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Clinical Commentary/Current Concept Review

# On Putting an End to the Backlash Against Electrophysical Agents

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Electrophysical agents (EPAs) are core therapeutic interventions in academic physical therapy curricula around the world. They are used concomitantly with several other therapeutic interventions such as exercise, manual therapy techniques, medications, and surgery for the management of a wide variety of soft tissue disorders. Over the past decade, the practice of EPAs has been the subject of intense scrutiny in the U.S. This has been colored by some physical therapists publicly engaging in bashing rhetoric that has yet to be officially and publicly addressed by the guiding organizations which, together, regulate the practice of physical therapy in this country. Published in world renowned public media are unsubstantiated mocking remarks against the practice of EPAs and unethical allegations against its stakeholders. This rhetoric suggests that EPA interventions are “magical” treatments and that those practitioners who include them in their plans of care may be committing fraud. Such bashing rhetoric is in striking contradiction to the APTA’s Guide to Physical Therapist Practice 4.0, which lists EPAs as one of its categories of interventions, the CAPTE’s program accreditation policy, and the FSBPT’s national licensing exam. The purpose of this commentary is to expose the extent of this discourse and to call to action the APTA, CAPTE, and FSBPT organizations, as well as physical therapists, with the aim at putting an end to this rhetoric.

## BACKGROUND

The authors read with great interest the recent clinical viewpoint article by Dr. Phil Page entitled *“Making the Case for Modalities: The Need for Critical Thinking in Practice”*.[1] Dr. Page discusses several elements that have contributed to the backlash against therapeutic modalities, also known as physical agents, biophysical agents, and electrophysical agents (EPAs). In this article, we use the term electrophysical agent (EPA) because it best reflects the electrical and physical types or forms of energy delivered by these agents to soft tissues. In making his case, Dr. Page rightfully singles out the conflicting and ironic messages coming from the American Physical Therapy Association (APTA), the Commission on Accreditation in Physical Therapy (CAPTE), and the Federation of State Boards of Physical Therapy (FSBPT) with regard to their official positions or policies towards EPAs in physical therapy in the U.S. The author concludes that it’s time for physical therapists to stop bashing the field of EPAs in social media.

The purpose of this commentary is to expose the extent of this discourse and to call to action the APTA, CAPTE, and FSBPT organizations, as well as physical therapists, with the aim of putting an end to this rhetoric. It is the authors’ conviction that this situation cannot continue because it may unfairly tarnish the reputation of the physical therapy profession and all its stakeholders - defined as clinicians, educators, researchers, third-party payers, manufacturers, distributors, APTA, CAPTE, FSBPT - and undermines the therapeutic value of EPAs in physical therapy practice.

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## HISTORY BEHIND THE RHETORIC

Words matter. They can be uplifting and inspiring. Words, especially in repeated verbal and written instances, can also be devastating and extremely harmful for the recipients. Of all the categories of therapeutic interventions listed in the APTA's Guide to Physical Therapist Practice 4.0,[2] the EPAs category appears to be the only one under the investigative microscope. No other category of interventions, to the best of the authors' knowledge, has been submitted to such intense scrutiny by the APTA, and to such persecution, by some physical therapists, in the public media.

### BACKLASH, BELIEF, PREJUDICE, ALLEGATION, AND STEREOTYPE

The backlash against EPAs is a mixture of beliefs, prejudices, allegations, and stereotypes. How do dictionaries define these words? A backlash is a "*strong and adverse reaction to something*" by a group of individuals, which is precisely the case here. A belief is an "*acceptance that something is true*". It is a personal conviction that has nothing to do with logic, evidence, or fact and, consequently, cannot be tested or disproved rationally. Unlike a belief, prejudice is "*a preconceived or - half-baked - opinion based on insufficient or unexamined evidence*". Prejudices, unlike beliefs, are testable. They can be contested and disproved based on facts. A fact is verifiable, and its validity is determined by researching the evidence. Often individuals form or accept prejudices without testing their truth. Allegations are *"claims or assertions, often made without proof, that someone has done something illegal or wrong".* Finally, a stereotype is a *"widely held but fixed and oversimplified image of a particular type of person or thing".* Together, these constructs provide the foundation for the following examples of derogatory rhetoric toward EPAs.

### ONE: "THERE IS LITTLE TO NO RESEARCH-BASED EVIDENCE"

A first long-held belief and/or prejudice is that there is little to no research-based evidence behind the practice of EPAs.[3] Why should physical therapists use therapeutic interventions for which there is no scientific evidence? It makes perfect sense, doesn't it! However, is it true that there is little to no research-based evidence behind the usage of EPAs? Convinced that it is true, some physical therapists have ridiculed the practice of EPAs in public newspapers. Their take-home message to the journalists was that EPAs are nothing but "voodoo treatments". For example, *"Treat Me, but No Tricks Please",* referring to the use of EPAs, is the title of an article[4] published a few years ago in the influential New York Times (NYT) newspaper. In this article, a physical therapist is quoted to say, "*More common are the voodoo treatments...and what might those be...none other than ice and heat and ultrasound...and laser*". Such a description is both factually incorrect and culturally insensitive. Recently, more physical therapists have continued the mockery, leading another NYT journalist to write an article[5] entitled *"What to Look for in a Physical Therapist: Not all P.T.s are created equal. Find a professional who values evidence over anecdote",* again referring to the "magical" nature of EPAs.

Is there research-based evidence behind the practice of EPAs? The answer is a resounding "yes"! Listed in databases like PubMed and PEDro are tens of thousands of peer-reviewed articles in the field of EPAs, written in the form of randomized controlled trials, systematic reviews, and meta-analyses that clinicians and scientists can consult and use for clinical and research purposes. For example, Bjordal et al,[6] in 2015, reported that there were, in the PEDro database alone, over 3200 randomized controlled EPA trials and that 57% of them were published after 2004. In 2021, Page[1] reported the results of an informal PubMed search in which over 220,000 papers on electrotherapy and ultrasound were found, as opposed to only 160,000 on therapeutic exercises and 26,000 on manual therapy techniques. Research-based evidence can also be found in several academic textbooks dedicated to the field of EPAs.[7-12]

Now, what about the therapeutic efficacy of EPAs? Before answering this important question, one must first keep in mind that the field of EPAs is primarily defined as the extracorporeal application of four types of energy (thermal, mechanical, electrical, and electromagnetic), using a variety of equipment, to human soft tissues for modulating signs and symptoms, as well as promoting tissue healing and body function.[7,8] Secondly, one must take into consideration that EPAs are therapeutic interventions used concomitantly with a broad range of other interventions such as, but not limited to, therapeutic exercises, manual therapy techniques, medications and surgical techniques, to manage a wide array of osteo-musculoskeletal, neurological, dermatological and cardio-respiratory disorders. Seldom are EPAs used as a monotherapy. The use of EPAs, combined with therapeutic exercises and manual therapy techniques, represents the core foundation of physical therapy interventions.

Are EPAs efficacious therapeutic interventions? The answer is "yes". Search results from databases reveal many randomized controlled trials, systematic reviews and meta-analyses demonstrating the efficacy of EPAs for a wide range of body disorders. For example, well-established is the efficacy of transcutaneous electrical nerve stimulation (TENS) for pain,[13-15] neuromuscular electrical stimulation (NMES) for quadriceps function following knee reconstruction,[16-19] low-intensity pulsed ultrasound (LIPUS) for bone fracture repair,[20,21] extracorporeal shockwave therapy for musculoskeletal disorders,[22-26] and electrical stimulation for tissue repair and wound management.[27-30] There is also evidence of therapeutic efficacy for other EPAs, for example, mechanical traction for lumbar disorders,[31,32] thermotherapy/cryotherapy for pain and swelling,[33-35] ultraviolet B therapy for dermatoses,[36-38] and low-level laser therapy (LLLT) for osteoarthritic pain.[39,40]

It is, of course, beyond the scope of this short commentary to list all the thousands of research-based articles related to the field of EPAs, and to critically appraise each of them for therapeutic efficacy. Note that the evidence for efficacy listed above rests, in most cases, on the results of

extensive systematic reviews and meta-analyses. As is the case with the use of manual therapy techniques, therapeutic exercises and medications, EPAs provide short-lasting therapeutic effects (up to a few hours) only and need to be re-applied several times over days and weeks in order to achieve a cumulative effect and therapeutic efficacy. In short, the above sampling of the evidence shows that EPAs are efficacious interventions. For physical therapists to continue to proclaim in public media that there is little to no research-based evidence, and no efficacy, behind the practice of EPAs is preposterous. Now is the time to dispel this message.

### TWO: "THE BODY OF RESEARCH-BASED EVIDENCE IS OF POOR QUALITY"

A second belief and/or prejudice to further bash the field of EPAs is that its body of research-based evidence is of poor scientific quality when compared to other physiotherapy interventions and disciplines and, therefore, not credible enough to establish a scientific foundation behind the field of EPAs. In 2014, Moseley and colleagues[41] investigated the quality of published randomized controlled trials, listed in the PEDro database, between subdisciplines in physiotherapy. Their results showed that the PEDro scores were higher when trial reports were more recent, published in English, and investigated EPAs. Nowhere in the scientific peer-reviewed literature can the authors find articles demonstrating that the quality of research articles in the field of EPAs is lower than that found in other subjects or disciplines in physical therapy. To continue to harbor and spread this message in public media is fallacious and unwarrantedly damaging to the field and its stakeholders. Now is also the time to dismiss such messages.

### THREE: "THE PASSIVE DELIVERY NATURE OF EPAS MAY BE HARMFUL TO PATIENTS'

A third prejudice put forward to single out and undermine the practice of EPAs is that these agents, because passively delivered, may be harmful to patients.[42] This assertion triggered a vigorous rebuttal, in the form of letters to the editor of Physical Therapy, from international stakeholders.[6,43] The main rebuttal argument is that if the passive delivery nature of a therapeutic intervention may be harmful to patients, then what to make, for example, of the practice of manual therapy techniques in physical therapy, and of the usage of medications and surgical techniques in medicine? The relevant factor is delivering the most appropriate and necessary interventions at the proper time during the course of the patient's disorder, regardless of whether these interventions are passively or actively delivered. There is absolutely nothing wrong with the passive delivery of therapeutic interventions per se as long as the treating physical therapist, physician or surgeon provides key instructions to his/her patient as to what to do and not to do at home, and until the next treatment, in order to maximize the therapeutic effectiveness of their passive treatments. However, it is wrong to deliver a therapeutic intervention, regardless of what it may be, without giving a clear set of instructions to patients to follow in order to ensure that he or she will take an active part in the whole therapeutic process. The bottom line is that the question of harm and benefit to the patient has nothing to do with the way a therapeutic intervention is delivered, i.e., passively, or actively, and much to do about the clinician's responsibility to provide proper instructions aimed at maximizing the therapeutic intervention's efficacy received by the patient. To claim that EPAs may be harmful to patients because they are passively delivered is prejudicial and as such must also be dismissed from the conversation.

### FOUR: "PRACTITIONERS OF EPAS MAY BE COMMITTING FRAUD"

Despite the existence of substantial and high-quality research-based evidence behind the field of EPAs, some physical therapists have taken their bashing rhetoric to the next level. The target is no longer the electrophysical agents themselves. The target has expanded to include those tens of thousands of physical therapists and physical therapist assistants who dare to include EPAs in their plans of care. The discourse escalated from belief and prejudice to allegation and stereotype. For example, there is evidence to show that one day after the public release of the APTA's Choosing Wisely list of Five *Things Physical Therapists and Patients Should Question,*[42] the Workgroup Chair for the publication asserted, in an interview published on the reputable U.S. National Public Radio's (NPR) website,[44] "*The evidence for any beneficial effect is nil. When I graduated with my physical therapy degree in 1979, these physical agents were a large part of practice. We've had a hard time getting rid of them. One reason why is that insurers continue to pay for passive physical agents. I know my insurer did*". The Workgroup Chair further commented, "*The continuous passive motion machines were thought to prevent stiff knees in people who had knee replacements, but studies have found that they don't help. It turned out to be a very expensive device that was not adding any quality. But people make money on the machines*".[44] Another physical therapist later commented in the NYT article[5] written by Smith *"There is very little, if any, evidence that ultrasound does anything at all. But PTs are using it, and they are charging for it, and they're getting reimbursed for it – basically for a technique that's not effective. Is that fraud? I don't know".*

## CROSSING THE LINE

By insinuating in renowned and influential public media that physical therapists who include EPAs in their plans of care are committing fraud, without providing irrefutable evidence to support their remarks, have some of our colleagues "crossed the line"? The authors strongly believe that they did. Stereotyping and alleging that physical therapists and other health care professionals who use EPAs are unscrupulous and corrupt individuals is outrageous and unethical. Expressing personal opinions and feelings can be valid and healthy, but not when it unjustly hurts the repu-

tation of others. There is simply no place for such abusive rhetoric.

## CALLS TO ACTION

Stakeholders in the field of EPAs have endured enough mockery and denigration. The authors believe that it is time for action. We share Dr. Page's viewpoint that there is an apparent conflicting and ironic messaging coming from the APTA, CAPTE, and FSBPT organizations regarding the practice of EPAs in the U.S.[1] To the best of the authors' knowledge, the long-standing bashing rhetoric against EPAs remains unanswered by these three professional organizations. Logic dictates that when an official position is under attack (e.g., EPAs are voodoo interventions), it is only reasonable to expect that it be defended. Here is the irony. In remaining silent, it appears that these professional organizations have chosen to ignore the problem or to let the bashing rhetoric continue between physical therapists, and among physical therapists, journalists, and the public. The authors consider that the silence coming from these organizations may be perceived by some physical therapists as support for more abusive and denigrating rhetoric. The public often forges opinions about health professions based on what they read in renowned newspapers and on credible websites. As evidenced above, ignoring the bashing rhetoric against EPAs will not make it go away, nor will it deter others from making similar false and denigrating comments about them in the future.

### CALL TO APTA, CAPTE AND FSBPT

Therefore, the authors call on the APTA, CAPTE, and FSBPT to address the problem by renewing their respective positions and support of EPAs in physical therapy. To list EPAs in the APTA's Guide to Physical Therapist Practice 4.0,[2] mandate all physiotherapy schools to include them in academic curricula (CAPTE),[45] and test students on the topic of EPAs before licensing (FSBPT),[46] conflicts with the resounding silence coming from these professional organizations regarding the long history of bashing against EPAs.

Are there similar adverse reactions from groups of physical therapists, or physical therapy organizations, against the practice of EPAs in other countries around the world? The answer is a definite "no". Just like Canada, Australia and Great Britain, to name only a few, the U.S. (APTA) is a one of the 127-country members of the World Physiotherapy (WP)[47] which advocates for the profession by representing national physiotherapy associations on the world scene. Before admission to WP membership, a national physiotherapy association must meet set criteria. For example, physical therapists from each national association must be able to implement a variety of therapeutic physiotherapy interventions, including integumentary repair and protection techniques, electrotherapeutic modalities, physical agents and mechanical modalities safely and effectively.[48] Moreover, the U.S. (APTA), via its own *Academy of Clinical Electrophysiology & Wound Management (ACEWM)*[49] which includes the *Biophysical Agents* subgroup,[50] is also a member of the WP's *International Society for Electrophysical Agents in Physiotherapy (ISEAP).*[51] As such, the APTA is rightly aligned with the rest of the world as to the inclusion of EPAs in physical therapy (PT) and physical therapy assistant (PTA) academic programs. The problem is not with the official recognition of EPAs in US physiotherapy curricula. The problem is with those members of the APTA who chose to bash EPAs in U.S. public media without any response from the official governing bodies of physical therapy in this country, namely the APTA, CAPTE and FSBPT organizations.

U.S. physical therapists (PTs) and physical therapist assistants (PTAs), as well as the public - our present and future patients - are confused. Should PTs and PTAs continue to include EPAs in their plan of care? Should the public seek therapeutic services from those PTs and PTAs who include EPAs in their plan of care, or those who do not? Also confused are university and college faculty members and academic administrators. Should the teaching of EPAs in the PT/PTA programs in the U.S. be augmented, maintained, diminished, or simply abandoned?[52,53] To let this abusive rhetoric continue without an official rebuttal response from the APTA, CAPTE or FSBPT will simply add to the confusion, and further tarnish not only the reputation of all stakeholders in the field of EPAs but, also, that of the physical therapy profession as a whole, in the public arena.

### CALL TO PHYSICAL THERAPISTS

Fraud, abuse, and waste are, unfortunately, part of the delivery of healthcare services around the world. In the U.S., health insurance fraud cost is estimated today to be approximately $308 billion.[54] The physical therapy profession, like medicine and any other health profession, is no exception. The sad reality is that there will always be unethical health practitioners. What can be done to counter fraud, abuse, and waste in physical therapy?

The authors call on our physical therapist colleagues to stop using newspapers and social media platforms as communication media through which they can expose their grievances against the practice and stakeholders of EPAs. Instead, we strongly recommend that they turn to professional and relevant published resources on the subject. For example, in its document entitled "*Preventing Fraud, Abuse, and Waste: A Primer for Physical Therapists*",[55] the APTA outlines the problems and provides physical therapists with ways to deal with them. The FSBPT, in one of its forum-type articles, entitled "*Fraudulent Billing and the Role of the Jurisdiction Licensing Board,*[56] also provides useful information on how to deal with fraudulent practices. Physical therapists who have solid reasons or facts to suspect fraud, abuse, or waste, not only related to the application of EPAs but also of any other therapeutic interventions listed in the APTA's Guide to Physical Therapist Practice 4.0,[2] have the obligation, under their Code of Ethics,[57] to report their concerns to their respective state licensing boards, not to journalists. One other thing physical therapists could do is read the blog article, published on the WebPT platform, entitled "*So you wanna blow the whistle: How to report fraud and abuse in health-care*".[58] The bottom line is that only

the licensing boards, not physical therapists and journalists, have the statutory authority to address malpractice, fraud, abuse and waste in physical therapy in the U.S.

The authors also call on physical therapists to use common sense and display ethical behavior, when dealing with the topic of EPAs or any other topics in the profession, before interacting with public media. Claiming that EPA interventions are voodoo treatments shows ignorance of the overwhelming body of research evidence behind EPAs. Suggesting that physical therapists who include EPAs in their plan of treatment may be committing fraud is unethical. The authors urge physical therapists to stop making unfounded sensationalistic comments to the public media. They ask them to test their beliefs, prejudices and allegations against the truth before stereotyping the stakeholders in the field of EPAs. There is simply no substitute for using sound judgment and moral principles, regardless of the situation one may wish to comment on.

## CONCLUSION

Stakeholders in the field of EPAs have endured enough invective. The goal of this commentary is to put an end to the backlash of EPAs. Calling on the APTA, CAPTE, and FSBPT to clarify their existing positions on the recognition and practice of EPAs appears to us as one of the best antidotes against further bashing rhetoric. The authors trust that their intervention will calm, and hopefully end, the mocking and denigrating rhetoric behind the usage of EPAs. To call on physical therapists to report their grievances against the inappropriate use of EPAs to their respective state licensing board, as opposed to the public media, is just common sense and the right and ethical thing to do. Freedom of expression is a fundamental right, and everyone is entitled to express his or her own beliefs, prejudices, allegations, and stereotypes, albeit within certain limitations. However, the authors are convinced that it is unwise, unethical, and self-serving to do so without testing them against the facts and without full, unbiased consideration of what such rhetoric might do to the respected, good reputation of other clinicians, like physical therapists, physical therapist assistants, athletic trainers and sports physicians who make regular and evidence-based use of EPAs in their plans of care for the benefit of all their patients, which also include amateur and professional athletes from around the world.[59]

Lastly, and perhaps more importantly, the American public needs to know the truth about the usage of EPAs in physical therapy. They need to know that EPAs, when used based on the best evidence and concomitantly with other therapeutic interventions, are efficacious in that they provide proper symptom management and positively affect soft tissue healing, commonly without side effects, in comparison to medications and surgical techniques, which come with their respective load of potential side effects and severe risks to health. The profession of physical therapy in the U.S. has much to gain by rectifying the abusive rhetoric against the EPAs put forward in renowned public media by some of its members. In doing so, the APTA will exert its leadership by reaffirming its compliance with the World Physiotherapy organization as to the curriculum related to and practice of EPAs, in addition to recognizing all its members who belong to its *ACEWM - Biophysical Agents* subgroup, as well as all those international members who belong to the ISEAP. By putting an end to the bashing of EPAs, the ultimate winners will be the patients and athletes we serve.

## CONFLICT OF INTEREST

Dr. Belanger reports potential conflicts of interest regarding textbooks royalties, consulting fees and payment for expert reports related to the field of EPA. Dr. Selkowitz reports a potential conflict of interest regarding his former role as an international content expert for ElectroPhysical Forum. Dr. Lawson reports a potential conflict of interest regarding his role as Editor of the Journal of Electrophysiology and Wound Management, and as Vice-Chair of the Biophysical Agents Special Interest Group of the APTA.

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# REFERENCES


1. Page P. Making the case for modalities: The need for critical thinking in practice. *Int J Sports Phys Ther*. 2021;16(5). doi:10.26603/001c.28326

2. American Physical Therapy Association (APTA). Guide to Physical Therapist Practice 4.0. Published 2023. https://store.apta.org/guide-to-physical-therapist-practice-3-0.html

3. Chipchase L. Is there a future for electrophysical agents in musculoskeletal physiotherapy? *Man Ther*. 2012;17(4):265-266. doi:10.1016/j.math.2012.04.001

4. Kolata G. Treat Me, but No Tricks Please. New York Times. Published January 6, 2010. https://www.nytimes.com/2010/01/07/health/nutrition/07best.html

5. Smith D. What to look for in a physical therapist: Not all P.T. are created equal. Find a professional who values evidence over anecdote. New York Times. Published July 6, 2021. https://www.nytimes.com/article/physical-therapist-search.html

6. Bjordal JM, Ronzio O, Baxter GD, Sluka KA. Letter to the editor on "The American Physical Therapy Association's top five Choosing Wisely recommendations." *Phys Ther*. 2015;95(2):275-278. doi:10.2522/ptj.2015.95.2.275

7. Belanger AY. *Therapeutic Electrophysical Agents: Evidence Behind Practice*. 3rd ed. Wolters Kluwer; 2014.

8. Belanger AY. *Therapeutic Electrophysical Agents: An Evidenced-Based Handbook*. 4th ed. Wolters Kluwer; 2023.

9. Draper D, Jutte L. *Therapeutic Modalities: The Art and Science*. 3rd ed. Lippincott Williams & Wilkins; 2020.

10. Bracciano A. *Physical Agent Modalities: Theory and Application for the Occupational Therapist*. 3rd ed. SLACK Books; 2022.

11. Prentice WE. *Therapeutic Modalities in Rehabilitation*. 6th ed. McGraw-Hill Medical; 2021.

12. Watson T, Nussbaum EL. *Electrophysical Agents: Evidence-Based Practice*. 13th ed. Elsevier; 2021.

13. Johnson MI, Paley CA, Jones G, Mulvey MR, Wittkopf PG. Efficacy and safety of transcutaneous electrical nerve stimulation (TENS) for acute and chronic pain in adults: a systematic review and meta-analysis of 381 studies (the meta-TENS study). *BMJ Open*. 2022;12(2):e051073. doi:10.1136/bmjopen-2021-051073

14. Elboim-Gabyzon M, Najjar SA, Shtarker H. Effects of transcutaneous electrical nerve stimulation (TENS) on acute postoperative pain intensity and mobility after hip fracture: A double-blinded, randomized trial. *Clin Interv Aging*. 2019;14:1841-1850. doi:10.2147/cia.s203658

15. Zhu Y, Feng Y, Peng L. Effect of transcutaneous electrical nerve stimulation for pain control after total knee arthroplasty: A systematic review and meta-analysis. *J Rehabil Med*. 2017;49(9):700-704. doi:10.2340/16501977-2273

16. Gatewood CT, Tran AA, Dragoo JL. The efficacy of post-operative devices following knee arthroscopic surgery: A systematic review. *Knee Surg Sports Traumatol Arthrosc*. 2017;25(2):501-516. doi:10.1007/s00167-016-4326-4

17. Hauger AV, Reiman MP, Bjordal JM, Sheets C, Ledbetter L, Goode AP. Neuromuscular electrical stimulation is effective in strengthening the quadriceps muscle after anterior cruciate ligament surgery. *Knee Surg Sports Traumatol Arthrosc*. 2018;26(2):399-410. doi:10.1007/s00167-017-4669-5

18. Taradaj J, Halski T, Kucharzewski M, et al. The effect of neuromuscular electrical stimulation on quadriceps strength and knee function in professional soccer players: return to sports after ACL reconstruction. *Biomed Res Int*. 2013;2013:1-9. doi:10.1155/2013/802534

19. Toth MJ, Tourville TW, Voigt TB, et al. Utility of neuromuscular electrical stimulation to preserve quadriceps muscle fiber size and contractility following anterior cruciate ligament injury and reconstruction: A randomized, sham-controlled, blinded trial. *Am J Sports Med*. 2020;48(10):2429-2437. doi:10.1177/0363546520933622

20. Leighton R, Watson JT, Giannoudis P, Papakostidis C, Harrison A, Steen RG. Healing of fracture nonunions treated with low-intensity pulsed ultrasound (LIPUS): A systematic review and meta-analysis. *Injury*. 2017;48(7):1339-1347. doi:10.1016/j.injury.2017.05.016

21. Palanisamy P, Alam M, Li S, Chow SKH, Zheng YP. Low-intensity pulsed ultrasound stimulation for bone fracture healing: a review. *J Ultrasound Med*. 2021;41(3):547-563. doi:10.1002/jum.15738

22. Yao G, Chen J, Duan Y, Chen X. Efficacy of extracorporeal shock wave therapy for lateral epicondylitis: A systematic review and meta-analysis. *Biomed Res Int*. 2020;18:2064781. doi:10.1155/2020/2064781

23. Yusof TN, Seow D, Vig KS. Extracorporeal shockwave therapy for foot and ankle disorders: A systematic review and meta-analysis. *J Am Podiatr Med Assoc*. 2022;12:18-191.

24. Liu WC, Chen CT, Lu CC, et al. Extracorporeal shock wave therapy shows superiority over injections for pain relief and grip strength recovery in lateral epicondylitis: A systematic review and network meta-analysis. *Arthroscopy*. 2022;38(6):2018-2034. doi:10.1016/j.arthro.2022.01.025

25. Al-Siyabi Z, Karam M, Al-Hajri E, Alsaif A, Alazemi M, Aldubaikhi AA. Extracorporeal shockwave therapy versus ultrasound therapy for plantar fasciitis: A systematic review and meta-analysis. *Cureus*. 2022;14:e20871. doi:10.7759/cureus.20871

26. Sun K, Zhou H, Jiang W. Extracorporeal shock wave therapy versus other therapeutic methods for chronic plantar fasciitis. *Foot Anke Surg*. 2020;26(1):33-38. doi:10.1016/j.fas.2018.11.002

27. Luo R, Dai J, Zhang J, Li Z. Accelerated skin wound healing by electrical stimulation. *Adv Healthc Mater*. 2021;10:e2100557. doi:10.1002/adhm.202100557

28. Cheah YJ, Buyong MR, Mohd Yunus MH. Wound healing with electrical stimulation technologies. A review. *Polymers*. 2021;13(21):3790. doi:10.3390/polym13213790

29. Khouri C, Kotzki S, Roustit M, Blaise S, Gueyffier F, Cracowski JL. Hierarchical evaluation of electrical stimulation protocols for chronic wound healing: An effect size meta-analysis. *Wound Repair Regen*. 2017;25(5):883-891. doi:10.1111/wrr.12594

30. Avendaño-Coy J, López-Muñoz P, Serrano-Muñoz D, Comino-Suárez N, Avendaño-López C, Martin-Espinosa N. Electrical microcurrent stimulation therapy for wound healing: A meta-analysis of randomized clinical trials. *J Tissue Viability*. 2022;31(2):268-277. doi:10.1016/j.jtv.2021.12.002

31. Vanti C, Panizzolo A, Turone L, et al. Effectiveness of mechanical traction for lumbar radiculopathy: A systematic review and meta-analysis. *Phys Ther*. 2021;101:pzaa231. doi:10.1093/ptj/pzaa231

32. Wang W, Long F, Wu X, Li S, Lin J. Clinical efficacy of mechanical traction as physical therapy for lumbar disk herniation: a meta-analysis. *Compu Math Methods Med*. 2022;5670303. doi:10.1155/2022/5670303

33. Kwiecien SY, McHugh MP, Howatson G. Don't lose your cool with cryotherapy: the application of phase change material for prolonged cooling in athletic recovery and beyond. *Front Sports Act Living*. 2020;2:118. doi:10.3389/fspor.2020.00118

34. Wang Y, Li S, Zhang Y, et al. Heat and cold therapy reduce pain in patients with delayed onset muscle soreness: A systematic review and meta-analysis of 32 randomized controlled trials. *Phys Ther Sport*. 2021;48:177-187. doi:10.1016/j.ptsp.2021.01.004

35. Kuyucu E, Bülbül M, Kara A, Koçyiğit F, Erdil M. Is cold therapy really efficient after knee arthroplasty? *Ann Med Surg*. 2015;11:475-478. doi:10.1016/j.amsu.2015.10.019

36. Zhang P, Wu MX. A clinical review of phototherapy for psoriasis. *Lasers Med Sci*. 2018;33(1):173-180. doi:10.1007/s10103-017-2360-1

37. Myers E, Kheradmand S, Miller R. An update on narrowband ultraviolet B therapy for the treatment of skin diseases. *Cureus*. 2021;13:e19182. doi:10.7759/cureus.19182

38. Jacob J, Pona A, Cline A, Feldman S. Home UV phototherapy. *Dermatol Clin*. 2020;38(1):109-126. doi:10.1016/j.det.2019.09.001

39. Clijsen R, Brunner A, Barbero M, Clarys P, Taeymans J. Effects of low-level laser therapy on pain in patients with musculoskeletal disorders: a systematic review and meta-analysis. *Eur J Phys Rehabil Med*. 2017;53(4):603-610. doi:10.23736/s1973-9087.17.04432-x

40. Stausholm MB, Naterstad IF, Joensen J, et al. Efficacy of low-level laser therapy on pain and disability in knee osteoarthritis: systematic review and meta-analysis of randomised placebo-controlled trials. *BMJ Open*. 2019;28:e031142. doi:10.1136/bmjopen-2019-031142

41. Moseley AM, Elkins MR, Janer-Duncan L, Hush JM. The quality of reports of randomized trials varies between subdisciplines of physiotherapy. *Physiotherapy Canada*. 2014;66(1):36-43. doi:10.3138/ptc.2012-68

42. White NT, Delitto A, Manal TJ, Miller S. The American Physical Therapy Association's top 5 Choosing Wisely recommendations. *Phys Ther*. Published online September 15, 2014. doi:10.2522/ptj.20140287

43. Belanger AY, Cameron MH, Michlovitz SL, Bellew JW, Freeman L. Letter to the editor on "The American Physical Therapy Associations' top five Choosing Wisely recommendations". *Phys Ther*. 2015;95(1):142-143. doi:10.2522/ptj.2015.95.1.142

44. Shute N. Farewell, heating pad: Physical therapists say it doesn't help. NPR. Published September 16, 2014. https://www.npr.org/

45. Commission on Accreditation in Physical Therapy Education (CAPTE). CAPTE Accreditation Handbook – PT Standards and Required Elements. https://www.capteonline.org/

46. Federation of State Boards in Physical Therapy (FSBPT). NPTE-PT test content outline. https://www.fsbpt.org/

47. World Physiotherapy. Membership. https://world.physio/our-members

48. World Physiotherapy. Physiotherapist Education Framework. https://world.physio/sites/default/files/2021-07/Physiotherapist-education-framework-FINAL.pdf

49. APTA. Academy of Clinical Electrophysiology & Wound Management. https://www.acewm.org/

50. APTA. Biophysical Agents Subgroup. https://www.acewm.org/content/special-interest-groups/biophysical-agents

51. World Physiotherapy. International Society for Electrophysical Agents in Physiotherapy. https://world.physio/subgroups/electrophysical

52. Selkowitz DM. Observations and recommendations on the investigation of clinical decision-making and usage involving electrophysical agents. *Israel J Health Policy Res*. 2015;4:54. doi:10.1186/s13584-015-0050-7

53. Greco JL, Lamberg EM. Biophysical agent curriculum in entry-level physical therapist education programs across the United States: A survey. *J Phys Ther Edu*. 2020;34(2):139-149. doi:10.1097/jte.0000000000000128

54. Insurance Fraud Costs the U.S. $308.6 Billion Annually. https://insurancefraud.org/wp-content/uploads/The-Impact-of-Insurance-Fraud-on-the-U.S.-Economy-Report-2022-8.26.2022.pdf

55. APTA. Preventing Fraud, Abuse, and Waste: A Primer for physical Therapists. https://www.apta.org/contentassets/1dcb4570f2294b758a94bdafb897bfad/preventing-fraud-abuse-waste-a-primer.pdf

56. Federation of State Boards Physical Therapy. Fraudulent Billing and the Role of the Jurisdiction Licensing Board. https://www.fsbpt.org/Portals/0/Content%20Manager/PDFs/Forum/Forum_Fall2014_FraudulentBilling.pdf

57. APTA. Code of Ethics for the Physical Therapist. https://www.apta.org/apta-and-you/leadership-and-governance/policies/code-of-ethics-for-the-physical-therapist

58. McDermott E. So You Wanna Blow the Whistle: How to Report Fraud and Abuse in Health Care. WebPT. https://www.webpt.com/blog/so-you-wanna-blow-the-whistle-how-to-report-fraud-and-abuse-in-health-care/

59. Statuta S, Pugh K. Training room procedures and use of therapeutic modalities in athletes. *Clin Sports Med*. 2019;38(4):619-638. doi:10.1016/j.csm.2019.06.006