$  m, body mass =  $72.8 \pm 13.8$  kg, fall-risk questionnaire score =  $1.37 \pm 1.59$  [score >4 indicates fall risk]) completed the study. Static and dynamic balance were assessed both in single-task and dual-task conditions through a force plate and an oscillating platform. The dominant handgrip strength was also measured with a dynamometer.

Details on the experimental design, data analysis, and statistical analysis can be found in the original publication available at the website noted on page 45.

## Results

Table 1 reports the results of all parameters obtained from both static and dynamic postural balance tests. The results of the correlational analysis are presented in Table 2. In detail, Pearson's correlation revealed non-statistically significant correlations between Total Stability Index and all the static postural parameters (namely, ellipse area, sway path, and maximal AP oscillations). Moreover, Pearson's correlation did not show any significant correlation between the static postural parameters and handgrip strength. On the contrary, a weak though significant negative correlation was found between TSI scores and handgrip strength test both in the ST ( $P < 0.05$ ;  $r = -0.264$ ) and in the DT ( $P < 0.05$ ;  $r = -0.302$ ) condition.

Paired t-tests showed an overall significant worsening of balance performance in the DT condition than in the ST condition, for all the parameters investigated (ellipse area:  $P < 0.001$ , Cohen's  $d = 0.40$ ; sway path:  $P < 0.001$ , Cohen's



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$d = 0.53$ ; maximal AP oscillations:  $P < 0.001$ , Cohen's  $d = 0.42$ ; TSI:  $P < 0.001$ , Cohen's  $d = 0.58$ ) as shown in Table 1. The one-way ANOVA showed statistically significant differences in the DT cost ( $P < 0.001$ ;  $\eta^2 = 0.099$ ) and the post-hoc multiple comparisons (Bonferroni test) showed a significantly higher ( $P < 0.001$ ) DT cost for TSI ( $147.80 \pm 24.55\%$ ) than ellipse area ( $72.93 \pm 19.46\%$ ), sway path ( $43.45 \pm 6.37\%$ ), and maximal AP oscillations ( $25.10 \pm 24.55\%$ ), respectively (Figure 1). Additionally, the number of correct answers given by each participant was significantly lower ( $P < 0.001$ ) in the BD-DT ( $4.03 \pm 2.16$ ) condition compared to the BS-DT ( $5.56 \pm 0.42$ ) condition.

## Discussion

The main purpose of this study was to compare the static and dynamic postural balance control in a group of older adults to understand whether these two conditions were interdependent from each other. Indeed, understanding whether a relationship between static and dynamic postural

balance exists may lead to important practical applications in the assessment of postural balance control among older adults. Our results showed a non-significant correlation between static and dynamic postural balance control in any of the indexes investigated, both in ST and DT conditions. Although static and dynamic postural balance control is ruled by the same structures (ie, cerebral cortex, basal ganglia, cerebellum, brainstem, and spinal cord), their different contribution in the 2 balance conditions could account for the non-significant correlations detected. Our findings are in line with previous research where bipedal quiet stance showed no correlation with proactive (Timed Up & Go test and Functional Reach Test) and reactive (perturbed standing) balance.

Indeed, the human bipedal quiet stance has been modeled as a single inverted pendulum whose pivot is located at the ankle. In this model, the projection of the center of mass falls in front of the ankle, creating a dorsiflexor moment around the ankle, which is continuously coun-

teracted by the stabilizing effect of tonic muscles. This oscillation could be considered as a mostly automatic process of postural control since the subject is largely unaware of the adjustments of postural muscles. Therefore, postural regulation mainly occurs at brainstem-spinal levels with neural circuits tuned by local loops of assistance or self-organized mechanisms due to the unperturbed and extremely predictable context. Conversely, when dynamic tasks are performed, continuous changes in the surrounding environment, acting forces, and sensory inputs happen, leading to a higher involvement of the cognitive process of postural control to achieve goal-directed movements. Thus, a prevalence of the supra-spinal postural strategy is required due to the ongoing regulation of the movement for the adaptation to the new environment.

Our results on the addition of a cognitive-demanding task showed an overall decrease in postural balance performance under DT compared to ST condition, both in the static and dynamic assessment. This is not surprising since

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postural regulation could never be considered as totally automatic. Moreover, older adults exhibit less automatic processing of posture while standing, leading to greater involvement of cognitive resources. Although the presence of a DT helped the subjects to address their attention to an external focus with a theoretical improvement of the balance performance (Masters and Maxwell, 2008), DT condition simultaneously resulted in increasing the complexity of the physiological and behavioral system. Consequently, an increase in information processing occurred, leading to cognitive-motor interference.

The theoretical approaches for explaining this DT interference are 2-fold: the capacity sharing model and the bottleneck model. In the first, it is assumed that people share a finite mental processing capacity among tasks. Thus, for each task that is performed, a section of this capacity is covered. When more than one task is performed, a decline of the performance on both tasks is registered if the total capacity is overcome. In the second model, it is postulated

that when two tasks are performed, they compete for the same processing operation; consequently, a bottleneck occurs, and one or both tasks will be impaired.

Since the two theoretical approaches are not mutually exclusive, they could together account for the greater worsening of postural balance (+147.8%) and cognitive (+38%) performance (ie, less correct answers given) detected under dynamic than static condition (Figure 2). During the dynamic test (Figure 2C), the voluntary control of postural balance required a greater processing capacity than in the static test (Figure 2A). Being the cognitive task of the same difficulty in both the balance conditions (Figures 2B,D), the older adults should have invested a higher mental processing capacity in the dynamic postural task without worsening the cognitive task. However, the performance of the cognitive task decreased as well: supposedly, the processing capacity required to cope with the dynamic test in the DT condition exceeded the overall available capacity. Finally, since the cognitive and

the postural task required the same central mechanism simultaneously, the resulting bottleneck contributed, together with the processing capacity saturation, to the highest worsening of both tasks in the dynamic condition (Figure 2D). Conversely, the bottleneck model could explain alone the worsening of the static postural performance (+25.10%, +43.45%, and +72.93% for ellipse area, sway path, and maximal AP oscillations, respectively). Indeed, the static postural task was less demanding (ie, less capacity required; Figure 2A) and allowed to cover each task without exceeding the total amount of the processing capacity (Figure 2B).

A difference between static and dynamic postural balance control has been detected looking at the handgrip test results. An intriguing significant weak correlation was found between handgrip strength and dynamic postural balance control. This correlation seems to demonstrate that the greater the strength of the older adults, the better the dynamic postural balance performance (ie, lower TSI). Although this relationship

*Continued on page 50*



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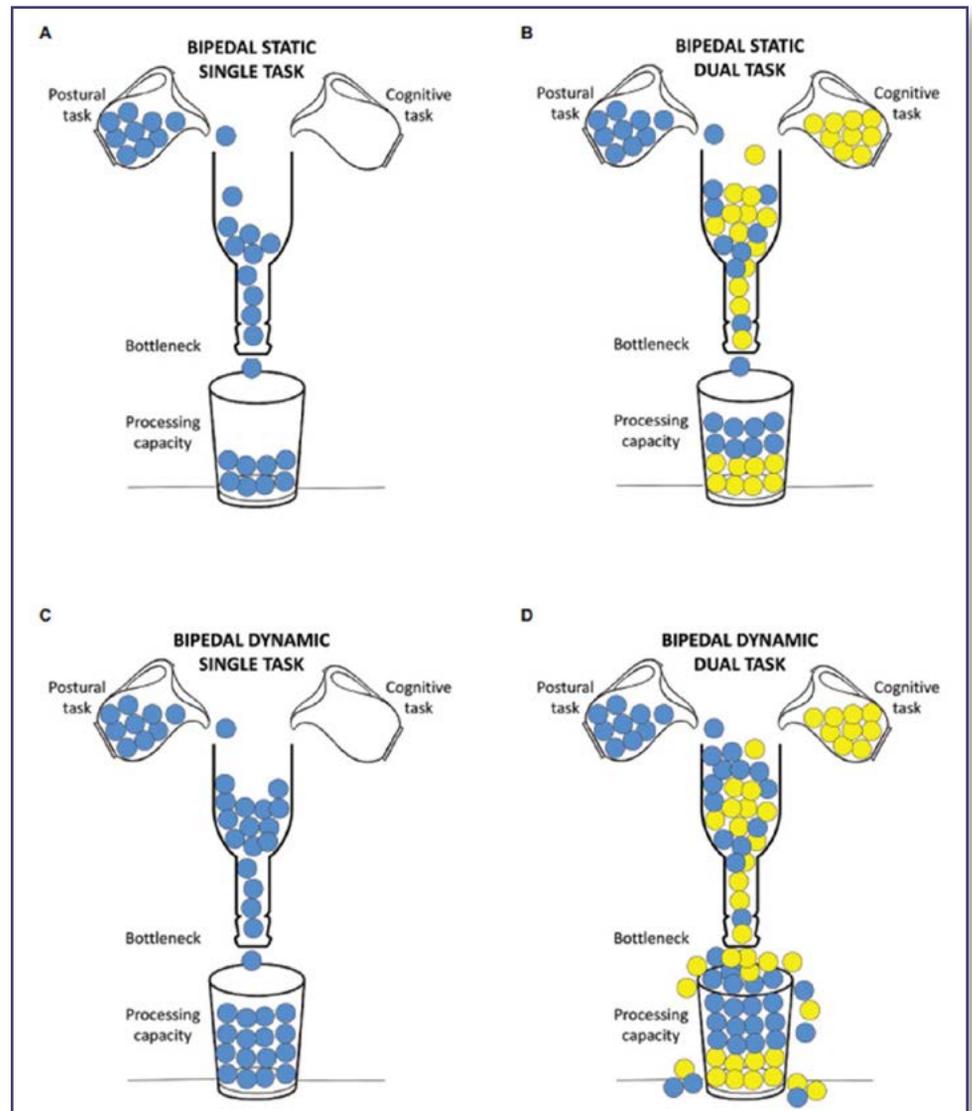


certainly deserves further investigation, our data are in line with the results published in 2014 by Forte et al, who pointed out the interaction between strength and dynamic postural balance. However, although the level of strength has often been related to fall-risk, its relationship with balance performance is still a debated issue in the scientific literature since some authors found no relationship between postural sway and strength or power.

It is relevant to mention some limitations of the present work. Postural balance control is a multifactorial construct in older adults. Although we enrolled a homogeneous group of healthy non-faller older adults thanks to the psychiatric screening, we could not control all the variables that might have affected balance performance, and thus, few of them could have been neglected, confounding some of our findings. Then, although we followed the recommendations of the international society of posturography for the static test standardization, the employment of the same feet position could have been challenging depending on the anthropometric characteristics of each subject. Last, the interpretation of the DT interference on brain structures and thus on balance performance followed a theoretical approach. Further studies measuring brain involvement while performing different balance tasks are warranted to support the interpretation presented in this study.

In conclusion, although the same structures govern static and dynamic postural balance control, the relative contribution of each structure is different in the two balance conditions. The absence of significant correlations supports this consideration, corroborating the assumption that postural balance assessments should include both static and dynamic conditions in older adults. Moreover, concurrently cognitive-interference tasks exacerbated the degradation of postural control performance, especially under dynamic conditions. Therefore, static and dynamic postural control assessments with cognitive tasks are encouraged to give clinicians more accurate indications on postural control for the development of tailored training programs. 

Alex Rizzato is a student in the Human Inspired Technology Research Centre in the De-



**Figure 2.** Capacity sharing and bottleneck model approaches to explain dual-task interference. (A) Inputs from the postural task (blue balls) cover a small part of the whole processing capacity (few balls in the glass) due to the mostly automatic control involved in quiet standing. No bottleneck occurs in this condition. (B) Under the static dual-task condition, a bottleneck results since postural (blue balls) and cognitive (yellow balls) tasks require the same mechanism at the same time. Moreover, the presence of both tasks covers a considerable part of the whole processing capacity (higher number of balls in the glass). (C) The dynamic postural task requires more processing capacity than static postural task (i.e., more blue balls in the glass). No bottleneck occurs in this condition. (D) Under the dynamic dual-task condition, a bottleneck occurs as for (B) and the processing capacity required, exceeds its total amount (the balls overflow the glass).

partment of Biomedical Sciences at the University of Padova in Italy.

Antonio Paoli, MD, BSc, FECSS, FACSM, is Professor and Chair of Sport and Exercise Sciences, Director of the Nutrition & Exercise Physiology Laboratory in the Department of Biomedical Sciences, University of Padova, Italy, and I am also professor and Chair of Strength Training and sport Nutrition at the Catholic University of Murcia (UCAM) in Spain.

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Giuseppe Marcolin, PhD, is Assistant Professor in the Department of Biomedical Sciences, University of Padova, Italy.

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# STRATEGIES TO IMPROVE SLEEP HYGIENE



**Aim for 7-10 hours of sleep per night depending on age and activity level.**

- Make gradual adjustments if trying to increase sleep



**Consider power naps —**

20-30-minute naps have been shown to be the most effective; longer naps may impair your sleep schedule.



**Establish a wind-down routine —**

prioritize a 20-30 minute routine before bed (e.g., reading, taking a hot shower, stretching or other relaxation techniques). It is best to avoid bright lights and screen time 1 hour prior to going to bed as the light can impact your melatonin release, which is important for sleep.



**Establish a consistent sleep schedule —**

go to bed and wake up at the same time every day of the week. For example, go to bed at 10 p.m. and wake up at 6 a.m. regardless of the day of the week. The key is consistency, not the times.



**Optimize your bedroom**

- Power down — make your bedroom technology free
- Make your room a cave — dark, quiet and cool
- Consider a noise machine or fan to decrease outside noises



**Healthy daily habits**

- Get daylight exposure (improves circadian rhythm)
  - Regular exercise improves sleep
- Avoid caffeine after noon
- Avoid/reduce alcohol: Alcohol may allow you to fall asleep easier but it interrupts/fragments sleep later in the night.
- Avoid late, heavy meals



**Consider a formal sleep evaluation for possible sleep disorders (e.g., sleep apnea).**

## THE CMU ATHLETIC TRAINING SLEEP PROGRAM

For additional reading, consult Walsh NP, Halson SL, Sargent C, et al. Sleep and the athlete: narrative review and 2021 expert consensus recommendations. Br J Sports Med 2021; 55:356–368.



# THE IMPORTANCE OF SLEEP FOR THE STUDENT\* ATHLETE

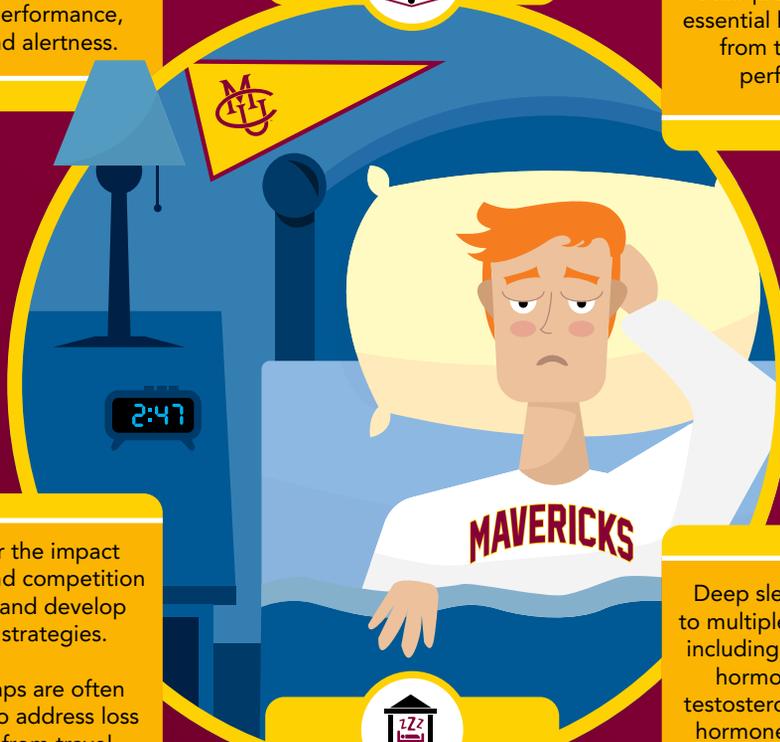


Studies show that 9-12 hours of sleep per/night results in improved athletic performance, mood and alertness.

The lack of sleep impairs cognition, focus, reaction time and balance.



Adequate sleep is an essential key to recovery from training and performance.



Consider the impact of travel and competition on sleep and develop coping strategies.

Power naps are often essential to address loss of sleep from travel, early/late practices, or competition.



**Bank sleep:** Obtaining more sleep, when possible, beyond normal, may improve athletic performance.

Deep sleep is essential to multiple body systems, including brain function, hormones (such as testosterone and growth hormone) and muscle/ bone repair and recovery.



## THE CMU ATHLETIC TRAINING SLEEP PROGRAM

For additional reading, consult Walsh NP, Halson SL, Sargent C, et al. Sleep and the athlete: narrative review and 2021 expert consensus recommendations. Br J Sports Med 2021; 55:356-368.

\* Ages 14-24

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Perfecting the fit of prostheses and orthoses just got significantly easier with the release of the new Click® Reel. Click Medical has developed and engineered this device to empower patients to make micro and macro adjustments—it adjusts both forward and backward—of their devices quickly and easily. The reel uses the newly invented Shift® Technology to quickly wind-up slack lace and then automatically “shift” into a power mode to provide fine-tuned fit. The technology also includes a clutch that delivers the ability to prescribe the optimal fit based on the user's needs, adding safety and convenience. The reel can be tuned by practitioners to repeat tension and prevent over-tightening. And finally, the reel is built with metal components for increased strength, safety, and product longevity, while boasting a 33% lower profile with the transition to metal parts instead of plastic.

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## IMPLANTABLE MAGNETS MAY IMPROVE PROSTHETIC CONTROL

Researchers at the Massachusetts Institute of Technology's (MIT's) Media Lab have developed a new strategy, called magnetomicrometry

(MM), that they believe could improve control of prosthetic limbs. The strategy is based on the idea that if sensors could measure what muscles in the residual limb are doing, those measurements would offer more precise control of a prosthesis. To achieve that, the researchers inserted pairs of magnets into muscles. By measuring how the magnets move relative to one another, the researchers can calculate how much the muscles are contracting and the speed of contraction.



Researchers at MIT's Media Lab have developed a new strategy that could offer more precise control of prosthetic limbs. Image courtesy of the researchers.

Two years ago, Cameron Taylor, an MIT postdoc, and Hugh Herr, PhD, a professor of media arts and sciences and head of the Biomechanics group in the Media Lab, developed an algorithm that greatly reduced the time needed for sensors to determine the positions of small magnets embedded in the body, thus overcoming a major hurdle. They tested their algorithm's ability to track magnets inserted in the calf muscles of turkeys. The magnetic beads they used were 3mm in diameter and were inserted at least 3cm apart. Using an array of magnetic sensors placed on the outside of the legs, the researchers found that they were able to determine the position of the magnets with a precision of 37 microns, as they moved the turkeys' ankle joints. These measurements could be obtained within 3 milliseconds.

For prosthetic control, the magnets would be inserted into the muscle of the residual limbs. The measurements of the magnets could

be fed into a computer model that predicts where the patient's phantom limb would be in space, based on the contractions of the remaining muscle. This strategy would direct the prosthesis to move the way the patient wants it to, matching the mental picture that they have of their limb position.

Within the next few years, the researchers hope to do a small study in human patients with transtibial amputations. They envision that the sensors used to control the prosthetic limbs could be placed on clothing, attached to the surface of the skin, or affixed to the outside of a prosthesis.

### CHI FOOTWEAR GRAPHENE SNEAKERS



CHI Footwear is a podiatrist-approved collection that was developed for hairstylists. This next-generation sneaker protects from a host of foot problems thanks to graphene technology, which is strong, flexible, and hard wearing. In particular, these graphene sneakers and inserts help kill germs by breaking down the cellular walls of bacteria, fungus, yeast, and other types of viruses; prevent odors; provide relief for plantar fasciitis; provide stability and balance; regulate body temperature for optimal comfort and support; reduce muscle fatigue; encourage the wearer to stand and walk properly; provide a healthy option for diabetic footwear; massage the foot while walking, providing energy and good circulation while fighting fatigue; and reduce inflammation and combat other symptoms caused by poor circulation. Available in women's and men's sizes and in a variety of attractive color combinations, this 15-piece

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### A NEW, INEXPENSIVE WAY TO HEAL CHRONIC WOUNDS

A Michigan State University (MSU) researcher is leading an international team of scientists to develop a low-cost, practical biopolymer dressing that helps heal chronic wounds such as diabetic foot ulcers (DFUs).

To develop that new technology, Morteza Mahmoudi, PhD, an assistant professor in the MSU College of Human Medicine and the Precision Health Program, drew on a wealth of experience in developing new materials for biomedical applications. The team started with a flexible framework of natural polymer nanofibers, including collagen. The framework provides a 3D scaffold that fosters cell migration and the development of new blood vessels, essentially replicating the function of the extracellular matrix, the natural support system found in healthy, living tissue.

"It's important that the physical and mechanical properties of the dressing are really close to that of skin," Mahmoudi said. "In order to heal, the new cells have to feel like they're at home."

To that framework, the team can incorporate proteins, peptides, and nanoparticles that not only spur the growth of new cells and blood vessels but also fight off bacteria by encouraging a patient's own immune system to join the charge. The dressing also degrades over time, meaning that nobody would have to change or remove it and potentially aggravate the wound site. And at roughly \$20 each, Mahmoudi believes that the dressings—if and when approved by regulatory agencies—will be affordable to even resource-strapped health-care systems faced with treating these serious wounds.



The transparent wound dressing is shown against a white background (above) and on a simulated wound (below). Photograph courtesy of MSU.

Moreover, preliminary trials show the dressing to be highly effective: Working with his collaborators, Mahmoudi conducted a small pilot trial of the wound dressing with 13 patients with chronic wounds, all of whom were cured, he said.

### O&P ASSISTANT PROGRAM OFFERED IN MI

A new Orthotist and Prosthetist Assistant Studies (OPA) specialization is being offered within the Bachelor of Science in Exercise Science (EXS) degree program in the Department of Human Movement Science at Oakland University, Rochester, MI. This is one of the first OPA programs to be launched in the U.S., and it is expected that this new program will serve as a model for others nationwide.

Combining a unique blend of disciplines (human movement, materials science, and engineering), the 26-credit-hour OPA specialization will prepare students with the skills needed to serve patients in many ways similar to other healthcare providers. A new 18-credit

## NEW & NOTEWORTHY

OPA minor is also available to students in any major across the university. This specialization is a professionally accredited field requiring post-graduate completion of a paid clinical residency. Candidates are eligible to sit for certification examination following the residency (several states also require licensure before allowing independent practice).

“The OPA program is a new program that offers the Health Science student a unique field blending patient care, rehabilitation, engineering elements of materials characteristics and biomechanical design, and so much more,” said Tamara Treanore, CO, founding director and special instructor of OPA.

Oakland University is currently pursuing national accreditation of the OPA specialization through the Commission on Accreditation of Allied Health Education Programs and the National Commission on Orthotic and Prosthetic Education.

## DERMADRY ANTI SWEAT DEVICE



Dermadry is designed to treat hyperhidrosis—otherwise known as excessive sweating. The brand’s medical device uses iontophoresis, a safe, effective, non-invasive, drug-free, and needle-free way to treat excessive sweating. Iontophoresis is a simple at-home treatment, referred to as a tap water iontophoresis, and it works by directing a small current through the skin, effectively neutralizing the connection between the nerves and the sweat glands. Dermadry treats severe sweating of feet, hands, and underarms with up to 6 weeks of dryness. Dermadry is cleared by the US Food & Drug

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## ARIA HOME PT



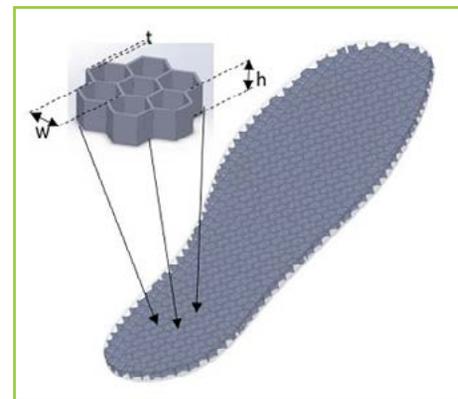
ARIA Home PT features advanced technology that keeps patients actively engaged in their own care and recovery, and care teams fully informed of each patient’s progress. Utilizing a 3D motion tracking technology-based solution for use at a patient’s home, it educates, engages, and guides the patient through their physical therapy (PT) regimen and provides robust data for clinician and physical therapist review including number, duration, and quality of reps on 25 different joints. It further provides the built-in ability for teleconsultation between patients and their clinicians. This interactive experience delivers measurable improvements in patient adherence (35% improvement) and cost reduction—an innovative approach shown to be as safe and effective as traditional physical therapy in a randomized control trial. Further, ARIA Home PT reported decreased readmissions (60%), outpatient visits (86%), home health visits (95%), and urgent care or emergency room visits (30%).

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## RESEARCHERS DEVELOP LOW-COST METHOD TO HELP PREVENT DFUS

Millions of people with diabetes are at risk of developing diabetic foot ulcers (DFUs), which often lead to amputations and other health complications. Now, scientists from the Staffordshire University Centre for Biomechanics and Rehabilitation Technologies (CRBT) in England have developed a new method to reliably detect this risk without the need for complex electronic in-shoe sensors.

“Routine overloading of the sole of the foot during daily activities can trigger the onset of foot ulcers, so being able to identify which areas in the sole of the foot are most affected is extremely important,” said Panagiotis Chatzistergos, PhD, associate professor in Orthopaedic Biomechanics.



Establishing low-cost methods to help prevent foot ulcers will reduce the global socioeconomic burden of diabetes and ultimately save lives. Image courtesy of Staffordshire University.

A common method involves assessing plantar pressure to prescribe special footwear or insoles; however, many clinicians cannot use this because it is expensive and difficult to use. Chatzistergos and colleagues have developed a novel concept to address this problem by using 3D-printed flexible hexagonal thin-wall, tunable structures that will help clinicians better understand the cause of ulcer development and lead to improved patient outcomes.

“We have used a 3D-printed thin-wall structure that changes its properties when repeatedly loaded above or below a tunable

threshold. We believe that this is a step change from current practice,” he said.

Patients would be required to wear the sensor insoles in their everyday footwear for a representative time period, for example a day or a week, before returning them for analysis. During the analysis of the sensor insole, plantar areas that were routinely subjected to higher pressures should be identifiable against those where pressure was below that threshold—the results of which could be potentially used in sensor insoles, as a screening tool for overloading, and to guide the prescription and design of custom-made therapeutic footwear and orthotics.

## RBKNEE KNEE OA ANALYSIS TOOL



Radiobotics has recently launched its knee osteoarthritis (OA) tool, RBknee (FDA-cleared) for the US market. This tool automates the analysis of knee OA x-rays. It provides both a visual overlay indicating the presence of knee OA (including joint space width measurements) on the x-ray as well as a report indicating the presence or lack thereof of knee OA. RBknee can be invaluable for healthcare practitioners as a tool to triage cases in their clinics (ensuring patients see those who can provide maximum impact for their disease) as well as providing visual aids to help patients better understand their condition using their own x-rays.

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## PRIMATRIX DERMAL REPAIR SCAFFOLD



PriMatrix is a unique scaffold for the management of wounds that includes diabetic foot ulcers (DFUs). Derived from fetal bovine dermis, this novel acellular dermal matrix provides an ideal environment to support cellular repopulation and revascularization processes critical in wound healing. PriMatrix is particularly rich in Type III collagen, a collagen found in fetal dermis that is active in developing and healing tissues. Recently published clinical data demonstrates that PriMatrix is an adaptable solution to address the most challenging DFUs in a single application. It also further supports PriMatrix’s clinical and economic value to healthcare professionals who are treating patients.

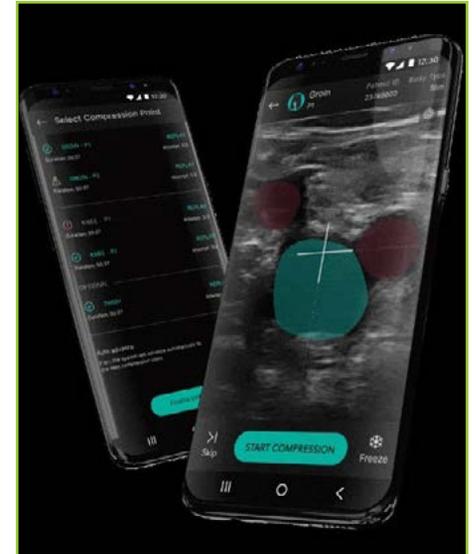
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## AI ALGORITHM TRAINED TO RECOGNIZE DVT

Researchers at Oxford University, Imperial College, and the University of Sheffield collaborated with English tech company ThinkSono to train a machine learning artificial intelligence (AI) algorithm (AutoDVT) to distinguish patients who had deep vein thrombosis (DVT) from those without DVT. The AI algorithm accurately diagnosed DVT when compared to the gold standard ultrasound scan, and the team worked out that using the algorithm could potentially reduce the cost of such examinations.

“Traditionally, DVT diagnoses need a specialist ultrasound scan performed by a trained radiographer, and we have found that the preliminary data using the AI algorithm coupled to a handheld ultrasound machine

shows promising results,” said study lead Nicola Curry, MD FRCP FRCPath, a researcher at Oxford’s Radcliffe Department of Medicine and clinician at Oxford University Hospitals NHS Foundation Trust.



ThinkSono AutoDVT App on a smartphone.

“The AI algorithm can not only be trained to analyze ultrasound images to discriminate the presence versus the absence of a blood clot, it can also direct the ultrasound wand user to the right locations along the femoral vein, so that even a non-specialist user can acquire the right images,” said study team member Christopher Deane from the Oxford Haemophilia and Thrombosis Centre.

The researchers are due to start a test-accuracy blinded clinical study, comparing the accuracy of AutoDVT with standard care to determine the sensitivity for picking up DVT cases.

## RETURN TO TRAINING IN THE COVID-19 ERA : THE PHYSIOLOGICAL EFFECTS OF FACE MASKS DURING EXERCISE

### **RETURN TO TRAINING IN THE COVID-19 ERA**

#### **The physiological effects of face masks during exercise**

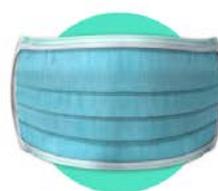
Reference: Epstein et al. SJMSS 2020

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16 participants performed a maximal incremental cycling test



**WITHOUT A MASK**



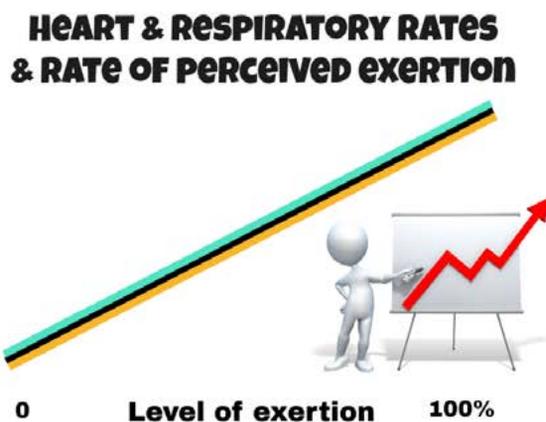
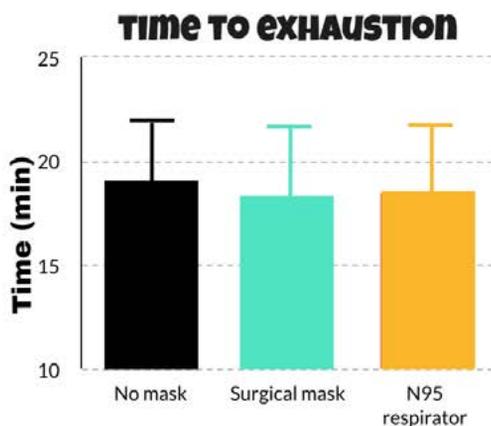
**WITH A SURGICAL MASK**



**WITH AN N95 RESPIRATOR**

## **RESULTS**

Time to exhaustion and the main physiological parameters did not differ substantially



## **IMPLICATION**

In healthy subjects, short-term moderate-strenuous aerobic physical activity with a mask is feasible & safe



Source: <https://ylmssportscience.com/2021/03/10/return-to-training-in-the-covid-19-era-the-physiological-effects-of-face-masks-during-exercise/>

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