2018 / volume 30 / number 4

ORTHOPAEDIC
PHYSICAL THERAPY PRACTICE

The magazine of the Academy of Orthopaedic Physical Therapy, APTA

ORTHOPAEDIC
PHYSICAL THERAPY PRACTICE

The magazine of the Academy of Orthopaedic Physical Therapy, APTA

In this issue

Regular features

OPTP Mission

To serve as an advocate and resource for the practice of Orthopaedic Physical Therapy by fostering quality patient/client care and promoting professional growth.

Publication Staff

Managing Editor & Advertising
Sharon L. Klinski
Academy of Orthopaedic Physical Therapy
2920 East Ave So, Suite 200
La Crosse, Wisconsin 54601
800-444-3982 x 2020
608-788-3965 FAX
Email: sklinski@orthopt.org

Editor
Christopher Hughes, PT, PhD, OCS

Associate Editor
Rita Shapiro, PT, MA, DPT

Book Review Editor
Rita Shapiro, PT, MA, DPT

Publication Title: *Orthopaedic Physical Therapy Practice* Statement of Frequency: Quarterly; January, April, July, and October
Authorized Organization's Name and Address: Academy of Orthopaedic Physical Therapy, 2920 East Avenue South, Suite 200, La Crosse, WI 54601-7202

Orthopaedic Physical Therapy Practice is indexed by Cumulative Index to Nursing & Allied Health Literature (CINAHL) and EBSCO Publishing, Inc.

ORTHOPAEDIC SECTION DIRECTORY

2018 / volume 30 / number 4

OFFICERS

President:
Stephen McDavitt, PT, DPT, MS, FAAOMPT, FAPTA
207-396-5165 • scfmpt@earthlink.net
2nd Term: 2016-2019

Vice President:
Lori Michener, PT, PhD, SCS, ATC, FAPTA
804-828-0234 • lmichene@usc.edu
1st Term: 2017-2020

Treasurer:
Kimberly Wellborn, PT, MBA
615-465-7145 • wellborn@comcast.net
2nd Term: 2018-2021

Director 1:
Aimee Klein, PT, DPT, DSc, OCS
813-974-6202 • Aklein1@health.usf.edu
2nd Term: 2018-2021

Director 2:
Duane "Scott" Davis, PT, MS, EdD, OCS
304-293-0264 • dsdavis@hsc.wvu.edu
1st Term: 2016-2019

Explore the **Orthopaedic Section** website at: orthopt.org

Explore all the independent study courses (ISCs) the Orthopaedic Section has to offer at: orthoptlearn.org

Office Personnel

(608) 788-3982 or (800) 444-3982

Terri DeFlorian, Executive Director
x2040 .... tdeflorian@orthopt.org

Tara Fredrickson, Executive Associate
x2030 .... tfred@orthopt.org

Leah Vogt, Executive Assistant
x2090 .... lvogt@orthopt.org

Sharon Klinski, Managing Editor
x2020 .... sklinski@orthopt.org

Laura Eichmann, Publishing Assistant
x2050 .... leichmann@orthopt.org

Brenda Johnson, ICF-based CPG Coordinator
x2130 .... bjohnson@orthopt.org

CHAIRS

MEMBERSHIP
Megan Poll, PT, DPT, OCS
908-208-2321 • meganpoll@gmail.com
1st Term: 2018-2021

Members: *Christine Becks (student), Thomas Fliss, Molly Baker O'Rourke, Nathaniel Mosher*

EDUCATION PROGRAM
Nancy Bloom, PT, DPT, MSOT
314-286-1400 • bloomn@wustl.edu
1st Term: 2016-2019

Vice Chair:
Emmanuel "Manny" Yung, PT, MA, DPT, OCS
203-416-3953 • yunge@sacredheart.edu
1st Term: 2016-2019

Members: *Erick Folkins, Valerie Spees, Cuong Pho, John Heick, Kate Spencer*

INDEPENDENT STUDY COURSE & ORTHOPAEDIC PRACTICE
Editor:
Christopher Hughes, PT, PhD, OCS, CSCS
724-738-2757 • chughes42@zoominternet.net
Term ISC: 2007-2019
Term OP: 2004-2019

ISC Associate Editor:
Gordon Riddle, PT, DPT, ATC, OCS, SCS
gordoncriddle@hotmail.com
2nd Term: 2017-2020

OP Associate Editor:
Rita Shapiro, PT, MA, DPT
Shapiro.rb@gmail.com
1st Term: 2017-2020

PUBLIC RELATIONS/MARKETING
Jared Burch, PT
908-839-5506 • jareddburch@gmail.com
1st Term: 2018-2021

Members: *Tyler Schultz, Adrian Miranda, William Stokes, Derek Charles, Ryan Maddrey, Kelsea Weber (student)*

RESEARCH
Dan White, PT, ScD, MSc, NCS
302-831-7607 • dkw@udel.edu
1st Term: 2016-2019

Vice Chair:
Amee Seitz PT, PhD, DPT, OCS
1st Term: 2016-2019

Members: *Joshua Stefanik, Marcie Harris-Hayes, Sean Rundell, Arie Van Duijn, Alison Chang, Louise Thoma*

ORTHOPAEDIC SPECIALTY COUNCIL
Pam Kikillus, PT, DHSc, OCS, CHT, FAAOMPT
253-709-8684 • pkikilus@greenriver.edu
Term: Expires 2019

Members: *Hilary Greenberger, Grace Johnson, Judith Geller*

PRACTICE
Kathy Cieslak, PT, DScPT, MSEd, OCS
507-293-0885 • cieslak.kathryn@mayo.edu
2nd Term: 2018-2021

Members: *James Spencer, Marcia Spoto, Mary Fran Delaune, Molly Malloy, Jim Dauber*

FINANCE
Kimberly Wellborn, PT, MBA
(See Treasurer)

Members: *Doug Bardugon, Penny Schulken, Judith Hess*

AWARDS
Lori Michener, PT, PhD, ATC, FAPTA, SCS
(See Vice President)

Members: *Kevin Gard, Marie Corkery, Murray Maitland*

JOSPT
Guy Simoneau, PT, PhD, FAPTA
guy.simoneau@marquette.edu

Executive Director/Publisher:
Edith Holmes
877-766-3450 • edithholmes@jospt.org

NOMINATIONS
Carol Courtney, PT, PhD, ATC
cacourt@uic.edu
1st Term: 2018-2021

Members: *Brian Eckenrode, Michael Bade*

APTA BOARD LIAISON –
Robert Rowe, PT, DPT, DMT, MHS

2018 House of Delegates Representative –
Kathy Cieslak, PT, DSc, OCS

ICF-based CPG Editors –
Guy Simoneau, PT, PhD, FAPTA
guy.simoneau@marquette.edu
1st Term: 2017-2020

Christine McDonough, PT, PhD
cmm295@pitt.edu
2nd Term: 2016-2019

RobRoy Martin, PT, PhD
martinr280@duq.edu
1st Term: 2018-2021

Special Interest Groups

OCCUPATIONAL HEALTH SIG
Lorena Pettet Payne, PT, MPA, OCS
406-581-3147 • lpettet@aol.com
2nd Term: 2016-2019

FOOT AND ANKLE SIG
Christopher Neville, PT, PhD
315-464-6888 • nevillec@upstate.edu
1st Term: 2016-2019

PERFORMING ARTS SIG
Annette Karim, PT, DPT, OCS, FAAOMPT
626-815-5020 ext 5072 • neoluvsonlyme@aol.com
2nd Term: 2017-2020

PAIN MANAGEMENT SIG
Carolyn McManus, MSPT, MA
206-215-3176 • carolynmcmanus24@gmail.com
1st Term: 2017-2020

IMAGING SIG
Charles Hazle, PT, PhD
606-439-3557 • crhazl00@uky.edu
1st Term: 2016-2019

ORTHOPAEDIC RESIDENCY/FELLOWSHIP SIG
Matthew Haberl, PT, DPT, OCS, ATC, FAAOMPT
608-406-6335 • matthaberl@hotmail.com
1st Term: 2018-2021

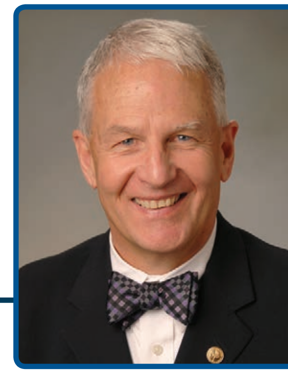
ANIMAL REHABILITATION SIG
Kirk Peck, PT, PhD, CSCS, CCRT
402-280-5633 • kpeck@creighton.edu
2nd Term: 2016-2019

Education Interest Groups

PTA
Jason Oliver, PTA
lsu73lsu73@yahoo.com

President's Corner

Call to PTA Members of the Academy of Orthopaedic Physical Therapy: Why the Lack of Involvement with Lots of Opportunities? What More Can the Academy do for You?



HISTORY

When I was a Director on the APTA Board of Directors (BOD) in March 2007, the APTA BOD had a Mega Issues Discussion on the PTA. The results of that discussion in summary revealed the following:

> *That APTA develop and communicate best practice service delivery models for a variety of practice settings that promote safe, effective, and efficient utilization of the Physical Therapist Assistant. The models should also clearly define the roles and responsibilities of the Physical Therapist and Physical Therapist Assistant in assuring effective communication, professional relationships, competent service delivery, assessment of ongoing clinical competence; and skill development.*

Source: http://www.apta.org/PTinMotion/2009/6/PTAViewpoint/

Further discussions following this directive led to an additional charge from the APTA BOD to establish a task force that included Board members, physical therapists (PTs), and physical therapist assistants (PTAs) (required to have experience working as part of the PT/PTA team in a clinical environment) to determine appropriate post entry-level pathway education for the PTA considering APTA positions, policies, standards, etc. This group was called Educational Pathways of the PTA Task Force.

http://www.apta.org/VolunteerGroups/TaskForce/EducationalPathwaysPTA/

One of the strategies recommended by the Educational Pathways of the PTA Task Force, became the framework for the Advance Proficiency Pathways Program whose purpose was to advance the post entry education for the PTA through providing a core group of courses with knowledge exams including content specific courses and mentored clinical experience for a formal authorization of advance knowledge, skills, and abilities. During the fall of 2012, a call out letter from APTA BOD, Shawne Soper, Speaker of the House and Chair of the PTA Education Pathways Task Force, to Section Presidents requested a workshop meeting at CSM 2013 to direct and create content that should be included for PTAs working specialty areas of physical therapist practice.

In 2011,the residing Orthopaedic Section President, Jay Irrgang, PT, PhD, announced that the Orthopaedic Section was committed to this initiative and through the BOD assigned and authorized me as the chair of a task force to complete the orthopaedic specialty framework for the program. The task force comprised of PTs and PTAs not only considered all relevant APTA documents including the PTA practice algorithm, etc. but also the framework within the third revision of the *Guide to Physical Therapist Practice*. The Section task force worked on this project for 5 years and included development and analysis of a survey sent to the Orthopaedic Section's 17,550 members. From the results of that survey, the task force reviewed the data and developed an educational content format from which Orthopaedic Section members validated advanced proficiency skills they expected for the physical therapist assistant to perform within an orthopaedic setting. The Orthopaedic Section delivered their findings and recommendations to APTA for their development of the PTA Advance Proficiency Pathway content for orthopedics. Currently, the advance proficiency pathways opportunities are available for PTAs in the following areas of practice: Acute Care, Cardiopulmonary, Geriatric, Oncology, Orthopedics, Pediatrics, and Wound Management.

When I took office as President of the Orthopaedic Section, I met with the PTA Caucus which included Amy Smith and Shawn Bagbey along with several others. The intent of the meeting was to let the Caucus know that the Orthopaedic Section was committed to helping the PTA through its completion of the Advance Proficiency Pathways opportunities in addition to providing growth opportunities within our PTA Education Interest Group structure. We also discussed the concern made from the Caucus that the Orthopaedic Section was not permitting PTAs to participate in its advanced clinical courses that were designed for the physical therapist.

The Caucus also recommended that the Orthopaedic Section improve its access for PTAs to information on our website and involve them in development of our education programs.

In my 5½ year tenure as Orthopaedic Section President combined with Jay Irrgang in his tenure, our PTA initiatives have included providing almost 10 years of manpower and financial support by:

1. completing our practice survey/analysis for advancing postgraduate PTA education within the orthopaedic setting;
2. developing and delivering an educational format for the APTA PTA Advance Proficiency Pathways Program;
3. creating improved information for our PTA Education Interest Group on our website;
4. offering publishing opportunities to PTAs;
5. providing presentation programming opportunities at CSM;
6. opening meeting opportunities at CSM to meet with PTA members to inquire about meeting their needs through correspondence, the website, and along those lines provided opportunities for face-to-face and conference call meetings; and
7. opening our advanced programming for PTs to include the PTAs in the framework of the APTA PT:PTA team algorithm that included:
    a. integrating that information on our website and within the framework of our advanced clinical annual meeting;
    b. adjusting different educational objectives and special orientation to all PTAs before programing, so they were well informed of expectations throughout the delivery of the educational experience; and
    c. providing face-to-face lunchtime meetings with our PTA participants to get feedback on meeting their needs.

RESULTS

With all these efforts on behalf of our PTA members over the past 10 years, the Academy of Orthopaedic Physical Therapy has seen absolutely no interest from PTAs for engagement in our CSM educational programming, educational opportunities within our independent study courses, publishing in our clinical magazine *OPTP*, meeting at CSM, or participating in conference call opportunities to enhance PTA opportunities within the Section. In sole reference to our advanced Annual Orthopaedic Meeting over the past 3 years, we had an attendance of only 9 PTAs for 2 years and 2 PTAs this year.

PLAN

Even though perplexed and frustrated in reconciling the lack of involvement we have witnessed across our efforts, we have not given up on our desire to facilitate and achieve high quality PTA participation within the general membership and PTA leadership opportunities within the PTA EIG. In the upcoming weeks, Jason Oliver PTA (current PTA EIG Chair) and I along with the Academy BoD, will once again be contacting the PTA leadership within APTA, as well as other PTs and PTAs across leadership and membership to inquire about other recommendations and strategies we might employ to enhance opportunities and involvement of PTAs in the Academy of Orthopaedic Physical Therapy. From this, we also are considering surveying the membership for ideas and if so we invite your input in that action. Lastly, I look forward to hearing from any member of the Academy of Orthopaedic Physical Therapy regarding their thoughts and recommendations in addressing our concern and desire for creating value and opportunity for our PTA members.

As it is appreciated that many hands make light work, let's all work together on this!

Editor's Note

Can You Hear Me Now?

Christopher Hughes, PT, PhD, OCS, CSCS

In continuing with our support of faculty-student research, I am pleased to present 5 manuscripts from the PT faculty and students in the DPT program at the George Fox University. These papers represent the culmination of the program's emphasis on evidence-based practice and research. George Fox University's Doctor of Physical Therapy (DPT) program emphasizes a problem-solving, evidence-based approach to learning and integrates clinical research into the practice of physical therapy. A sincere thanks to Dr. Jeff Houck, PT, PhD, Director of Research in the DPT program at George Fox University and also to the all the students and faculty for presenting their work!

This familiar phrase has likely become a part of pop culture forever. For the actor/spokesperson, Paul Marcarelli, it made him a very wealthy pitchman. There have been reports that Mr. Marcarelli's net worth of around $10 million came almost entirely from those commercials. In marketing circles, his switch from Verizon to Sprint was almost viewed as scandalous. Sprint keenly crafted a creative strategy of its own by having him be the most credible person to tell everyone that NOW all networks are the same, but that only Sprint can give you the best value for the same network quality!

With so many interruptions vying for our attention today, it is easy to lose the focus on the task at hand and falsely believe that we can multi-task to the same level as giving our undivided attention to the present. The irony is that as more communication devices and methods become available, it appears the more the quality of good old human-to-human communication suffers.

Putting all the marketing hype and commercialism aside, clinicians unequivocally relate to this communication mantra in patient care. Our time and ability to relate to patients through education, motivation, and just overall general empathy makes us a valued but scarce resource in today's health care system. However, as of late this seems to be under attack by societal trends and new emerging norms.

Not a day goes by without someone getting "burned" for a regretful post or misrepresented tweet. Effective communication requires practice and adaptability to new forms of communication and above all a healthy dose of common sense. Today's communication modes are not accompanied with any formal training program with regard to etiquette and the amplification effects associated with communicating rapidly to a worldwide audience. The health care arena is not immune to the pressures to embrace new communication modes. Business and marketing gurus constantly advocate that clinics and providers jump into social media. This can be a slippery slope. Not only in terms of marketing but also privacy and HIPAA concerns. It is now commonplace to login to patient-based web portals to achieve immediate access to garner patient records and test results. The irony is that without having a layman's interpretation of such medical jargon, reports can often lead to frustration, confusion, and unneeded anxiety. Data compromises and hacking breeches also occur at the cost of the luxury of immediate communication and access.

All this aside, let's just deal with communication from the standpoint of its lowest common denominator: one-to-one interaction. Today, clinicians are asked to treat multiple patients, document more, and in general oversee duties and responsibilities that at times can be humanely impossible without a sacrifice of quality.

Yes…I get it; the pressures of staying profitable supersede the idealisms of utopia treatments of seeing one patient an hour. Understandably, it is hard to do good things if you cannot balance the accounting ledger. When time is shortening, usually the first thing that gets shortened is direct communication. But the breach in communication is not all on us as a provider. I can count more than a few times when therapy consults have been interrupted by patients choosing to remain tethered to their cell phones in a classically conditioned Pavlovian response. Such is the world in which we live.

Obviously not only is this trend frustrating to therapist and patient alike, but also to the student intern. Students justifiably focus intensively on learning the mechanics of care such as manual skills, modality use, device fittings, etc. The priority becomes consuming for your own use rather than conveying to the consumer. Communication skills often take a back seat. Time management and listening skills are hard to teach to a generation that has literally been weaned on the attention deficit technologies of texting, tweeting, YouTube, and Facebook postings. If you cannot make your point in 280 characters words, then I am moving on! These privileges may fit within the genre of today, but it contradicts everything that is sacred in the patient process…communication in any form, verbal, non-verbal, or written is one of the most essential aspects of our job. Nothing irritates a patient more (anyone for that matter) than not being heard. Patients routinely complain not only of brief encounters with providers but also of the frustrations they have when providers interrupt, monopolize, assume, and just cut off their expression of why they have sought care and advice. Busy clinics can be a breeding ground for misplaced assumptions, rushed care, and ultimately, costly mistakes.

So if we cannot go back to the good old days and spend all the time we would like with patients, we should at least place a premium on the time we do have with them. We should treat that time as the sanctuary it is and recognize it as a time to professionally collect, assimilate, and highlight our empathy and decision-making skills at various levels.

In my opinion, the following recommendations will never go out of style:

- Include introductory pleasantries and smile.
- Make eye contact.
- Stay organized with your interview.
- Do not appear rushed, even if you are. Take the time.
- Keep the conversation relevant.
- Use concise words and speak clearly.
- Listen without interrupting.

A simple resource advocated to improve communication from the patient perspective is a trademarked program called Ask Me 3 created by the National Patient Safety Foundation.[1] Ask Me 3 is a patient education program designed to enhance communication between patients and health care providers. Patients are encouraged to become active members of their health care team and promote improved health outcomes. The program recommends patients pose 3 questions to their health care providers:

1. What is my main problem?
2. What do I need to do?
3. Why is it important for me to do this?

If clinicians recognize these 3 patient needs, then it will be easier to tailor our communications accordingly.

Today, patients recognize they can play an active role in getting better. Not only do they have immediate access to more information, they are more comfortable questioning decisions. When communicating our roles and expertise clearly, these two emerging patient characteristics can be attributed to care rather than deficits in a patient-centered care model.

In conclusion, let's not forget the big "C" which in this context stands for caring. Skilled clinicians have this attribute in spades and it often can equal the playing field in a number of ways. If you care, then everything you do and say becomes validated just a little more and carries just a little more credibility. Patients who experience a good rapport with their therapist are more likely to be satisfied with their care, share pertinent information to allow for accurate diagnosis of their problems, follow advice, and ultimately comply with any prescribed treatments. In the end, patients do not care how much you know until they know how much you care! Lastly, thanks for finishing this editorial. Oh, who am I kidding, I lost you at the 280th character!

REFERENCE

1. Institute for Healthcare Improvement. Ask Me 3: Good Questions for Your Good Health. www.ihi.org/resources/Pages/Tools/Ask-Me-3-Good-Questions-for-Your-Good-Health.aspx. Accessed August 19, 2018.

A Study of Outcomes Following Collaborative Medical Doctor/Physical Therapist Primary Care Service for Musculoskeletal Problems

Dan Kang, DPT[1]
Sarah Rahkola, MD[2]
Catherine Vandehaar, DPT[1]
Andrea Mulligan, DPT[1]
Kevin Morikawa, DPT[1]
Amador Marcano, DPT[1]
Tyler Cuddeford, PT, PhD[1]
Jeff Houck, PT, PhD[1]

[1]George Fox University, Newberg, OR
[2]Providence Medical Group Newberg, Newberg, OR

ABSTRACT

Background and Purpose: Collaborative medical doctor/physical therapist primary care services are not described in the literature. The 2 purposes of this observational study were to describe a collaborative medical doctor/physical therapist primary care service, and to describe simple, one question, outcomes including patient acceptable symptom state (PASS), global rating of normal function (GRNF), and success of treatment (SOT) at intake, 1 to 7 days, and 45 to 60 days follow-up. **Methods:** Patients were seen for 1 to 2 visits and typically received exercise, hands on treatment, ie, manual therapy, and education. Medical doctor/physical therapist collaborative encounters and provider training are described. Outcome measures were recorded at the first visit, via phone once between 1 to 7 days and once between 45 to 60 days. Descriptive data was calculated at each time point. **Findings:** Examples of collaborative diagnosis and treatment opportunities are tabulated. A total of 31.9% of patients were PASS Yes at intake (n=402). At 1 to 7 days (n=157; 50.3%) and 45 to 60 days (n=93; 55.9%), the proportion of PASS Yes patients were higher. There was little difference in the GRNF scale at any follow-up. At 45 to 60 days, the SOT question indicated most patients (45.7%) reported "improved" and 29.3% of patients reported as "partly cured" or "cured." **Clinical Relevance:** Collaborative opportunities for diagnosis and treatment in primary care are provided. A model using the PASS, GRNF, and SOT questions for judging the urgency which a service needs modification to meet patient needs is proposed. **Conclusion:** A collaborative medical doctor/physical therapist model is a viable option to improve primary care services. This descriptive data suggests some level of success, however, there is little relevant data for comparison.

Key Words: patient acceptable symptom state, global rating of normal function, interprofessional model

INTRODUCTION

Models of primary care physical therapy services have tended to focus on direct access rather than collaborative models.[1-3] Medical providers are motivated to collaborate with the specialist because of the potential to improve care and reduce provider burden.[4] Low staff and other factors contribute to poor provider satisfaction and retention making health reform difficult in primary care.[4] By having a physical therapist take on responsibilities in primary care, the potential to implement neglected, well-supported, health initiatives may become realistic.[5,6] This parallels suggestions to integrate primary care and specialty care (ie, physical therapy) around a particular set of patient needs (ie, musculoskeletal problems) to increase value and lower costs.[7] In addition, organizing teams around patient needs fits well into existing integrative models of care delivery in primary care.[8] The motivations for physical therapists to collaborate in primary care include the opportunity to directly address patient needs[1] with immediate access to patients that would benefit from physical therapy.[2] The proportions of patients in primary care are typically older, female, and frequently present with multiple medical problems.[9,10] Addressing the needs of these patients may be better managed by a team integrating services in primary care.[7]

Developing an effective service for patients with musculoskeletal (MS) complaints that documents patient recovery as a routine part of primary care remains elusive.[11-13] Although benefits of early physical therapy show promise,[14-16] more data is necessary. For example, one clinical trial found little benefit of early 4 session treatment for low back pain.[14] However, "triage" physical therapy, described as an evaluation with minimal treatment of advice and exercise, and follow-up of 1 to 2 visits demonstrated benefits.[17-20] Assessment of triage consultation demonstrated better outcomes for health state, and several outcomes on a validated Quality from the Patients Perspective Questionnaire.[18-20] Studies also noted decreased imaging and other medical services compared to usual care.[17] However, existing studies do not use a patient-reported outcome (PRO) that quantifies patient health status to define the value of therapist involvement in primary care. Currently there is no practical feedback provided to the therapist in primary care to determine the outcomes. Providing 1 to 2 treatment services in primary care will require outcome assessments to determine if the minimal services are improving patient health outcomes, experiences, and are cost effective.[12]

Use of disease specific outcome measures appears impractical given the multiple diagnoses of patients attending primary care. New instruments that measure generic health domains like the Patient Reported Outcome Information Management System (PROMIS) show some distinct advantages.[13] However, wide spread implementation of these computer adaptive measures requires strong technology support and provider adoption.[21] Another alternative is simple dichotomous generic measures such as patient acceptable symptom state (PASS),[22,23] global rating of normal function (GRNF),[20] and success of treatment (SOT).[21] These single question measures are simple and provide distinctly different views of patient outcome. The PASS is a yes or no question that asks patients if they are currently satisfied with their level of symptoms and activity.[22-27] This question gives a measure of whether patients are able to live with their current state of health. In contrast, the GRNF asks patients to rate whether their joint or body region is normal on a 0 to 10 scale.[28] The GRNF likely provides an internal reference of whether the patient senses his or her body as normal. The

SOT question focuses on the outcome of the provider experience, asking the patient simply if he or she considers the "…treatment a success?"[29] The response choices are "Not Helped," "Improved," "Partly Cured," and "Cured." While these 3 questions are relatively quick to administer, and the information provided is fairly general, together they suggest whether the patient's current state is "livable" (PASS Yes), consider his or her body "normal" (GRNF), and whether the treatment provided was a success (SOT). All are separate and relevant benchmarks of the effectiveness of a service.

The purpose of this case report was to describe the collaborative physical therapist/medical doctor model of care and report on simple generic PROs (PASS, GRNF, and SOT) at appropriate intervals after care. The hypothesis was that these outcome measures would provide a global evaluation regarding primary care services sufficiently useful to determine how well the collaborative medical doctor/physical therapist service was meeting patient needs as defined by the 3 PRO measures.

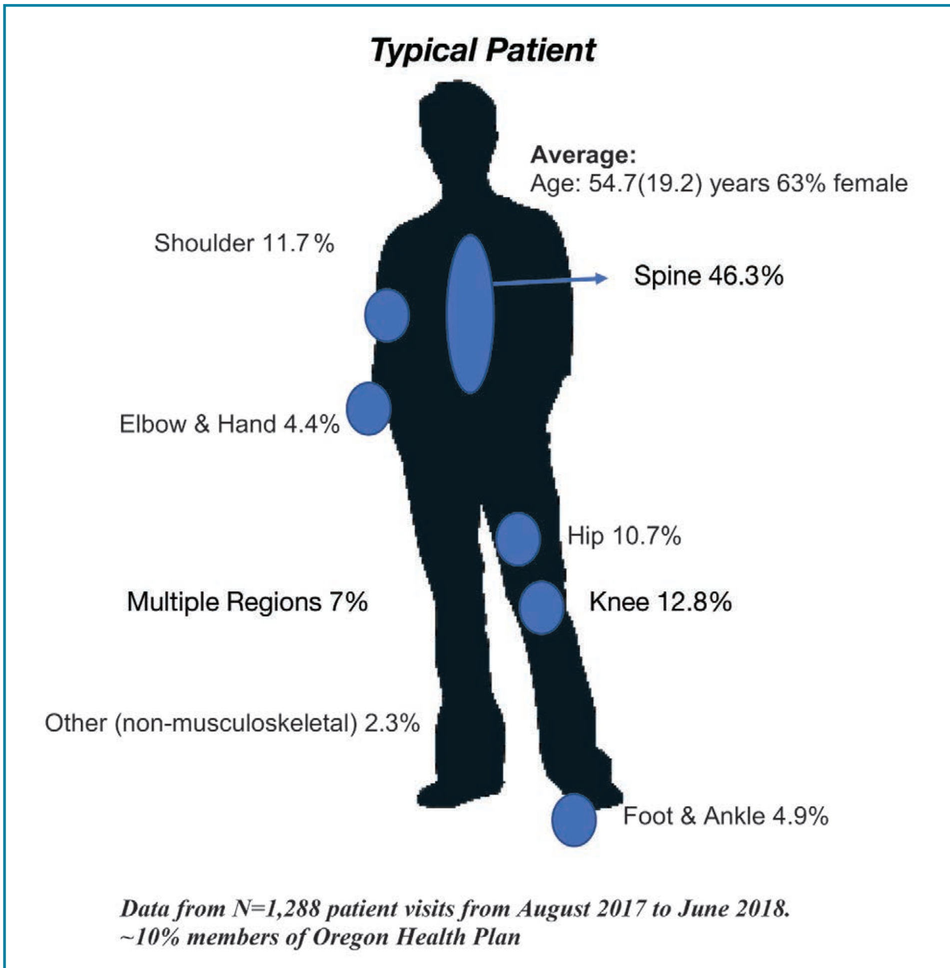


Figure 1. Typical patient by age, gender, and joint or body region of musculoskeletal problem.

Description of Collaborative Medical Doctor /Physical Therapist Primary Care Service

Patients attending primary care physical therapy services between August 2016 and June 2018 were included in this analysis. The only eligibility criteria were that each participant consented at intake to allow their data to be used for research. A review of 1,288 records showed that the average patient was 54.7 ± 19.2 years old and 63% were female. The proportion of body region/joints affected was by a large margin associated with the spine 46.3%, with the next highest regions being the knee 12.8%, shoulder 11.7%, and hip 10.7% (Figure 1).

The collaborative medical doctor/physical therapist primary care service consisted of evaluation and treatment during the primary care visit. One physical therapist was staffed to service 13 medical doctors and 6 physician assistants. The medical doctor/physician assistant identified patients as they came in with MS complaints for consultation with physical therapy, which occurred either together with the medical doctor/physician assistant or after the medical doctor/physician assistant completed the encounter. The physical therapy service included (1) consultation for diagnosis or treatment related decisions, (2) co-treatment with the provider, and (3) independent treatment unique from the medical doctor/physician assistant provider (Table 1). Consultation typically involved discussion of diagnosis, need for imaging, and benefit of referral or specific treatments. Co-treatment among providers occurred often. Patients frequently mention MS complaints as a secondary rather than a primary medical problem. Note that typical patients this age attending primary care have multiple chronic illnesses they are managing.[9,10] These patients were best cared for using a co-treatment approach, providing both medical doctor/physician assistant medical consultation and physical therapy consultation in a single appointment. Independent diagnosis and treatment also occurred frequently. These patients would benefit in a direct access, fee for service model.

Documentation showed that a majority of patients receiving physical therapy care in this model were instructed in exercise and education. A review of therapist notes of 1,285 patient encounters showed that patients received one or more hands on treatments such as manual therapy, exercise, education, and referral for further treatment (Figure 2). Time with patients varied from a few minutes to 45 minutes depending on the type of problem, patient needs, and patient availability.

Therapist training involved preparation and ongoing training to address provider and patient needs. Prior to implementation, imaging related clinical practice guidelines were reviewed including cervical spine,[30,31] low back pain,[32] shoulder,[33] and knee.[34] In addition, clinical practice guidelines for low back pain[35] and neck pain[36] were also reviewed. Throughout the trial period one-half day "bootcamps" were held between a team of 3 and 4 providers covering the service. To address patient needs, specific areas were identified by the medical doctor/physician assistant providers and became the focus of these training sessions. These sessions included training on a mixture of topics including cognitive behavioral approaches to pain with an emphasis on spine related problems.[37,38] The work of O'Sullivan and the

Table 1. Examples of Interactions in Primary Care Collaborative Treatment Model That May Create Value and Possible Charges

	Case Examples	Therapist Skill/Expertise Required
Consultation with provider		
Diagnosis-related	Imaging decisions–ankle/knee trauma	Ottawa Ankle/Knee Rules, Fracture Management
Treatment-related	Chronic pain–repeat visit or failed therapy	Biopsychosocial Model, Multi-modal Approach
Co-treatment with provider		
Both Treat Same Problem	Shoulder pain in patient with stage IV cancer - Scapula pain and instability	Shoulder Diagnosis
Treat Distinct Problems	Patient with renal disease and low back pain (unable to take NSAIDs)	Pharmacology Medical Diagnoses
Independent diagnosis and treatment (provider not typically trained or no time)		
Spine related		
Manual Therapy/Exercise	STarT Back Tool: acute onset, low and Mod risk, PROMIS scores, movement screen	CPG Low Back Pain
Psychologically Informed PT (Targeted Approach)	STarT Back Tool: moderate and high risk, PROMIS scores, movement screen	Cognitive Functional Therapy
Geriatric care		
Screening for Falls	STEADI screening for falls	Geriatric Care
Home Exercise for Falls Prevention	Otago based home exercise program	Balance Training
Non-spine related		
Hip/Knee OA Nonsurgical	Presurgery decision-making related for knee OA – exercise/NSAIDs/imaging	OA Management
Hip/Knee OA Postsurgical	Postoperative care – continued pain and low function – increase activity for cardiac fitness	OA Management
Shoulder problem	Rotator cuff decision making	Shoulder Diagnosis

Provider = Physician assistant, nurse practitioner, or medical doctor
Orange – likely no charge, Blue – incident to charge, Green – charge fee for service

Abbreviations: NSAIDs, nonsteroidal anti-inflammtory drugs; PROMIS, Patient Reported Outcome Management Information System; CPG, clinical practice guidelines; STEADI, Stopping Elderly Accidents, Death, and Injuries; OA, osteoarthritis

concept of guided behavioral experiments were emphasized.[39,40] Basic spinal manipulation techniques were also practiced and shared among practitioners with an emphasis on standard techniques.[41] Also, the benefits of "stay active" advice[42] and principals of behavior change to engage in physical activity were reviewed.[43]

Provider (medical doctor/physician assistant) training included quarterly in-services and challenging beliefs of targeted providers. Working with the medical director, specific targeted areas were presented for collaboration with the providers. The training sessions included (1) introduction of the collaborative medical doctor/physical therapist model, (2) two sessions on the low back pain approach, (3) non-traumatic rotator cuff tears, and (4) STopping Elderly Accidents, Deaths and Injuries (STEADI). It is worth noting that the STEADI program is a largely unimplemented CDC recommended program that is reimbursable by Medicare that remains largely unimplemented.[5,6] In addition to formal training, informal collaboration was important. Interactions frequently provided opportunities to challenge non-evidence-based treatments such as overuse of injections, over reliance on imaging, and underutilization of rehabilitation services. In fact, referrals to physical therapy providers increased from 16.5% the year before to 31.0% during the implementation of the program.

Outcome Measurements

At the initial encounter, the treating therapist obtained PASS and GRNF prior to treatment. Patients were also called once between 1 and 7 days and once between 45 and 60 days after their treatment. Selected PROMIS scales (not reported here), PASS, and GRNF were collected at 1 to 7 days posttreatment. All of these scales and SOT were collected at the 45- to 60-day call back point. All study procedures were approved by the George Fox University Human Subjects Review Board.

The PASS question was derived from previous studies that sought to define when patients reached a point of symptoms and activity that they judged satisfactory (Table 2).[23] A common wording to define a PASS state was used, "Taking into account all the activities you do during your daily life, your level of pain, and also your function, do you consider your current state satisfactory?"[23] A PASS Yes state is consistent with low levels of pain and moderate levels of function on other PRO scales that approximate normative values or slightly worse than normal in patients with MS problems.[44,45]

A GRNF rating asks patients to rate their joint or body region relative to normal. A global rating is used widely in psychology to capture a broad judgement from the patient regarding various attributes.[28] Similarly, they are used in some validated rehabilitation scales to capture normal function.[46,47] In this study, participants were asked to rate their joint or body region relative to normal function. The caller altered the joint or body

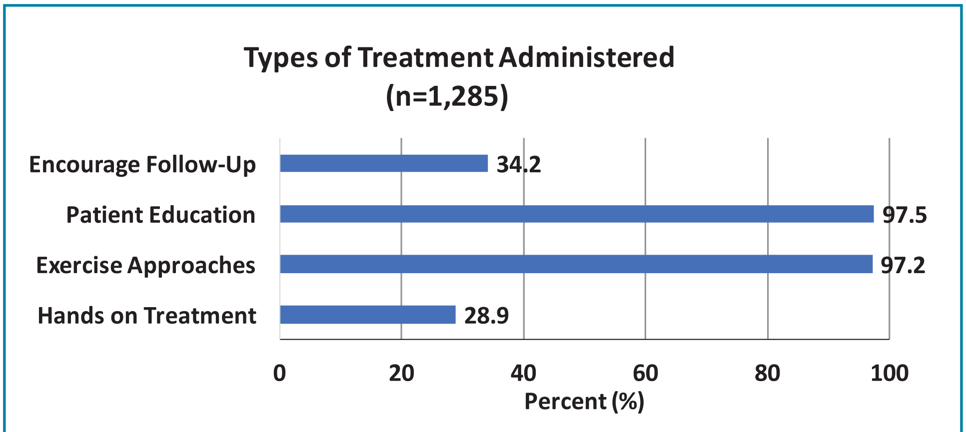


Figure 2. Typical treatments patients received from a physical therapist.

region (Table 2) for the primary or treated problem determined from the medical record. For patients with multiple problems (7%), the patient answered relative to their primary problem.

The SOT question was used to validate a new treatment satisfaction scale and is consistent with other studies of patient success.[29] Questions of patient's perception of treatment success were used post foot and ankle orthopedic surgery.[48] The specific SOT question allows for some graduation in responses including "Not Helped," "Improved," "Partly Cured," and "Cured." For the purposes of assessing primary care, these categories have good face validity. Patients "Not Helped" likely do not associate improvement with treatments received with their MS problem. In contrast, patients "Partly Cured" or "Cured" can be considered a success, where patients perceive the treatment received as contributing to "cure" or close to it. Patient's responding "Improved" likely perceive the effects of their treatment between these two extremes. Clinically, when high proportions of "Not Helped" responses occur, revision of the current protocols might be prioritized.

Outcome Results

The PASS question was obtained at intake (prior to treatment) (n=402), 1 to 7 days after treatment (n=157), and 45 to 60 days (n=93) after treatment. At intake, patients seeking care varied on a PASS "Yes" response from 25% to 40% (Figure 3). The overall average was 31.9%, suggesting that 32% of patients were likely attending primary care for prevention or reassurance rather than rehabilitation. Tracking progress from intake 1 to 7 days follow-up showed a marked difference from intake with 50.3% of patients reporting as PASS Yes at 1 to 7 days (18.4% more than at intake) (Figure 4). There was less difference from 1 to 7 days and 45 to 60 days (5.6%); however, a majority of patients reported as PASS Yes (55.9%) at 45 to 60 day follow-up.

The GRNF rating was also obtained at intake (prior to treatment) (n=402), 1 to 7 days after treatment (n=157), and 45 to 60 days (n=93) after treatment. The GRNF rating varied little over a 5-month period at intake, ranging from an average of 5.3 ± 2.1 to 5.6 ± 2.1. The overall average was 5.6 ± 2.1 suggesting patients felt their joint or body region was 5.6/10 at intake. There was little difference in the GRNF scale at 1 to 7 days (5.8 ± 2.2) and 45 to 60 day follow-up (6.2 ± 2.4).

Finally, the SOT question was obtained at 45 to 60 days (n=93) after treatment (Figure 5). The largest proportion (45.7%) reported "improved." The proportions of patients reporting as "not helped" was 25.0% compared to 29.3% of patients reporting as "partly cured" or "cured."

DISCUSSION

This study describes a collaborative primary care physical therapist/medical doctor model and provides initial data on generic simple outcomes related to PASS, GRNF, and SOT. To our knowledge this is the first report of outcomes from primary care for MS problems to report these simple generic outcomes. These outcomes contrast with generic health domains such as PROMIS, which focus on actionable areas of need from the perspective of the patient's perceived health status, eg, fatigue or physical function. The outcomes used in this case provide global benchmarks to judge whether the overall service is meeting patient needs based on how "livable" current symptoms are (PASS), whether the patient perceives him or herself as "normal," and whether he or she perceives the treatment received a success. These outcomes present a mixed view of the collaborative service. However, because there is no previous data on the same outcomes for comparison, it is difficult to know if this is better than previous performance.

The description of the collaborative physical therapist/medical doctor service contrasts with current primary care services that focus on direct access.[1] A current review of direct access services notes that although direct access services are available, few patients access care through this mechanism.[1] Current models of emergency department services note standing orders for specific MS problems that allow therapists to engage in clinical decision-making independently.[49] The described collaborative service combines both direct access and collaborative care in a primary care environment (Table 1). A key advantage to this approach is achieving greater access to patients that may benefit from physical therapy services.[2] What is

Table 2. Simple Outcomes Used to Assess Collaborative Medical Doctor/Physical Therapist Primary Care Service

Global Rating of Normal Function (GRNF)	How would you rate the function of your ______________ **[Fill in problem]** on a scale of 0 to 10 with 10 being normal, excellent function, and 0 being the inability to perform any of your usual daily activities which may include sports?
Patient Acceptable Symptom State (PASS)	Taking into account all the activity you have during your daily life, your level of pain, and also your functional impairment, do you consider that the current state of your foot and ankle is satisfactory?
Success of Treatment (SOT)	How successful was the treatment for your problem? Not Helped Improved Partly Cured Cured

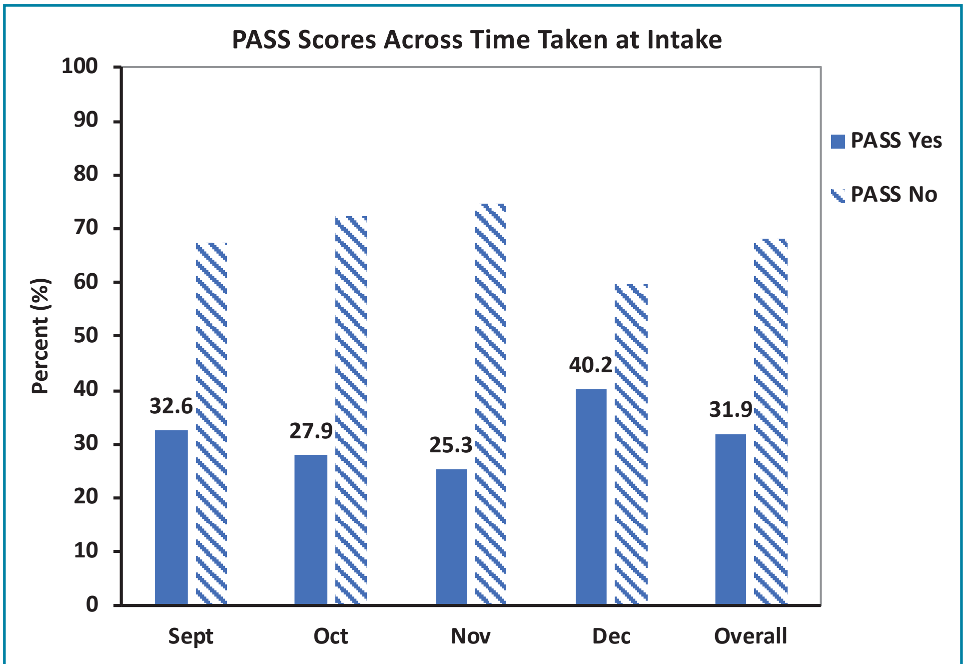


Figure 3. Patient acceptable symptoms state (PASS) question at intake (prior to treatment) (N=402) over a 4-month period.

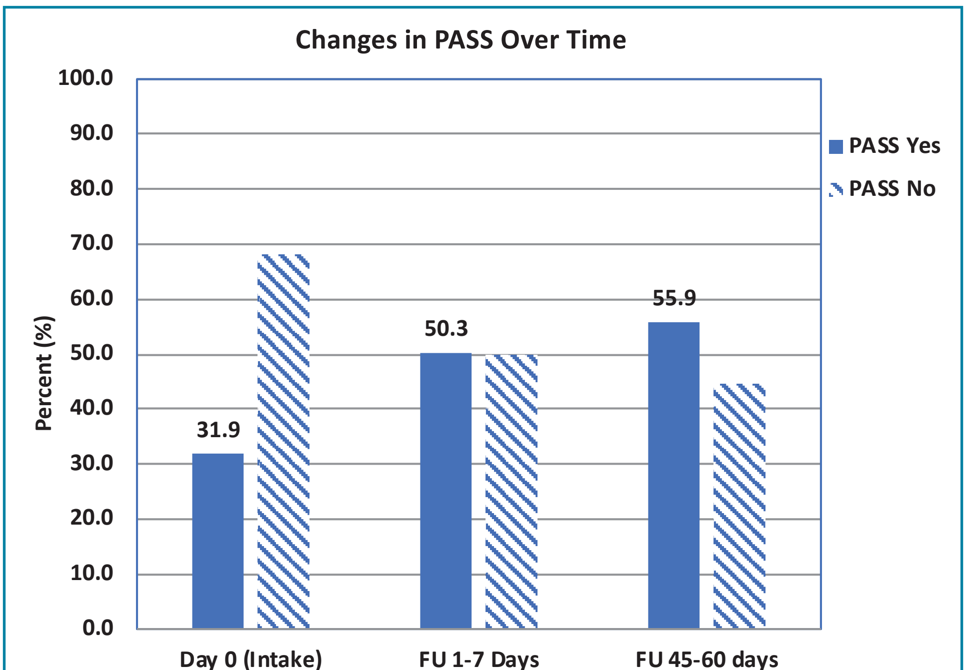


Figure 4. Patient acceptable symptoms state (PASS) question at intake (prior to treatment) (N=402), 1 to 7 days after treatment (N=157) and 45 to 60 days (N=93) after treatment.

unique in this model is that the role of the physical therapist is focused on improving primary care service either independently or by sharing management for MS problems. This will likely lead to an extension of the role of physical therapy in caring for other medical problems such as geriatric care and cardiovascular problems. However, long-term, ongoing assessment will be a relevant part of this service.[11,12]

The PASS question showed a clear trend toward improvement, especially over the 1 to 7 day intake interval. Surprisingly, at intake there were a significant number of patients that were PASS "Yes" (25-40%). This suggests that these patients had either relatively minor problems to start with or were primarily seeking reassurance. This underscores an unanticipated use of the PASS question. The PASS may serve at intake as a quick benchmark to assist the clinician in understanding the primary reason for the visit, reassurance or symptom/activity problems severe enough to interfere with normal function. The PASS question also showed differences at specific time points. The proportion of patients reporting PASS "Yes" at 1 to 7 day follow-up was ~18% higher than at intake. The difference between 1 to 7 days and 45 to 60 days was much smaller (5.6%), suggesting few patients likely experienced continued improvement or natural recovery after the 1 to 7 days. This data suggests early assessment using PASS could be effective for monitoring treatment outcomes. The overall outcome suggests the majority were satisfied with their symptoms/activity, however, a large proportion of patients remained PASS "No" (~44%) even at 45 to 60 days follow-up.

The GRNF rating underscore that patients continued to feel their joint or body region was not normal. The average GRNF score at 45 to 60 days was 6.2 ± 2.4 out of 10. Outcomes from standard physical therapy services are arguably better on disease specific scales.[27] However, these scales do not reference normal and only sample a small and distinct group of patients that attend physical therapy. It is unclear if physical therapy applied to a much broader sample would see similar success.[14] The GRNF rating suggests on average patients were not feeling "normal" as a result of time or treatments received.

The SOT question showed a large majority of patients felt helped ("improved," "partly cured," or "cured") in response to their treatment (Figure 5). This question directly asks patients to assign a benefit to the treatment received. At 45 to 60 days, a majority of patients (45.7%) felt "improved," 21.7% "partly cured," and 7.6% "cured." Only a small minority (20%) felt "not helped." This data suggests that although most patients received minimal care they assigned benefit to the treatment even 45 to 60 days after their primary care encounter.

While these simple generic questions lack specificity of other generic measures such as PROMIS, they offer a quick profile of how a service is performing from a patient's perspective. At face value, services whose outcomes are associated with a majority of patients that find their condition livable (PASS Yes), see their body as "Normal," and attribute benefit to the treatment received should be seen as successful. And, services where a majority of

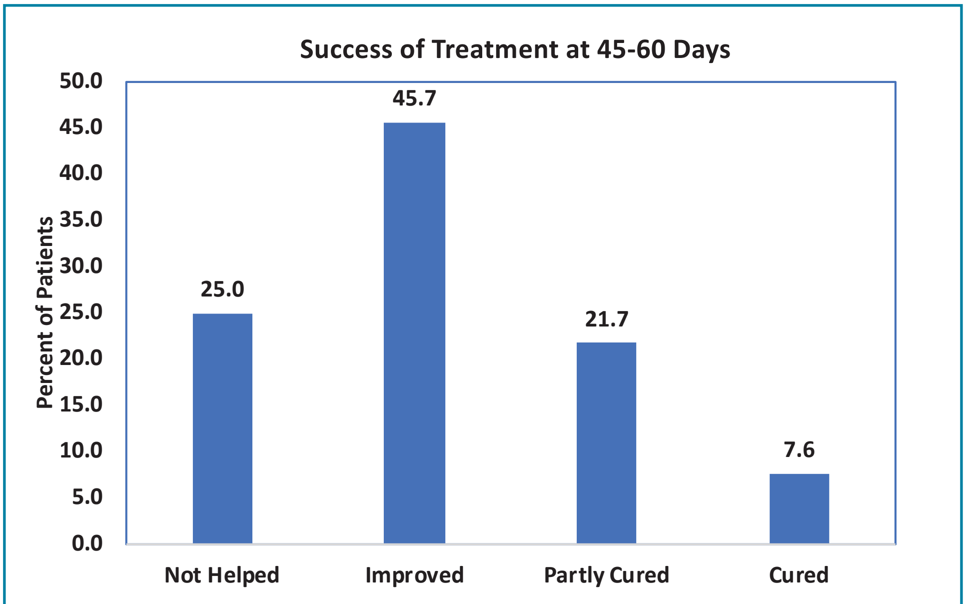


Figure 5. The success of treatment question responses at 45 to 60 days (N=93) after treatment.

people find their condition not livable (PASS No), their body as "Abnormal," and respond that the treatment was "Not Helpful" should be revised. Although anecdotal, an example interpretation of how the 3 questions could lead to prioritization of services that are in urgent, moderate, or low priority for revision are suggested (Table 3). Applying this example to the collaborative medical doctor/physical therapist service presented here deems it in moderate need of revision.

Limitations

There are currently many different outcome assessments evolving. This data focused on a few generic outcome questions. Also, the data represents cross sectional measures at each time point. A prospective sample followed longitudinally would be preferred. The collaborative service was new and provided minimal services to patients. Whether this service improved on medical doctor only care has not been answered. The outcomes themselves, irrespective of how the service is delivered, show there is room for significant improvement in care management associated with MS problems presenting in primary care.

CONCLUSIONS

This study of the collaborative medical doctor/physical therapy service suggests point of care collaborations that may benefit patients in primary care with significant opportunities in existing integrated primary care models. The simple generic assessment questions were very efficient and provide for assessment of 3 distinct patient outcomes. These individual questions may serve as a basic set of patient outcomes or complement other PRO assessments to determine the success of service models.

Table 3. Example Interpretation of Scores on the Three Outcome Questions and How They Might Be Used to Trigger a Revision of Care

	Urgent Need for Revision–Are New Approaches Available?	Moderate Need for Revision–Weigh Value of New Approaches Available?	No Need for Revision
PASS	>50% PASS Yes	50-70% PASS Yes	PASS Yes >70%
GRNF	GRNF < 5	GRNF 5-7	GRNF >7
SOT	Not Helped >30% Partly Cured or Cured <30%	Not Helped 20% to to 30% Most patients Improved but Not Cured	Not Helped <10% Partly Cured or Cured >50%

Abbreviations: PASS, patient acceptable symptom state; GRNF, global rate of normal function; SOT, success of treatment

REFERENCES

1. Boissonnault WG, Lovely K. Hospital-based outpatient direct access to physical therapist services: current status in Wisconsin. *Phys Ther*. 2016;96(11):1695-1704.
2. Frogner BK, Harwood K, Pines J, Andrilla H, Schwartz M, Washington TG. Does unrestricted direct access to physical therapy reduce utilization and health spending? *Health Care Cost Institute*. Issue Brief, Feburary 25, 2016.
3. Pendergast J, Kliethermes SA, Freburger JK, Duffy PA. A comparison of health care use for physician-referred and self-referred episodes of outpatient physical therapy. *Health Serv Res*. 2012;47(2):633-654. doi: 10.1111/j.1475-6773.2011.01324.x. Epub 2011 Sep 23.
4. Bodenheimer T, Sinsky C. From triple to quadruple aim: care of the patient requires care of the provider. *Ann Fam Med*. 2014;12(6):573-576. doi: 10.1370/afm.1713.
5. Casey CM, Parker EM, Winkler G, Liu X, Lambert GH, Eckstrom E. Lessons learned from implementing CDC's STEADi falls prevention algorithm in primary care. *Gerontologist*. 2017;57(4):787-796.
6. Eckstrom E, Parker EM, Lambert GH, Winkler G, Dowler D, Casey CM. Implementing STEADI in academic primary care to address older adult fall risk. *Innov Aging*. 2017;1(2):1-9.
7. Porter ME, Pabo EA, Lee TH. Redesigning primary care: a strategic vision to improve value by organizing around patients' needs. *Health Aff (Millwood)*. 2013;32(3):516-525. doi: 10.1377/hlthaff.2012.0961.
8. Jackson GL, Powers BJ, Chatterjee R, et al. Improving patient care. The patient centered medical home. a systematic review. *Ann Intern Med*. 2013;158(3):169-178.
9. Salisbury C. Multimorbidity: redesigning health care for people who use it. *Lancet*. 2012;380(9836):7-9. doi: 10.1016/S0140-6736(12)60482-6. Epub 2012 May 10.

10. Violan C, Foguet-Boreu Q, Flores-Mateo G, et al. Prevalence, determinants and patterns of multimorbidity in primary care: a systematic review of observational studies. *PLoS One*. 2014;9(7):e102149. doi: 10.1371/journal.pone.0102149. eCollection 2014.
11. Porter ME. What is value in health care? *N Engl J Med*. 2010;363(26):2477-2481. doi: 10.1056/NEJMp1011024. Epub 2010 Dec 8.
12. Porter ME, Lee TH. The strategy that will fix health care. *Harv Bus Rev*. 2013;(10):50-70.
13. Baumhauer JF. Patient-reported outcomes-are they living up to their potential? *N Engl J Med*. 2017;377(1): 6-9. doi: 10.1056/NEJMp1702978.
14. Fritz JM, Magel JS, Mcfadden M, et al. Early physical therapy vs usual care in patients with recent-onset low back pain a randomized clinical trial. *JAMA*. 2015;314(14):1459-1467. doi: 10.1001/jama.2015.11648.
15. Fritz JM, Childs JD, Wainner RS, Flynn TW. Primary care referral of patients with low back pain to physical therapy: impact on future health care utilization and costs. *Spine (Phila Pa 1976)*. 2012;37(25):2114-2121. doi:10.1097/BRS.0b013e31825d32f5.
16. Fritz JM, Kim M, Magel JS, Asche CV. Cost-effectiveness of primary care management with or without early physical therapy for acute low back pain: economic evaluation of a randomized clinical trial. *Spine (Phila Pa 1976)*. 2017;42(5):285-290. doi:10.1097/BRS.0000000000001729.
17. Bornhoft L, Larsson ME, Thena J. Physiotherapy in primary care triage –the effects on utilization of medical services at primary health care clinics by patients and sub-groups of patients with musculoskeletal disorders: a case-control study. *Physiother Theory Pract.* 2015;31(1):45-52. doi: 10.3109/09593985.2014.932035. Epub 2014 Jul 2.
18. Bornho L, Larsson ME, Thorn J. Physiotherapy in primary care triage–the effects on utilization of medical services at primary health care clinics by patients and sub-groups of patients with musculoskeletal disorders: a case-control study. *Physiother Theory Pract*. 2015;31(1):45-52. doi:10.3109/09593985.2014.932035.
19. Samsson KS, Larsson ME. Physiotherapy triage assessment of patients referred for orthopaedic consultation - long-term follow-up of health-related quality of life, pain-related disability and sick leave. *Man Ther*. 2015;20(1):38-45. doi:10.1016/j.math.2014.06.009.
20. Samsson KS, Bernhardsson S, Larsson ME. Perceived quality of physiotherapist-led orthopaedic triage compared with standard practice in primary care: a randomised controlled trial. *BMC Musculoskelet Disord*. 2016;17:257. doi:10.1186/s12891-016-1112-x.
21. Papuga MO, Dasilva C, McIntyre A, Mitten D, Kates S, Baumhauer JF. Large-scale clinical implementation of PROMIS computer adaptive testing with direct incorporation into the electronic medical record. *Health Systems*. 2018;7(1):1-12.
22. Emerson Kavchak AJ, Cook C, Hegedus EJ, Wright AA. Identification of cut-points in commonly used hip osteoarthritis-related outcome measures that define the patient acceptable symptom state (PASS). *Rheumatol Int*. 2013;33(11):2773-2782. doi: 10.1007/s00296-013-2813-1. Epub 2013 Jun 29.
23. Kvien TK, Heiberg T, Hagen B. Minimal clinically important improvement/difference (MCII/ MCID) and patient acceptable symptom state (PASS): what do these concepts mean? *Ann Rheum Dis*. 2007;66 (suppl 3):iiii 40-41.
24. Levy DM, Kuhns BD, Chahal J, Philippon MJ, Kelly BT, Nho SJ. Hip arthroscopy outcomes with respect to patient acceptable symptomatic state and minimal clinically important difference. *Arthroscopy.* 2016;32(9):1877-1886. doi: 10.1016/j.arthro.2016.05.014. Epub 2016 Jun 18.
25. Muller B, Yabroudi Ma, Lai C-L, et al. Defining patient acceptable symptom state thresholds for the IKDC Subjective Knee Form and KOOS for patients undergoing ACL reconstruction. *Orthop J Sports Med*. 2013;1(4 suppl):9-11. doi: 10.1177/2325967113S00069.
26. Salaffi F, Carotti M, Gutierrez M, Carlo MD, Angelis RD. Patient acceptable symptom state in self-report questionnaires and composite clinical disease index for assessing rheumatoid arthritis activity: identification of cut-off points for routine care. *Biomed Res Int*. 2015;2015:930756. doi.10.1155/2015/930756 Epub 2015 Jun 18.
27. Wright AA, Hensley CP, Gilbertson J, Leland JM 3rd, Jackson S. Defining patient acceptable symptom state thresholds for commonly used patient reported outcomes measures in general orthopedic practice. *Man Ther*. 2015;20(6):814-819. doi: 10.1016/j.math.2015.03.011. Epub 2015 Mar 27.
28. Aas IH. Guidelines for rating Global Assessment of Functioning (GAF). *Ann Gen Psychiatry*. 2011;10:2. doi: 10.1186/1744-859X-10-2.
29. Hawthorne G, Sansoni J, Hayes L, Marosszeky N, Sansoni E. Measuring patient satisfaction with health care treatment using the Short Assessment of Patient Satisfaction measure delivered superior and robust satisfaction estimates. *J Clin Epidemiol*. 2014;67(5):527-537. doi: 10.1016/j.jclinepi.2013.12.010.
30. Stiell IG, Clement CM, O'Connor A, et al. Multicentre prospective validation of use of the Canadian C-Spine Rule by triage nurses in the emergency department. *CMAJ*. 2010;182(11):1173-1179. doi: 10.1503/cmaj.091430. Epub 2010 May 10.
31. Michaleff ZA, Maher CG, Verhagen AP, Rebbeck T, Lin CW. Accuracy of the Canadian C-spine rule and NEXUS to screen for clinically important cervical spine injury in patients following blunt trauma: a systematic review. *CMAJ*. 2012;184(16):E867-876. doi: 10.1503/cmaj.120675 Epub 2012 Oct 9.
32. Flynn TW, Smith B, Chou R. Appropriate use of diagnostic imaging in low back pain: a reminder that unnecessary imaging may do as much harm as good. *J Orthop Sports Phys Ther*. 2011;41(11):838-846. doi: 10.2519/jospt.2011.3618. Epub 2011 Jun 3.
33. Pedowitz RA, Yamaguchi K, Ahmad CS, et al. American Academy of Orthopaedic Surgeons Clinical Practice Guideline on: optimizing the management of rotator cuff problems. *J Bone Joint Surg Am*. 2012;94(2):163-167.
34. Yao K, Haque T. The Ottawa knee rules: a useful clinical decision tool. *Aust Fam Physician*. 2012;41(4):223-224.
35. Delitto A, George SZ, Van Dillen LR, et al. Low back pain. Clinical Practice Guidelines Linked to the International

Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2012;42(4):A1-57. doi: 10.2519/jospt.2012.0301. Epub 2012 Mar 30.
36. Blanpied PR, Gross AR, Elliott JM, et al. Neck pain: revision 2017. *J Orthop Sports Phys Ther*. 2017;47(7):A1-A83. doi: 10.2519/jospt.2017.0302.
37. Vibe Fersum K, O'Sullivan P, Skouen JS, Smith A, Kvåle A. Efficacy of classification-based cognitive functional therapy in patients with non-specific chronic low back pain: a randomized controlled trial. *Eur J Pain*. 2013;17(6):916-928. doi: 10.1002/j.1532-2149.2012.00252.x. Epub 2012 Dec 4.
38. O'Sullivan PB, Caneiro JP, O'Keeffe M, et al. Cognitive functional therapy: an integrated behavioral approach for the targeted management of disabling low back pain. *Phys Ther*. 2018;98(5):408-423. doi: 10.1093/ptj/pzy022.
39. Cañeiro JP, Ng L, Burnett A, Campbell A, O'Sullivan P. Cognitive functional therapy for the management of low back pain in an adolescent male rower: a case report. *J Orthop Sports Phys Ther*. 2013;43(8):542-554. doi: 10.2519/jospt.2013.4699. Epub 2013 Jun 11.
40. O'Sullivan P, Caneiro JP, O'Keeffe M, O'Sullivan K. Unraveling the complexity of low back pain. *J Orthop Sports Phys Ther*. 2016;46(11):932-937.
41. Flynn TW, Wainner RS, Fritz JM. Spinal manipulation in physical therapist professional degree education: a model for teaching and integration into clinical practice. *J Orthop Sports Phys Ther*. 2006;36(8):577-587.
42. Olaya-Contreras P, Styf J, Arvidsson D, Frennered K, Hansson T. The effect of the stay active advice on physical activity and on the course of acute severe low back pain. *BMC Sports Sci Med Rehabil*. 2015;7:19. doi: 10.1186/s13102-015-0013-x. eCollection 2015.
43. Ben-Ami N, Chodick G, Mirovsky Y, Pincus T, Shapiro Y. Increasing recreational physical activity in patients with chronic low back pain: a pragmatic controlled clinical trial. *J Orthop Sports Phys Ther*. 2017;47(2):57-66.
44. Muller B, Yabroudi Ma, Lynch A, et al. Defining thresholds for the patient acceptable symptom state for the IKDC Subjective Knee Form and KOOS for patients who underwent ACL reconstruction. *Am J Sports Med*. 2016;44(11):2820-2826.
45. Tashjian RZ, Deloach J, Porucznik CA, Powell AP. Minimal clinically important differences (MCID) and patient acceptable symptomatic state (PASS) for visual analog scales (VAS) measuring pain in patients treated for rotator cuff disease. *J Shoulder Elbow Surg*. 2009;18(6):927-932. doi: 10.1016/j.jse.2009.03.021. Epub 2009 Jun 16.
46. Irrgang JJ, Anderson AF, Boland AL, et al. Development and validation of the international knee documentation committee subjective knee form. *Am J Sports Med*. 2001;29(5):600-613.
47. Martin RL, Irrgang JJ, Burdett RG, Conti SF, Van Swearingen JM. Evidence of validity for the Foot and Ankle Ability Measure (FAAM). *Foot Ankle Int*. 2005;26(11):968-983.
48. Anderson MR, Baumhauer JF, DiGiovanni BF, et al. Determining success or failure after foot and ankle surgery using Patient Acceptable Symptom State (PASS) and Patient Reported Outcome Information System (PROMIS). *Foot Ankle Int*. 2018;39(8):894-902. doi.10.1177/1071100718769666.
49. Lebec MT, Jogodka CE. The physical therapist as a musculoskeletal specialist in the emergency department. *J Orthop Sports Phys Ther*. 2009;39(3):221-229. doi: 10.2519/jospt.2009.2857.

Employing Evidence-based Clinical Decision-making in Physical Therapy Management of Patellar Tendinopathy

Jason Brumitt, PT, PhD, ATC, CSCS[1]
Marcey Keefer-Hutchison, PT, DPT, SCS, ATC, CMP[1]
Nicole Jones, PT, DPT[1]
Dacia House, PT, DPT[1]
Katherine Porter, PT, DPT[1]

[1]George Fox University, Newberg, OR

ABSTRACT

Background and Purpose: Patellar tendinopathy is a challenging condition to treat. Numerous conservative and invasive procedures have been attempted; however, some individuals with patellar tendinopathy fail to fully recover with treatment. The purpose of this article is to discuss the pathophysiology associated with this condition, detail a differential diagnosis for musculoskeletal conditions of the anterior knee, highlight examination priorities for patella tendinopathy (also known as jumper's knee), and review conservative evidence-based treatments. **Methods:** Medline (1950 – May 2018) and CINAHL (1982 – May 2018) were searched to identify relevant research related to this report. **Findings:** Several exercise strategies have been developed for patients with patellar tendinopathy. Evidence supports prescribing a single-leg squat exercise performed on a 25º decline board; however, there may be clinical situations where alternate treatment protocols are warranted. **Clinical Relevance:** Physical therapists should prescribe, at a minimum, the single-leg squat exercise performed on a decline board for patients with patellar tendinopathy. Patients who do not tolerate the pain that might be associated with the decline squat could initially be prescribed an isometric or an isotonic training program. **Conclusion:** Therapeutic exercise programs for patellar tendinopathy have demonstrated improvements in pain, function, and allowed athletes to return to sport. However, conservative treatment programs may not always be successful; therefore, invasive procedures are sometimes warranted. Additional research is warranted to determine the most efficacious exercise approach.

Key Words: athlete, eccentric exercise, jumper's knee, tendinitis, tendinosis

CASE INTRODUCTION

A 20-year-old male NCAA Division II collegiate basketball player has been referred by the team's physician to physical therapy for evaluation and treatment of his right anterior knee pain. The athlete reports that he has been experiencing pain "somewhere on the front of his knee" while playing basketball for the last 3 months. He reports experiencing pain when rebounding and sometimes when performing a jump stop. To prepare for the upcoming season he has been playing basketball 4 days a week and weightlifting 5 days a week. His goal is to be able to play this season without pain.

This case example describes a common musculoskeletal condition known as "jumper's knee." As the name implies, jumper's knee is an overuse injury that is experienced by the athlete who frequently jumps during his or her sport (eg, basketball, volleyball). The purpose of this article is to discuss the pathophysiology associated with this condition, detail a differential diagnosis for musculoskeletal conditions of the anterior knee, highlight examination priorities for patella tendinopathy (also known as jumper's knee), and review conservative evidence-based treatments.

INTRODUCTION

Patellar tendinopathy is an overuse injury affecting athletic individuals (age range 14 - 30 years), and is most frequently reported by athletes who play volleyball and basketball.[1-4] Repetitive microtrauma, likely the result from loading the tendon during jumping and landing, leads to microrupture of tendon fibers and associated histopathological changes.[5] Patellar tendinopathy occurs primarily at the tendon's insertion at the inferior portion of the patella[6,7]; however, it has also been found at the tibial tubercle insertion site and proximal to the patella.[8,9] Prevalence of patellar tendinopathy, also known as jumper's knee, has been reported to occur in over 30% of elite male basketball players and over 50% in high level male volleyball players.[4,10-12]

Patellar tendinopathy is a challenging condition to treat. Numerous conservative and invasive procedures have been attempted; however, some individuals with patellar tendinopathy fail to fully recover with treatment. Many athletes will play with pain or continue to play with some level of pain after cessation of treatment while others will prematurely retire from their sport due to this condition.[6,13]

PATHOPHYSIOLOGY

The term tendinopathy is an umbrella term describing a diseased tendon. Under the tendinopathy umbrella are the conditions tendinitis and tendinosis. Tendinitis denotes that the tendon is diseased and involves an inflammatory process whereas tendinosis denotes a degenerative tendon state that is thought to lack an inflammatory component. These are important distinctions because treatment approaches for each condition differ. For example, a physical therapist may elect to use a variety of treatments, including some modalities, for an acute injury (eg, tendinitis) whereas the primary treatment for a chronic tendon injury (eg, tendinosis) is exercise (see forthcoming discussion). Some have suggested that there may be an inflammatory component associated with tendinosis.[14-16] For example, several inflammatory markers including prostaglandin have been identified in individuals with patellar tendon pain.[17,18] Regardless of the presence of inflammation, patellar tendinopathy is marked by degenerative changes and histopathological changes and there is no evidence to support the use of certain physical therapy treatments (eg, modalities) for tendinosis.

RISK FACTORS

Several risk factors for developing patellar tendinopathy have been presented in the literature: lower extremity strength, quadriceps and hamstring flexibility, weight, body mass index, leg length difference, ultrasonographic evidence of patellar tendon abnormality, waist-to-hip ratio, jump performance, higher vertical ground reaction forces, and training volumes.[1,9,19-27] However, many of the cited risk factors have been reported in cross-sectional studies; therefore, prospective cohort studies are needed to elucidate the significance of each factor to patellar tendinopathy onset.

EXAMINATION

Diagnosis of patellar tendinopathy is frequently based on patient history of pain, pain with palpation to the patellar tendon, pain with loading/activity, and is confirmed by imaging.[28,29] A patient with a suspected case of patellar tendinopathy will likely report a gradual onset of symptoms versus a traumatic mechanism of injury. The subjective information provided by the patient will allow the physical therapist to generate primary and alternate hypotheses (diagnoses); these diagnoses will help guide the therapist's decisions as to which tests and measures should be performed during the examination.

The patient's history may reveal clinical features associated with patellar tendinopathy. For example, it is common that patients with patellar tendinopathy may have had a prior history of jumper's knee and/or a prolonged period of symptoms of 3 or more months.[29] A patient will often report pain during loading/activity and increased pain the day after a provocative event.[29,30] A patient with patellar tendinopathy may also report pain when ascending/descending stairs or when sitting for prolonged periods.[29] It is important to note that these pain provoking activities are also experienced by those with other diagnoses for anterior knee pain and should be considered as part of the differential diagnosis.[31]

If a patient has been referred with a diagnosis of patellar tendinopathy or when the condition has been diagnosed by the physical therapist, every patient should complete the Victorian Institute of Sport Assessment – Patella (VISA-P) questionnaire when completing the intake paperwork.[32,33] The VISA-P is a pen-and-paper outcome tool that is used to assist in the diagnosis of patellar tendinopathy and to track progress during rehabilitation.[33] This tool uses a 100-point scale and a score of 80 or below suggests the presence of patellar tendinopathy.[20,34,35] It has been recommended to re-administer the VISA-P tool every 4 weeks.[29] The minimal clinically important difference associated with the VISA-P is 13 points.[32]

A diagnosis of patellar tendinopathy may appear simple: patellar tendon pain with loading/activity, pain with palpation to the tendon, and confirmed by imaging the tendon with a diagnostic ultrasound. However, a clinician should perform a comprehensive musculoskeletal examination to identify deficits and to rule out alternate diagnoses. Table 1 presents components of the examination that should be included as part of the comprehensive musculoskeletal examination when patellar tendinopathy is suspected and the typical findings associated with patellar tendinopathy for those tests and measures.

Diagnostic Ultrasound Imaging

Diagnostic ultrasound imaging of the patellar tendon has value in confirming the diagnosis of patellar tendinopathy.[1,29,33,39] The presence of a patellar tendon abnormality is marked by a hypoechoic region (Figure 1) and/or a thickened tendon. The hypoechoic region is a darker region located within the tissue (Figure 2). Ultrasound imaging is considered the gold standard test for patellar tendon abnormality.[33,35]

To collect images of the patellar tendon, the athlete should assume a supine position on a treatment table with the knee flexed to 110°. Multiple images including transverse and longitudinal views should be collected. A longitudinal view of the patellar tendon will display the tendon structure from the distal pole of the patella to its insertion site. Transverse views will display cross-sectional images at the proximal and distal insertion points and at the midpoint of the tendon. Correlating suspected lesions between the two views assists in determining the presence of the condition.

TREATMENT

A variety of treatments are prescribed by rehabilitation professionals and by orthopedic physicians for patients with patellar tendinopathy. Therapeutic exercise is the primary treatment used by physical therapists and other rehabilitation clinicians.[35,40-43] Extracorporeal shockwave therapy, surgery, ultrasound-guided intra-tissue percutaneous electrolysis, sclerosing injections, medication, and platelet-rich plasma injections may be used by physicians.[40,44-54]

Physical Therapy

The primary conservative treatment modality for patients with patellar tendinopathy is therapeutic exercise. In the past two decades several exercise strategies for patients with patellar tendinopathy have been proposed.[41-43,49,55-60] Eccentric loading of the patellar tendon has received the most attention in the literature; however, recent reports suggest a potential role for prescribing either isotonic (exercises including both concentric and eccentric components) or isometric exercises.[49,55-60]

Table 1. Examination Priorities for a Patient with Patellar Tendinopathy

Domain	Typical Findings
Patient History[29,33]	Prior history of patellar tendinopathy and report of pain with loading, eg, jumping, climbing stairs. Pain, as measured by Visual Analog Scale. Decreased function as measured by Victorian Institute of Sport Assessment – Patella questionnaire.
Manual Muscle Testing[26,37,38]	Weakness in one or more of the following muscles: gluteus maximus, gluteus medius, quadriceps, hamstrings, gastrocnemius, and soleus.
Flexibility Testing[28]	
Thomas Test	Decreased quadriceps flexibility
Straight Leg Raise	Deceased hamstring flexibility
Range of Motion Testing[21,36]	Decreased ankle dorsiflexion range of motion.
Weight-bearing ankle dorsiflexion range of motion	Backman et al[21] found ankle range of motion of under 36.5º as a risk factor for developing patellar tendinopathy in junior elite basketball players.
Functional Testing	
Single-Leg Decline Squat[33]	Patient will report pain; likely increasing as knee flexion angle increases.
Jump or Hop Tests	Patient will report pain; pain often worse with either longer jump/hops and/or drop jumps from greater heights.
Palpation[29]	Pain elicited with palpation to the inferior pole of the patella; pain may also be elicited from other locations along the tendon.

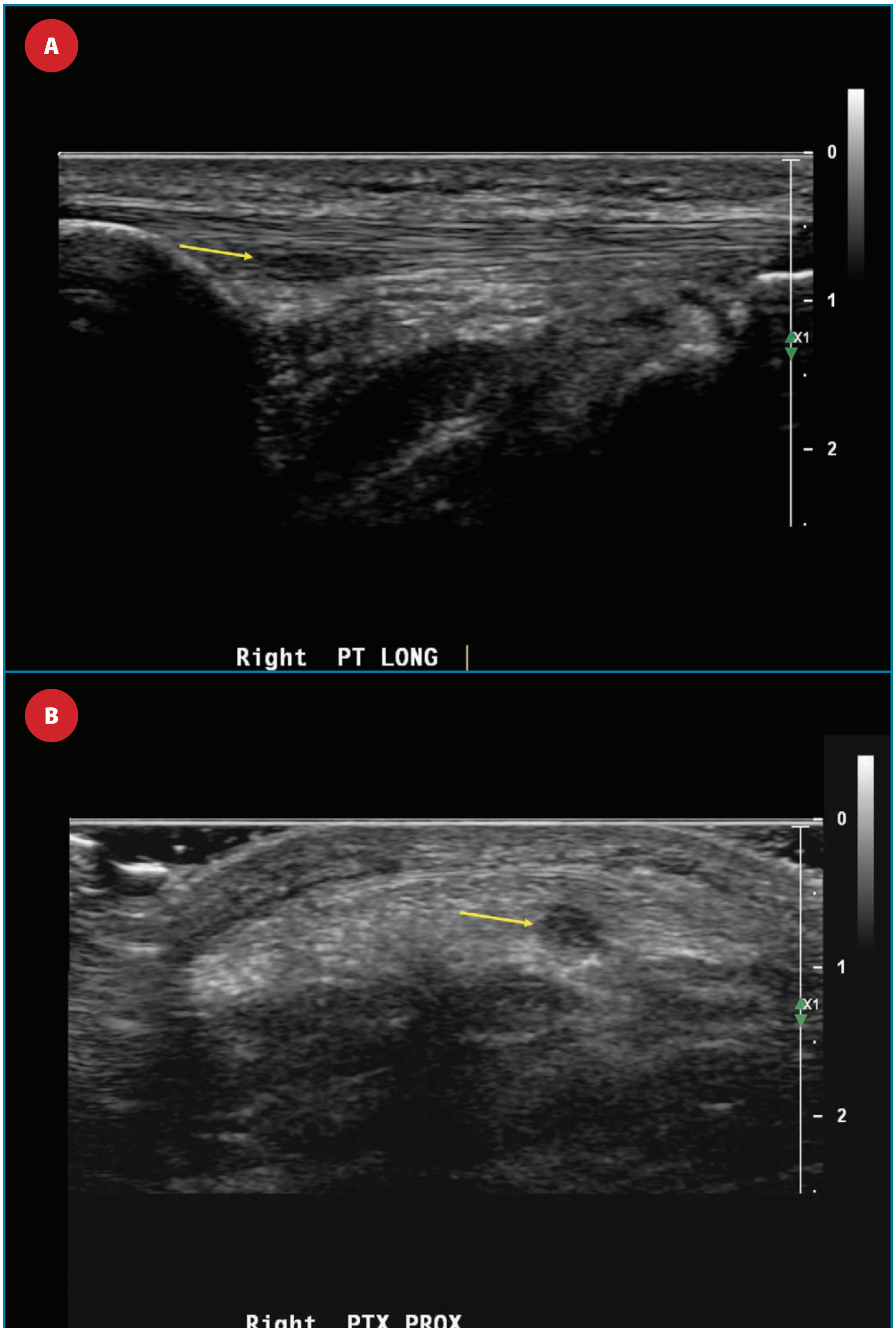


Figure 1. A, Right patellar tendon with hypoechoic region (longitudinal view). B, Right patellar tendon with hypoechoic region (cross-sectional view).

drop squat (eccentric exercise) group or to a leg extension/leg curl (concentric exercise) group. Subjects in the drop squat group (n = 10) performed this exercise for 3 sets of 20 repetitions 5 days a week. Use of hand weights were added once the subject was able to "easily" perform the desired sets/repetitions. Subjects (n = 9) in the concentric exercise group performed 3 sets of 10 repetitions of leg extensions and leg curls 5 days a week. Applied resistance was increased as the subject was able to complete the desired sets/repetitions. Both groups were allowed to use ice, anti-inflammatory medications, and to rest during the initial two weeks of the 12-week program. In addition, subjects in both groups were allowed to initiate a jogging program once their pain had resolved. Both groups experienced a significant improvement in pain scores; however, there was not a significant difference between groups. Hamstring strength significantly improved in both groups from baseline; interestingly quadriceps strength did not significantly increase from baseline. Ninety percent (9 of 10) of subjects in the drop squat group returned to sport by 12 weeks whereas only 66% (6 of 9) of subjects in the concentric group returned to sport by the end of the treatment program. While both groups experienced decreases in pain, some subjects in each group failed to improve and some reported an increase in pain. These results may have been influenced by the overall sample size and the prescribed exercise programs.

Studies subsequent to Cannell et al[55] have emphasized eccentrically loading the patellar tendon with the single-leg squat performed on a 25º decline squat board (Figure 3). Biomechanical analysis of the single-leg squat on a decline board has been evaluated in several studies.[62,67,68] Kongsgaard et al[62] found patella tendon strain and knee extensor muscle activation to be significantly greater during the single-leg squat on the decline board than the traditional version of the exercise. Zwerver et al[67] reported greater knee moment values when the decline was greater than 15º and the knee moment is increased when the subject wears a weighted backpack.

Purdam et al[56] compared outcomes such as pain and return to activity in subjects with patellar tendinopathy who performed either a unilateral squat on a 25º decline board or a unilateral squat with the foot flat on the ground. Subjects in both groups performed 3 sets of 15 repetitions twice a day of their respective exercise for 12 weeks. Subjects were instructed to squat to the point of 90º of knee flexion. Discomfort was allowed

Eccentric Loading

During a typical isotonic exercise, there is a concentric component (shortening) and an eccentric component (lengthening) of the muscle contraction. Isolated eccentric loading has become popular in the treatment of patellar tendinopathy and other tendinopathies.[41-43] It has been proposed that a tendon will undergo more load and stretch during an eccentric contraction compared to a concentric muscular contraction.[43,61,62] Eccentric exercise has been shown to stimulate collagen synthesis with deposition of Type I collagen at the tendon.[63-66]

A series of clinical studies have demonstrated the role for eccentric loading during a rehabilitation program for patients with patellar tendinopathy (Table 2). Cannell et al[55] randomized a small sample of subjects with patellar tendinopathy to either a

Figure 2. Right patellar tendon without hypoechoic region (longitudinal view).

when performing the exercises and subjects were instructed to increase the load during exercise by adding weight to a backpack whenever they experienced a decrease in discomfort during exercise. Subjects were also instructed to not participate in sport during the first 8 weeks of treatment but were allowed to resume painfree jogging or cycling during the final 4 weeks of treatment. Subjects in the decline squat group experienced a significant decrease in pain as measured by a Visual Analog Scale (VAS); whereas those in the traditional unilateral squat group did not. Sixty-six percent of subjects in the decline squat group were able to return to activity whereas only 11% in the non-decline squat group were able to return to preinjury status. Subjects from both groups who failed to recover from this treatment program were referred for surgery.

Young et al[69] compared pain and function in elite volleyball players who either performed a unilateral squat on a 25º decline board (n = 9) or a unilateral squat on a 10 cm step (n = 8). Both groups experienced significant improvements in pain on VAS and function reported on VISA-P after 12 weeks of treatment and at the one-year follow-up. However, subjects in the decline squat group experienced clinically significant improvements in VISA-P scores at 12 months.

Jonsson et al[57] found the decline squat protocol for 12 weeks (3x15 repetitions twice daily, pain allowed during exercise, increasing load by adding weights to backpack as pain lessened) was superior in reducing pain and improving function when compared to a concentric squat protocol on the decline board. Both groups were instructed to either squat to 70º (eccentric exercise) or extend from 70º (concentric exercise).

The decline squat exercise has also been compared to other modalities, exercises, and physician-based treatments. Stasinopoulos et al[70] reported significantly greater improve-

Table 2. Summary of Exercise Rehabilitation Programs for Patients with Patellar Tendinopathy

Drop Squat[55]	Single-Leg Squat on Decline Board[56,57,69]	Heavy Slow Resistance Training Program[49,60]	Rio et al Isometric and Isotonic Training Programs[58,59,70]
• Subject assumes a standing posture • Next, rapidly lowers body into the squat position with one's thighs approximately parallel to the ground • 3 sets of 20 repetitions • Hand weights are added when subject is able to perform desired sets/repetitions "easily" • Experience of pain during exercise is allowed	Program Details: • 3 sets x 15 repetitions performed on a 25º decline board (Figure 3) • Squat to 60º to 90º of knee flexion • Program performed 2 times a day for 12 weeks • Moderate pain during exercise performance is allowed • Load is increased by adding weight to a backpack once tendon pain decreases	Program Details: • 3 training sessions per week for 12 weeks • 3 exercises: squat, leg press, hack squat • 4 sets per exercise; repetitions vary per week Week 1: 15 repetitions Week 2-3: 12 repetitions Week 4-5: 10 repetitions Week 6-8: 8 repetitions Week 9-12: 6 repetitions • Each repetition duration 6 seconds: 3 seconds per eccentric component/3 seconds per concentric component • 2-3 minutes rest between sets • Knee flexed to 90º during each repetition	Isometric Program • Isometric knee extension with knee extension locked to 60º • 5 repetitions; each repetition held for 45 seconds • Performed at 70%[58]-80%[59,80] of maximum voluntary contraction • 1-2 minute rest between repetitions[58,59] Isotonic Program Leg extension exercise • 4 sets x 8 repetitions • 4 seconds per eccentric component, 3 seconds per concentric component • Load increased each week by 2.5%[58,59,80]

Figure 3. Unilateral squat performed on a 25° decline squat board.

ments in pain in subjects with patellar tendinopathy who performed a unilateral squat and stretching exercises for the quadriceps and hamstrings compared to those who either received pulsed ultrasound or 10 minutes of deep transverse friction massage to the tendon. The use of other physical agents such as cryotherapy may only be of benefit in acute (tendinitis) stages, whereas these modalities have not proven beneficial in chronic case (tendinosis).

Frohm et al[61] compared outcomes in subjects with patellar tendinopathy based on allocation to the decline squat training program or to eccentric training with the Bromsman device (squat exercise) performed two times per week. Subjects in both groups experienced improved VISA-P scores after 12 weeks and there were no differences in outcomes between groups.[61] Dimitrios et al[71] reported a benefit to include static stretching exercises to an eccentric exercise rehabilitation program. Subjects who performed the decline squat exercise program and stretching exercises for the quadriceps and hamstrings had significantly better VISA-P scores after treatment and at the 6-month follow-up session than those who only performed the decline squat program.

A decline squat program has been compared to, or included as part of, treatments offered by physicians like platelet-rich plasma, extracorporeal shockwave therapy, topical glyceryl trinitrate, corticosteroids, ultrasound-guided galvanic electrolysis technique, and intra-tissue percutaneous electrolysis.[42,44,45,49,50,52-54,72-75] The outcomes associated with many of the physician offered treatments are equivocal. Many have reported outcomes associated with the decline single-leg squat exercise to be superior or equal to invasive procedures. Many agree that management of patellar tendinopathy should be first attempted with an exercise program.

Should Athletes with Jumper's Knee Withdraw from Sport during Treatment?

Visnes et al[76] found initiating an eccentric exercise treatment program for an athlete with patellar tendinopathy during that athlete's sport season may not be effective at resolving symptoms. Elite amateur volleyball players with patellar tendinopathy performed single-leg decline squats on a 25º decline board 3 sets of 15 repetitions, 2 times a day increasing load as tolerated for a 12-week period. A control group of volleyball athletes performed their usual training programs. They found no change in VISA-P scores at short-term (6 weeks) or long-term (6 months) follow-up periods. The failure of those in the decline squat group to experience improvements in pain or function has been used as a rationale to evaluate other exercise regimens in athletes with patellar tendinopathy.

Not all health care providers agree that athletes should be removed from competing while rehabilitating. Saithna et al[77] conducted a systematic review to evaluate evidence associated with removing athletes from sport, or not, and success with therapy. They concluded that there is a lack of strong evidence to recommend that an athlete with patellar tendinopathy should be removed from sport, noting that many athletes improved with an eccentric loading exercise program while competing.

Isotonic and Isometric Exercise Programs

Exercise, whether eccentric or concentric in nature, will lead to collagen synthesis, blood flow increases, changes in tendon mechanical properties, and tissue hypertrophy.[78,79] Researchers argue that a pain provoking eccentric exercise program for a patient with jumper's knee may be ineffective if performed during the season and/or may exacerbate one's symptoms.[24,56,76] To address symptoms associated with patellar tendinopathy in athletes during their sport season, recent studies have investigated the role for isotonic and isometric exercises to reduce pain and improve function. In addition, it has been argued that eccentric versus concentric contraction in the treatment may not be as important as the load applied during exercise.[43]

Kongsgaard et al[49] conducted a randomized controlled trial comparing outcomes in patients who were allocated to either a decline squat group, a heavy slow resistance (HSR) training group, or a corticosteroid injection group (Table 2). All 3 groups experienced improvements in VAS and VISA-P scores at 12 weeks. The exercise groups maintained their improvements at the 6-month follow-up period; subjects in the HSR group were more satisfied with treatment than those in the decline squat group.[49] In a subsequent study, the HSR program found improvements in fibril morphology.[60]

Other researchers have been exploring the role of isometric and isotonic exercises in the treatment of patellar tendinopathy. Rio et al[58] compared pain post-exercise in a small population (n = 6) of volleyball players. Subjects either performed an isometric exercise or an isotonic exercise (see Table 2). Rio et al[58] found a single exercise session of isometric exercises significantly reduced pain during the single-leg squat test with pain reduction lasting 45 minutes. The isotonic program led to a significant, but smaller, reduction of pain immediately after exercise; however, this pain reduction was not maintained at the 45-minute mark.[58]

A follow-on study by van Ark et al[80] used a similar treatment program (Table 2). However, subjects performed exercises during 4 treatment sessions over the course of 4 weeks. In this larger study (n = 29) both groups experienced significant improvements in median pain scores during the single-leg squat test and there were no differences in outcomes between groups.

Using the aforementioned protocol, Rio et al[59] found again that both groups experienced pain reduction; however, isometric exercises were more effective in achieving immediate pain reduction. The VISA-P scores also improved over the 4-week period with no inbetween group differences. Rio et al[59] suggests that the exercises could be used to reduce one's pain prior to sport participation and/or after a training session.

Comprehensive Treatment Approach

Limitations associated with the decline squat exercise includes that some subjects have failed to recover or have experienced worsening symptoms. The isometric exercise, as well as the isotonic leg extension protocol, have demonstrated pain reduction associated with patellar tendinopathy in active individuals; however, these regimens have not been compared against either a decline squat program or the HSR program. The HSR program has demonstrated efficacy in reducing pain and higher patient satisfaction scores; however, this program requires access to several pieces of gym equipment.

Could a multi-modal approach provide better outcomes? Scattone Silva et al[81] applied a rehabilitation program consisting of therapeutic exercises and a jump-landing modification strategy in a 21-year-old male volleyball player with patellar tendinopathy. The program consisted of a two phase program performed 3 sessions per week for 8 weeks. In phase 1, prone hip extension with 90º of knee flexion and hip extension in quadruped with 90º of knee flexion were performed. In phase 2, the bird dog and single-limb deadlift were performed. The jump-landing modification during both phases emphasized a forward trunk lean, greater levels of hip flexion, and soft landings. The patient was able to participate in the rehabilitation program while continuing to compete in his sport. The patient was asymptomatic after completion of the program with improvements maintained at a 6-month follow-up session.

Treatment Recommendation

There are several therapeutic exercise approaches to treating patients with patellar tendinopathy. The factors that may influence the exercise program are dependent upon the patient's pain tolerance during exercise and/or if the patient is currently in-season. In those cases an isometric training program may be preferable. If a patient can tolerate loading during exercise and/or if the athlete is in their off-season, a physical therapist could prescribe either the decline squat program or an isotonic exercise program. Additional studies comparing an eccentric exercise protocol versus an isotonic exercise protocol are warranted to determine the most efficacious and cost-effective approach.

REFERENCES

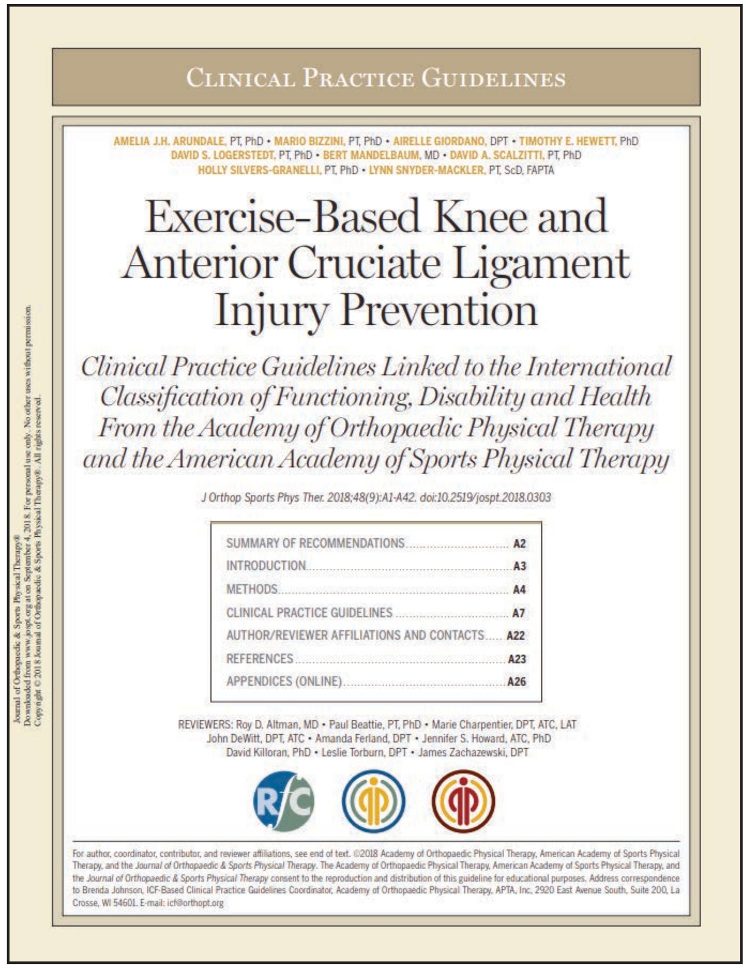
1. Cook JL, Khan KM, Kiss ZS, Purdam CR, Griffiths L. Prospective imaging study of asymptomatic patellar tendinopathy in elite junior basketball players. *J Ultrasound Med*. 2000;19(7):473-479.
2. Cook JL, Khan KM, Kiss ZS, Griffiths L. Patellar tendinopathy in junior basketball players: a controlled clinical and ultrasonographic study of 268 patellar tendons in players aged 14-18 years. *Scand J Med Sci Sports*. 2000;10(4):216-220.
3. Gisslen K, Alfredson H. Neovascularization and pain in jumper's knee: a prospective clinical and sonographic study in elite junior volleyball players. *Br J Sports Med*. 2005;39(7):423-428.
4. Lian OB, Engebretsen L, Bahr R. Prevalence of jumper's knee among elite athletes from different sports: a cross-sectional study. *Am J Sports Med*. 2005;33(4):561-567.
5. Abate M, Silbernagel KG, Siljeholm C, et al. Pathogenesis of tendinopathies: inflammation or degeneration? *Arthritis Res Ther*. 2009;11(3):235. doi: 10.1186/ar2723. Epub 2009 Jun 30.
6. Cook JL, Khan KM, Harcourt PR, Grant M, Young DA, Bonar SF. A cross sectional study of 100 athletes with jumper's knee managed conservatively and surgically. The Victorian Institute of Sport Tendon Study Group. *Br J Sports Med*. 1997;31(4):332-336.
7. Coleman BD, Khan KM, Maffulli N, Cook JL, Wark JD. Studies of surgical outcome after patellar tendinopathy: clinical significance of methodological deficiencies and guidelines for future studies. Victorian Institute of Sport Tendon Study Group. *Scand J Med Sci Sports*. 2000;10(1):2-11.
8. Ashford RL, Cassella JP, McNamara S, Stevens RM, Turner P. A retrospective magnetic resonance image study of patellar tendinosis. *Phys Ther Sport*. 2002;3(3):134-142.
9. Feretti A. Epidemiology of jumper's knee. *Sports Med*. 1986;3(4):289-295.
10. Lian O, Holen KJ, Engebretsen L, Bahr R. Relationship between symptoms of jumper's knee and the ultrasound characteristics of the patellar tendon among high level male volleyball players. *Scand J Med Sci Sports*. 1996;6(5):291-296.
11. Zwerver J, Bredeweg SW, van den Akker-Scheek I. Prevalence of jumper's knee among nonelite athletes from different sports. a cross-sectional survey. *Am J Sports Med.* 2011;39(9):1984-1988. doi: 10.1177/0363546511413370. Epub 2011 Jul 7.
12. Janssen I, van der Worp H, Hensing S, Zwerver J. Investigating Achilles and patellar tendinopathy prevalence in elite athletics. *Res Sports Med*. 2018;26(1): 1-12. doi: 10.1080/15438627.2017.1393748. Epub 2017 Oct 24.
13. Kettunen JA, Kvist M, Alanen E, Kujala UM. Long-term prognosis for jumper's knee in male athletes. A prospective follow-up study. *Am J Sports Med*. 2002;30(5):689-692.
14. Dean BJ, Gettings P, Dakin SG, Carr AJ. Are inflammatory cells increased in painful human tendinopathy? A systematic review. *Br J Sports Med*. 2016;50(4):216-220. doi: 10.1136/bjsports-2015-094754. Epub 2015 Aug 5.
15. Rees JD, Stride M, Scott A. Tendons–time to revisit inflammation. *Br J Sports Med*. 2014;48(21):1553-1557. doi: 10.1136/bjsports-2012-091957. Epub 2013 Mar 9.
16. Scott A, Backman LJ, Speed C. Tendinopathy: update on pathophysiology. *J Orthop Sports Phys Ther*. 2015;45(11):833-841. doi: 10.2519/jospt.2015.5884. Epub 2015 Sep 21.
17. Fu SC, Wang W, Pau HM, Wong YP, Chan KM, Rolf CG. Increased expression of transforming growth factor-beta 1 in patellar tendinosis. *Clin Orthop Relat Res*. 2002;(400):174-183.
18. Rolf CG, Fu BS, Pau A, Wang W, Chan B. Increased cell proliferation and associated expression of PDGFR-beta causing hypercellularity in patellar tendinosis. *Rheumatology (Oxford)*. 2001;40(3):256-261.
19. Fietzer AL, Chang YJ, Kulig K. Dancers with patellar tendinopathy exhibit higher vertical and braking ground reaction forces during landing. *J Sports Sci.* 2012;30(11):1157-1163. doi: 10.1080/02640414.2012.695080. Epub 2012 Jul 4.
20. Mann KJ, Edwards S, Drinkwater EJ, Bird SP. A lower limb assessment tool for athletes at risk of developing patellar tendinopathy. *Med Sci Sports Exerc*. 2013;45(3):527-533. doi: 10.1249/MSS.0b013e318275e0f2.
21. Backman LJ, Danielson P. Low range of ankle dorsiflexion predisposes for patellar tendinopathy in junior elite basketball players: a 1-year prospective study. *Am J Sports Med*. 2011;39(12):2626-2633. doi: 10.1177/0363546511420552. Epub 2011 Sep 14.
22. Khan KM, Maffulli N, Coleman BD, Cook JL, Taunton JE. Patellar tendinopathy: some aspects of basic science and

clinical management. *Br J Sports Med*. 1998;32(4):346-355.
23. Visnes H, Bahr R. Training volume and body composition as risk factors for developing jumper's knee among young elite volleyball players. *Scand J Med Sci Sports*. 2013;23(5):607-613. doi: 10.1111/j.1600-0838.2011.01430.x. Epub 2012 Jan 20.
24. Visnes H, Bahr R. The evolution of eccentric training as treatment for patellar tendinopathy (jumper's knee): a critical review of exercise programmes. *Br J Sports Med*. 2007;41(4):217-223.
25. de Vries AJ, van der Worp H, Diercks RL, van den Akker-Scheek I, Zwerver J. Risk factors for patellar tendinopathy in volleyball and basketball players: A survey-based prospective cohort study. *Scand J Med Sci Sports*. 2015;25(5):678-684. doi: 10.1111/sms.12294. Epub 2014 Aug 5.
26. Crossley KM, Thancanamootoo K, Metcalf BR, Cook JL, Purdam CR, Warden SJ. Clinical features of patellar tendinopathy and their implications for rehabilitation. *J Orthop Res*. 2007;25(9):1164-1175.
27. van der Worp H, de Poel HJ, Diercks RL, van den Akker-Scheek I, Zwerver J. Jumper's knee or lander's knee? A systematic review of the relation between jump biomechanics and patellar tendinopathy. *Int J Sports Med*. 2014;35(8):714-722. doi: 10.1055/s-0033-1358674. Epub 2014 Feb 27.
28. Witvrouw E, Bellemans J, Lysens R, Danneels L, Cambier D. Intrinsic risk factors for the development of patellar tendinitis in an athletic population. A two-year prospective study. *Am J Sports Med.* 2001;29(2):190-195.
29. Malliaras P, Cook J, Purdam C, Rio E. Patellar tendinopathy: clinical diagnosis, load management, and advice for challenging case presentations. *J Orthop Sports Phys Ther*. 2015;45(11):887-898. doi: 10.2519/jospt.2015.5987. Epub 2015 Sep 21.
30. Rio E, Moseley L, Purdam C, et al. The pain of tendinopathy: physiological or pathophysiological? *Sports Med*. 2014;44(1):9-23. doi: 10.1007/s40279-013-0096-z.
31. Wilk KE, Davies GJ, Mangine RE, Malone TR. Patellofemoral disorders: a classification system and clinical guidelines for nonoperative rehabilitation. *J Orthop Sports Phys Ther*. 1998;28(5):307-322.
32. Hernandez-Sanchez S, Hidalgo MD, Gomez A. Responsiveness of the VISA-P scale for patellar tendinopathy in athletes. *Br J Sports Med*. 2014;48(6):453-457. doi: 10.1136/bjsports-2012-091163. Epub 2012 Sep 25.
33. Mendonca Lde M, Ocarino JM, Bittencourt NF, Fernandes LM, Verhagen E, Fonseca ST. The accuracy of the VISA-P questionnaire, single-leg decline squat, and tendon pain history to identify patellar tendon abnormalities in adult athletes. *J Orthop Sports Phys Ther*. 2016;46(8):673-680. doi: 10.2519/jospt.2016.6192. Epub 2016 Jul 3.
34. Edwards S, Steele JR, McGhee DE, Beattie S, Purdam C, Cook JL. Landing strategies of athletes with an asymptomatic patellar tendon abnormality. *Med Sci Sports Exerc*. 2010;42(11):2072-2080. doi: 10.1249/MSS.0b013e3181e0550b.
35. Woodley BL, Newsham-West RJ, Baxter GD. Chronic tendinopathy: effectiveness of eccentric exercise. *Br J Sports Med*. 2007;41(4):188-198; discussion 199.
36. Bennell KL, Talbot RC, Wajswelner H, Techovanich W, Kelly DH, Hall AJ. Intra-rater and inter-rater reliability of a weight-bearing lunge measure of ankle dorsiflexion. *Aust J Physiother*. 1998;44(3):175-180.
37. Kountouris A, Cook J. Rehabilitation of Achilles and patellar tendinopathies. *Best Pract Res Clin Rheumatol*. 2007;21(2):295-316.
38. Hebert-Losier K, Schneiders AG, Newsham-West RJ, Sullivan SJ. Scientific bases and clinical utilization of the calf-raise test. *Phys Ther Sport*. 2009;10(4):142-149. doi: 10.1016/j.ptsp.2009.07.001. Epub 2009 Aug 5.
39. Cook JL, Khan KM, Kiss ZS, Purdam CR, Griffiths L. Reproducibility and clinical utility of tendon palpation to detect patellar tendinopathy in young basketball players. Victorian Institute of Sport tendon study group. *Br J Sports Med.* 2001;35(1):65-69.
40. Rodriguez-Merchan EC. The treatment of patellar tendinopathy. *J Orthop Traumatol.* 2013;14(2):77-81. doi: 10.1007/s10195-012-0220-0. Epub 2012 Dec 28.
41. Malliaras P, Barton CJ, Reeves ND, Langberg H. Achilles and patellar tendinopathy loading programmes: a systematic review comparing clinical outcomes and identifying potential mechanisms for effectiveness. *Sports Med*. 2013;43(4):267-286. doi: 10.1007/s40279-013-0019-z.
42. Larsson ME, Kall I, Nilsson-Helander K. Treatment of patellar tendinopathy–a systematic review of randomized controlled trials. *Knee Surg Sports Traumatol Arthrosc*. 2012;20(8):1632-1646. doi: 10.1007/s00167-011-1825-1. Epub 2011 Dec 21.
43. Couppe C, Svensson RB, Silbernagel KG, Langberg H, Magnusson SP. Eccentric or concentric exercises for the treatment of tendinopathies? *J Orthop Sports Phys Ther*. 2015;45(11):853-863. doi: 10.2519/jospt.2015.5910. Epub 2015 Oct 15.
44. Abat F, Gelber PE, Polidori F, Monllau JC, Sanchez-Ibanez JM. Clinical results after ultrasound-guided intratissue percutaneous electrolysis and eccentric exercise in the treatment of patellar tendinopathy. *Knee Surg Sports Traumatol Arthrosc*. 2015;23(4):1046-1052. doi: 10.1007/s00167-014-2855-2. Epub 2014 Jan 30.
45. Andriolo L, Altamura SA, Reale D, Candrian C, Zaffagnini S, Filardo G. Nonsurgical treatments of patellar tendinopathy: multiple injections of platelet-rich plasma are a suitable option: a systematic review and meta-analysis. *Am J Sports Med*. 2018;363546518759674. doi: 10.1177/0363546518759674.
46. Bahr R, Fossan B, Loken S, Engebretsen L. Surgical treatment compared with eccentric training for patellar tendinopathy (jumper's knee). A randomized, controlled trial. *J Bone Joint Surg Am*. 2006;88(8):1689-1698.
47. Dupley L, Charalambous CP. Platelet-rich plasma injections as a treatment for refractory patellar tendinosis: a meta-analysis of randomised trials. *Knee Surg Relat Res*. 2017;29(3):165-171. doi: 10.5792/ksrr.16.055.
48. Hoksrud A, Bahr R. Ultrasound-guided sclerosing treatment in patients with patellar tendinopathy (jumper's knee). 44-month follow-up. *Am J Sports Med*. 2011;39(11):2377-2380. doi: 10.1177/0363546511417097. Epub 2011 Aug 12.
49. Kongsgaard M, Kovanen V, Aagaard P, et al. Corticosteriod injections,

eccentric decline squat training and heavy slow resistance training in patellar tendinopathy. *Scand J Med Sci Sports*. 2009;19(6):790-802. doi: 10.1111/j.1600-0838.2009.00949.x. Epub 2009 May 28.
50. Korakakis V, Whiteley R, Tzavara A, Malliaropoulos N. The effectiveness of extracorporeal shockwave therapy in common lower limb conditions: a systematic review including quantification of patient-rated pain reduction. *Br J Sports Med*. 2018;52(6):387-407. doi: 10.1111/j.1600-0838.2009.00949.x. Epub 2009 May 28
51. Schwartz A, Watson JN, Hutchinson MR. Patellar tendinopathy. *Sports Health*. 2015;7(5):415-420. doi: 10.1177/1941738114568775. Epub 2015 Jan 23.
52. Steunebrink M, Zwerver J, Brandsema R, Groenenboom P, van den Akker-Scheek I, Weir A. Topical glyceryl trinitrate treatment of chronic patellar tendinopathy: a randomised, double-blind placebo-controlled clinical trial. *Br J Sports Med.* 2013;47(1):34-39. doi: 10.1136/bjsports-2012-091115. Epub 2012 Aug 28.
53. Thijs KM, Zwerver J, Backx FJ, et al. Effectiveness of shockwave treatment combined with eccentric training for patellar tendinopathy: a double-blinded randomized study. *Clin J Sport Med*. 2017;27(2):89-96. doi: 10.1097/JSM.0000000000000332.
54. van Rijn D, van den Akker-Scheek I, Steunebrink M, Dierks RL, Zwerver J, van der Worp H. Comparison of the effect of 5 different options for managing patellar tendinopathy: a secondary analysis. *Clin J Sport Med*. 2017. doi: 10.1097/JSM.0000000000000520. Epub ahead of print.
55. Cannell LJ, Taunton JE, Clement DB, Smith C, Khan KM. A randomised clinical trial of the efficacy of drop squats or leg extension/leg curl exercises to treat clinically diagnosed jumper's knee in athletes: pilot study. *Br J Sports Med*. 2001;35(1):60-64.
56. Purdam CR, Johnsson P, Alfredson H, Lorentzon R, Cook JL, Khan KM. A pilot study of the eccentric decline squat in the management of painful chronic patellar tendinopathy. *Br J Sports Med*. 2004;38(4):395-397.
57. Jonsson P, Alfredson H. Superior results with eccentric compared to concentric quadriceps training in patients with jumper's knee: a prospective randomised study. *Br J Sports Med*. 2005;39(11):847-850.
58. Rio E, Kidgell D, Purdam C, et al. Isometric exercise induces analgesia and reduces inhibition in patellar tendinopathy. *Br J Sports Med*. 2015;49(19):1277-1283. doi: 10.1136/bjsports-2014-094386. Epub 2015 May 15.
59. Rio E, van Ark M, Docking S, et al. Isometric contractions are more analgesic than isotonic contractions for patellar tendon pain: an in-season randomized clinical trial. *Clin J Sport Med*. 2017;27(3):253-259. doi: 10.1097/JSM.0000000000000364.
60. Kongsgaard M, Qvortrup K, Larsen J, et al. Fibril morphology and tendon mechanical properties in patellar tendinopathy: effects of heavy slow resistance training. *Am J Sports Med*. 2010;38(4):749-756. doi: 10.1177/0363546509350915. Epub 2010 Feb 12.
61. Frohm A, Saartok T, Halvorsen K, Renstrom P. Eccentric treatment for patellar tendinopathy: a prospective randomised short-term pilot study of two rehabilitation protocols. *Br J Sports Med*. 2007;41(7):e7
62. Kongsgaard M, Aagaard P, Roikjaer S, et al. Decline eccentric squats increases patellar tendon loading compared to standard eccentric squats. *Clin Biomech*. 2006;21(7):748-754.
63. Kjaer M. Role of extracellular matrix in adaptation of tendon and skeletal muscle to mechanical loading. *Physiol Rev*. 2004;84(2):649-698.
64. Langberg H, Skovgaard D, Petersen LJ, Bulow J, Kjaer M. Type I collagen synthesis and degradation in peritendinous tissue after exercise determined by microdialysis in humans. *J Physiol*. 1999;521 Pt 1:299-306.
65. Langberg H, Olesen J, Skovgaard D, Kjaer M. Age related blood flow around the Achilles tendon during exercise in humans. *Eur J Appl Physiol*. 2001;84(3):246-248.
66. Langberg H, Ellingsgaard H, Madsen T, et al. Eccentric rehabilitation exercise increases peritendinous type I collagen synthesis in humans with Achilles tendinosis. *Scand J Med Sci Sports*. 2007;17(1):61-66.
67. Zwerver J, Bredeweg SW, Hof AL. Biomechanical analysis of the single-leg decline squat. *Br J Sports Med*. 2007;41(4):264-268; discussion 268.
68. Frohm A, Halvorsen K, Thorstensson A. Patellar tendon load in different types of eccentric squats. *Clin Biomech (Bristol, Avon)*. 2007;22(6):704-711.
69. Young MA, Cook JL, Purdam CR, Kiss ZS, Alfredson H. Eccentric decline squat protocol offers superior results at 12 months compared with traditional eccentric protocol for patellar tendinopathy in volleyball players. *Br J Sports Med*. 2005;39(2):102-105.
70. Stasinopoulos D, Stasinopoulos I. Comparison of effects of exercise programme, pulsed ultrasound and transverse friction in the treatment of chronic patellar tendinopathy. *Clin Rehabil*. 2004;18(4):347-352.
71. Dimitrios S, Pantelis M, Kalliopi S. Comparing the effects of eccentric training with eccentric training and static stretching exercises in the treatment of patellar tendinopathy. A controlled clinical trial. *Clin Rehabil*. 2012;26(5):423-430. doi: 10.1177/0269215511411114. Epub 2011 Aug 19.
72. Liddle AD, Rodriguez-Merchan EC. Platelet-rich plasma in the treatment of patellar tendinopathy: a systematic review. *Am J Sports Med*. 2015;43(10):2583-2590. doi: 10.1177/0363546514560726. Epub 2014 Dec 18.
73. Dragoo JL, Wasterlain AS, Braun HJ, Nead KT. Platelet-rich plasma as a treatment for patellar tendinopathy: a double-blind, randomized controlled trial. *Am J Sports Med*. 2014;42(3):610-618. doi: 10.1177/0363546513518416. Epub 2014 Jan 30.
74. Mani-Babu S, Morrissey D, Waugh C, Screen H, Barton C. The effectiveness of extracorporeal shock wave therapy in lower limb tendinopathy: a systematic review. *Am J Sports Med*. 2015;43(3):752-761. doi: 10.1177/0363546514531911. Epub 2014 May 9.
75. Larsson ME, Kall I, Nilsson-Helander K. Treatment of patellar tendinopathy–a systematic review of randomized controlled trials. *Knee Surg Sports Traumatol*

Arthrosc. 2012;20(8):1632-1646. doi: 10.1007/s00167-011-1825-1. Epub 2011 Dec 21.
76. Visnes H, Hoksrud A, Cook J, Bahr R. No effect of eccentric training on jumper's knee in volleyball players during the competitive season. A randomized controlled trial. *Clin J Sport Med*. 2005;15(4):227-234.
77. Saithna A, Gogna R, Baraza N, Modi C, Spencer S. Eccentric exercise protocols for patella tendinopathy: should we really be withdrawing athletes from sport? A systematic review. *Open Orthop J*. 2012;6:553-557. doi: 10.2174/1874325001206010553. Epub 2012 Nov 30.
78. Couppe C, Kongsgaard M, Aagaard P, et al. Habitual loading results in tendon hypertrophy and increased stiffness of the human patellar tendon. *J Appl Physiol (1985)*. 2008;105(3):805-810. doi: 10.1152/japplphysiol.90361.2008. Epub 2008 Jun 12.
79. Seynnes OR, Erskine RM, Maganaris CN, et al. Training-induced changes in structural and mechanical properties of the patellar tendon are related to muscle hypertrophy but not to strength gains. *J Appl Physiol*. 2009;107(2):523-530. doi: 10.1152/japplphysiol.00213.2009. Epub 2009 May 28.
80. van Ark M, Cook JL, Docking SI, et al. Do isometric and isotonic exercise programs reduce pain in athletes with patellar tendinopathy in-season? A randomised clinical trial. *J Sci Med Sport*. 2016;19(9):702-706. doi: 10.1016/j.jsams.2015.11.006. Epub 2015 Dec 7.
81. Scattone Silva R, Ferreira AL, Nakagawa TH, Santos JE, Serrao FV. Rehabilitation of patellar tendinopathy using hip extensor strengthening and landing-strategy modification: case report with 6-month follow-up. *J Orthop Sports Phys Ther*. 2015;45(11):899-909. doi: 10.2519/jospt.2015.6242. Epub 2015 Sep 21.

Academy of Orthopaedic Physical Therapy Members



CLINICAL PRACTICE GUIDELINES

AMELIA J.H. ARUNDALE, PT, PhD • MARIO BIZZINI, PT, PhD • AIRELLE GIORDANO, DPT • TIMOTHY E. HEWETT, PhD
DAVID S. LOGERSTEDT, PT, PhD • BERT MANDELBAUM, MD • DAVID A. SCALZITTI, PT, PhD
HOLLY SILVERS-GRANELLI, PT, PhD • LYNN SNYDER-MACKLER, PT, ScD, FAPTA

Exercise-Based Knee and Anterior Cruciate Ligament Injury Prevention

Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability and Health From the Academy of Orthopaedic Physical Therapy and the American Academy of Sports Physical Therapy

J Orthop Sports Phys Ther. 2018;48(9):A1-A42. doi:10.2519/jospt.2018.0303

SUMMARY OF RECOMMENDATIONS A2
INTRODUCTION A3
METHODS A4
CLINICAL PRACTICE GUIDELINES A7
AUTHOR/REVIEWER AFFILIATIONS AND CONTACTS A22
REFERENCES A23
APPENDICES (ONLINE) A26

REVIEWERS: Roy D. Altman, MD • Paul Beattie, PT, PhD • Marie Charpentier, DPT, ATC, LAT
John DeWitt, DPT, ATC • Amanda Ferland, DPT • Jennifer S. Howard, ATC, PhD
David Killoran, PhD • Leslie Torburn, DPT • James Zachazewski, DPT

For author, coordinator, contributor, and reviewer affiliations, see end of text. ©2018 Academy of Orthopaedic Physical Therapy, American Academy of Sports Physical Therapy, and the *Journal of Orthopaedic & Sports Physical Therapy*. The Academy of Orthopaedic Physical Therapy, American Academy of Sports Physical Therapy, and the *Journal of Orthopaedic & Sports Physical Therapy* consent to the reproduction and distribution of this guideline for educational purposes. Address correspondence to Brenda Johnson, ICF-Based Clinical Practice Guidelines Coordinator, Academy of Orthopaedic Physical Therapy, APTA, Inc, 2920 East Avenue South, Suite 200, La Crosse, WI 54601. E-mail: icf@orthopt.org

Journal of Orthopaedic & Sports Physical Therapy®
Downloaded from www.jospt.org at on September 4, 2018. For personal use only. No other uses without permission.
Copyright © 2018 Journal of Orthopaedic & Sports Physical Therapy®. All rights reserved.

We are happy to make this Clinical Practice Guideline (CPG) on **Exercise-Based Knee and Anterior Cruciate Ligament Injury Prevention** available. Please share the supplemental videos with coaches, players, parents, and patients.

Link to CPG:
https://www.jospt.org/doi/full/10.2519/jospt.2018.0303

Court Version Video:
https://www.jospt.org/doi/suppl/10.2519/jospt.2018.0303/suppl_file/Sep2018-CPG-KneeInjuryPrevention-Court.mp4

Field Version Video:
https://www.jospt.org/doi/suppl/10.2519/jospt.2018.0303/suppl_file/Sep2018-CPG-KneeInjuryPrevention-Field.mp4

Link to all Ortho CPGs:
https://www.orthopt.org/content/practice/clinical-practice-guidelines

Does Multidimensional Health Assessment Using PROMIS Scales Enhance Clinical Decision-making for Patients with Orthopedic Problems? A Case Series

Ryan Jacobson, PT, DPT, PCS[1]
Li-Zandre Philbrook, DPT[1]
Dan Kang, DPT[1]
Tyler Cuddeford, PT, PhD[1]
Jeff Houck, PT, PhD[1]

[1]George Fox University, Newberg, OR

ABSTRACT

Background and Purpose: Patient Reported Outcomes Measurement Information System (PROMIS) scales efficiently assess patient problems in multiple generic health domains. The purpose of this study was to describe how scores on 4 PROMIS scales—physical function (PF), pain interference (PI), fatigue, and self-efficacy (SE)—were used to determine treatment in a group of patients with orthopedic problems. **Methods:** Patients (n=45) with musculoskeletal pain were administered the PROMIS scales at initial evaluation. Scores were coded for severity to determine a *key health domain* (PF/PI, fatigue, or SE) that became the priority for treatment. Three case descriptions are presented. **Findings:** High proportions of PROMIS scores (45-65%) were "mild" or "severe." Only 35.6% of patients fit the PF/PI key health domain, with 35.6% categorized SE and 28.9% fatigue. Cases illustrate a distinct treatment approach for each key health domain. **Clinical Relevance:** Generic health domains captured by PROMIS provide a new framework for clinical decision-making and patient engagement. The generic health domains provide a quick efficient method to target specific areas of health. **Conclusion:** Two-thirds of patients with orthopedic diagnoses presented with problems outside of the typical PF/PI domain captured by current patient-reported outcomes. Combining the PF and PI domains was supported by strong convergent validity. Case examples illustrate how identifying key health domains influences patient interactions and clinical decision-making.

Key Words: patient-reported outcomes, generic health outcomes, fatigue, self-efficacy

INTRODUCTION

Although physical therapy embraces patient-centered care, affording patients a clear voice in their health management is not always achievable. One approach to giving patients a voice is through patient-reported outcomes (PROs).[1,2] At the systems level, providers make decisions on health quality almost exclusively based on process outcomes, rather than on patient outcomes.[2,3] This is ironic since repeated studies have demonstrated that provider priorities do not align with patient priorities.[4-6] And, when evidence shows clinical decisions should emphasize patient priorities (eg, pain and functional activities) over pathology, providers continue to base decisions on pathology.[7] Although real barriers exist to widespread use of PROs,[8] resistance to adoption is likely a failure to imagine a clear benefit to patients. Arguments in favor of PROs include "giving patients a voice"[1] and altering processes to define health quality.[2,3] While these arguments are significant, what may unintentionally be missed is that generic health domain PROs provide a new framework for clinical decision-making.

New PRO scales are now available across a spectrum of generic health domains (eg, physical function, pain interference, fatigue, and self-efficacy) that assess a patient's global health rather than disease-specific effects.[9,10] The Patient Reported Outcomes Measurement Information System (PROMIS) scales were developed through the National Institute of Health for research and clinical use.[9] Each scale is available as a computer adaptive test (CAT), offering a high degree of efficiency and low patient burden.[11,12] These scales were rigorously developed using an item response theory that increases precision over the classical measurement theory.[13] The PROMIS scales were calibrated and normalized to the US population based on the 2010 census.[14] Emerging data shows that their psychometric properties are equivalent or better than current state-of-the-art disease-specific instruments used for orthopedic problems.[11,15-20] Selected PROMIS health domain scales pertinent to physical therapy include physical function (PF), pain interference (PI), fatigue, and self-efficacy (SE). Compared to current disease-specific measures, the PROMIS scales capture generic health domains with very low floor and ceiling effects and adequate sensitivity to change, making them effective tools for tracking patient status.[21]

A focus on generic measures from multiple health domains makes it possible to realize a more holistic health approach to patient care in physical therapy. However, moving from a disease-specific focus to a holistic or generic health domain focus is a paradigm shift for providers that has theoretical, though unproven, benefits. Physical therapists may resist using these scales because of fears associated with inefficiency, increased time demand, and low clinical impact.[9] Providers need a concrete model of how these scales impact patient decision making, along with data supporting the benefit of using these scales in practice.

Although an optimal set of generic health domain measures for physical therapy is unclear, a potential set of measures would likely assess PF, PI, fatigue, and SE. The importance of PF and PI is underscored by the fact that most disease-specific measures currently in use are designed to measure these constructs.[22-24] Because the PROMIS PF and PI scales are similar in construct to many disease-specific scales, it is not surprising that they yield similar clinical information.[11,15-19] What is novel about a generic health domain approach is the ability to also efficiently assess other health domains important to clinical decision-making—domains that alter clinical decisions at the point of care. Fatigue is not correlated to physical function and pain, yet is an important predictor of health status for a number of medical problems, including orthopedic impairment.[25-28] Self-efficacy of symptom management is a positive health attribute that assesses a person's confidence in managing his or her own health condition.[29] New approaches to care emphasize enhancing patient self-efficacy to increase activity participation for individuals with orthopedic impairment.[30-32] Altogether, these 4 generic PROMIS scales provide an interesting new set of measures for the physical therapist. The PF and PI scales are consistent with current constructs of clinical decision-making; however, fatigue and SE are not typically measured as part of a physical therapy evaluation. Especially important to note is that PF, PI, fatigue, and SE are each directly linked to distinct clinical treatment approaches, and therefore scores on these scales may drive important clinical choices (Figure 1).

The purpose of this mixed methods study, quantitative and qualitative, was to describe typical scores on 4 generic health domain scales (PROMIS PF, PI, fatigue, and SE) at initial evaluation in a general orthopedic population. Specific hypotheses included that: (1) each PROMIS scale would demonstrate a clinically relevant number of patients that score either 0.5 or 1.0 standard deviation worse than the US average (quantitative); (2) for each patient a *key health domain* (PF, PI, fatigue, or SE) could be identified that would determine the *primary* treatment approach (quantitative); (3) PROMIS PF and PI scores would show strong convergent validity, while PROMIS, fatigue, and SE would show low to moderate correlations with PROMIS PF and PI (quantitative); and (4) specific cases would provide clinical examples of how identifying a patient's key health domain leads to a distinct clinical focus for treatment (qualitative).

METHODS

Outcomes measure data was analyzed for 45 consecutive patients over a 3-month period. All patients were seen for physical therapy evaluation in a university-based outpatient physical therapy clinic in rural Oregon. Each presented with musculoskeletal chief complaints involving the low back, neck, and upper or lower extremity pain symptoms. Every patient was given the set of 4 PROMIS scales (PF, PI, fatigue, and SE). Forty of these patients completed a diagnosis-specific outcomes measure (eg, Oswestry Disability Index),[19,24] while the other 5 failed to complete the measure. The PROMIS scores were coded for level of health domain severity as "WNL" (within normal limits), "mild" or "severe" (Table 1). Based on this severity coding for the set of 4 PROMIS scores, a key health domain descriptor was ascribed to each patient—"PF, PI," "fatigue" or "SE" (Table 2).

Generic Health Domains

The set of 4 PROMIS scales were completed by each patient using the PROMIS iPad app (Glinberg & Associates, Inc). The PROMIS CAT asks multiple questions for each health domain, requiring patients to self-rate on a 5-point Likert scale, selecting appropriately difficult questions based on prior responses.[11,13,14,29,33] The resulting PROMIS score is a T-score, with 50 being the average in US population and 10 points equivalent to one standard deviation.[14] Data is downloaded directly from the app or viewed in real time on the iPad for clinical decsions. The iPad app stores data online, however, meets regulations for patient privacy.

The PROMIS PF scale measures capability in movement, upper extremity use, and instrumental activities of daily living (eg, "running errands"), with higher numeric scores reflecting better physical capability.[14,21] The PROMIS PI measures the consequences of pain related to patient engagement in all aspects of life, including physical tasks, with higher scores reflecting worse pain interference.[10,34] The PROMIS fatigue measures the experience and impact of tiredness and exhaustion as these decrease ability to function in daily activities, with higher scores reflecting worse fatigue.[33] The PROMIS SE measures a person's confidence in managing his or her health condition, with higher scores reflecting better self-efficacy.[29]

Analysis

Descriptive statistics including the mean, standard deviation, and range for each PROMIS scale at the initial physical therapy evaluation were calculated in Excel (Microsoft Corporation, Redmond, WA). For hypothesis #1, T-scores for each PROMIS scale were coded for health domain severity (ie, WNL, mild, or severe) per the criteria in Table 1. This data was used to generate percentages and a stacked column

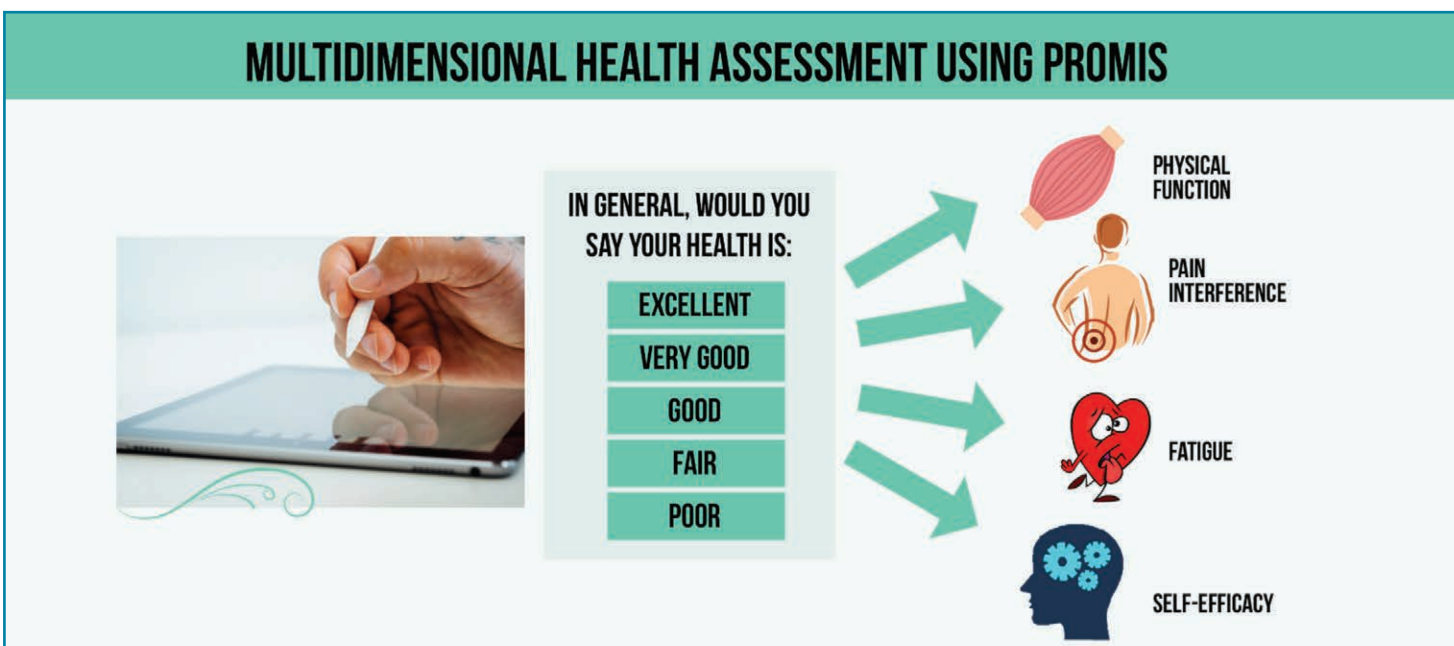


Figure 1. Multidimensional generic health domain assessment using PROMIS computer adaptive testing to obtain unfiltered patient-reported insight into the patient's own health.

Table 1. Criteria for Health Domain Severity Coding

Severity	Criteria
WNL	PROMIS score < 0.5 standard deviation from US average or better than average
Mild	PROMIS score 0.5 to 1 standard deviation worse than US average
Severe	PROMIS score > 1 standard deviation worse than US average

Abbreviations: WNL, within normal limits, PROMIS, Patient-Reported Outcomes Measurement Information System; US, United States

Table 2. Criteria for Identifying the Key Health Domain

Key Health Domain Descriptor	Definition Based on Health Domain Severity
PF/PI	PF, PI: **mild, severe** Fatigue: **WNL** SE: **WNL**
Fatigue	PF, PI: **WNL, mild, severe** Fatigue: **mild, severe** SE: **WNL** *or* Fatigue: **severe** SE: **mild**
SE	PF, PI: **WNL, mild, severe** Fatigue: **WNL, mild** SE: **mild** *or* SE: **severe**

Abbreviations: PF, physical function; PI, pain interference; WNL, within normal limits; SE, self-efficacy

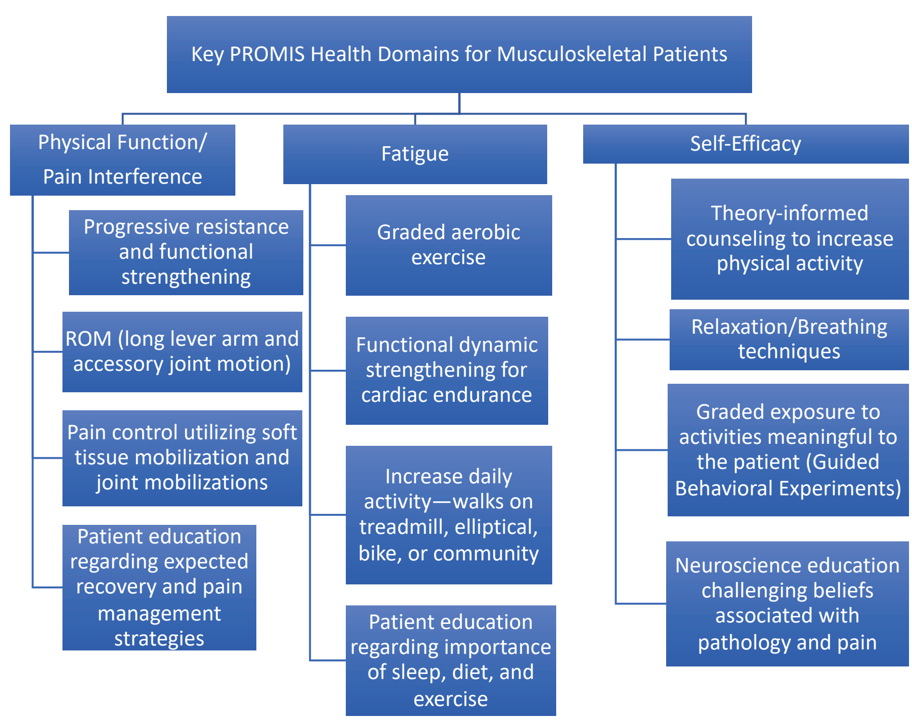
chart for visual interpretation. High proportion (>30%) of patients falling into the mild or severe categories indicated the potential importance of the generic health domain. For hypothesis #2, a key health domain was ascribed by applying the criteria in Table 2 and then used to generate percentages and a pie chart for visual interpretation. The criteria were developed based on how the PROMIS scales were being used to make clinical decisions. Because each key health domain became the priority for treatment, each was matched with a specific set of clinical treatments (Figure 2). The proportions of patients falling into each treatment category represent the frequency of that particular treatment approach. For hypothesis #3, Pearson correlation coefficients were performed among all possible pairs of PROMIS scales. Correlations above 0.6 demonstrated high convergence, while r-values between 0.3 and 0.6 were seen as low convergence and r-values below 0.3 as divergence. High convergence (PF, PI) supports grouping the scales into one domain, where low convergence or divergence support clinically using the scales as separate domains. For hypothesis #4, qualitative case descriptions of 3 ideal cases were selected that illustrate the clinical decisions made based on PROMIS scores from the initial evaluation. Each case describes initial findings, summary of interventions with examples of specific key therapeutic activities, and case resolution.

RESULTS

Data was available from 45 patients, of which 80% were female, ranging in age from 17 to 74 years old with the average being 38.3 ± 17.3. Eighteen patients presented with a chief complaint in the lower extremity, 12 in the low back, 12 in the neck, and 3 in the upper extremity. The average PROMIS PF T-score was 44.0 ± 7.8 and the range was 22 to 60. Likewise, the average PI was 59.5 ± 6.9, range 47 to 75; the average fatigue was 55.2 ± 8.4, range 35 to 74; and the average SE was 44.3 ± 5.4, range 32 to 57.

The proportion of patients whose PROMIS scores were greater than 0.5 standard deviation varied from 44.7% to 64.6% for the selected scales, with PI being the highest at 64.6%. Both fatigue and SE were at 47.9% (Figure 3).

The proportion of patients that fit a particular key health domain descriptor was nearly evenly distributed among the 3 categories (Figure 4A). "Self-efficacy" was the key descriptor for 35.6% of the patients, with the "PF, PI" descriptor ascribed to 35.6% of patients as well, and "fatigue" ascribed



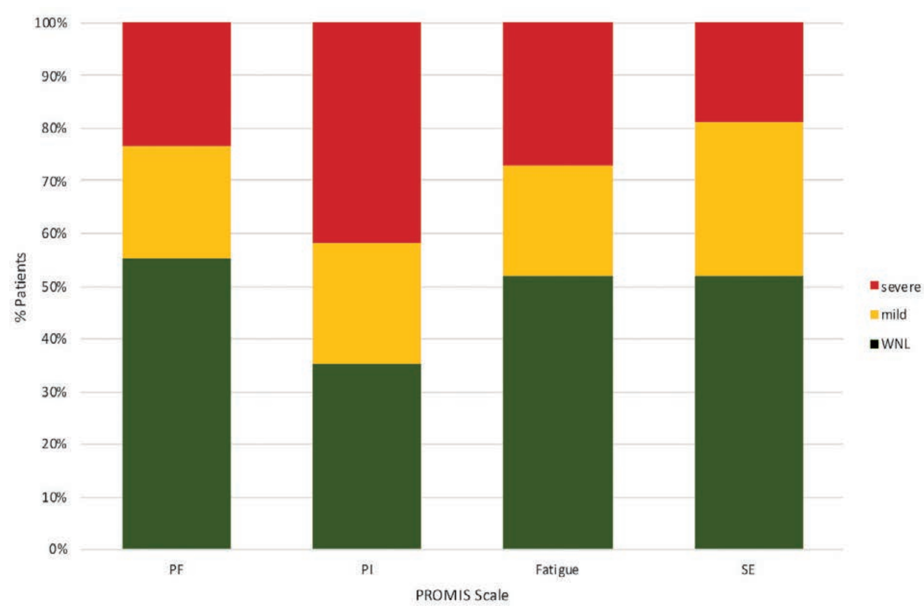
Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; ROM, range of motion

Figure 2. Description of therapeutic strategies for key PROMIS health domains identified by patients.

to 28.9%. Following this analysis, all 45 PROMIS score sets were re-coded such that any patient who scored greater than 0.5 standard deviation (worse) on *both* the fatigue and SE scales were ascribed the descriptor "complex." With this re-coding, 28.9% of patients fell into this fourth category (Figure 4B).

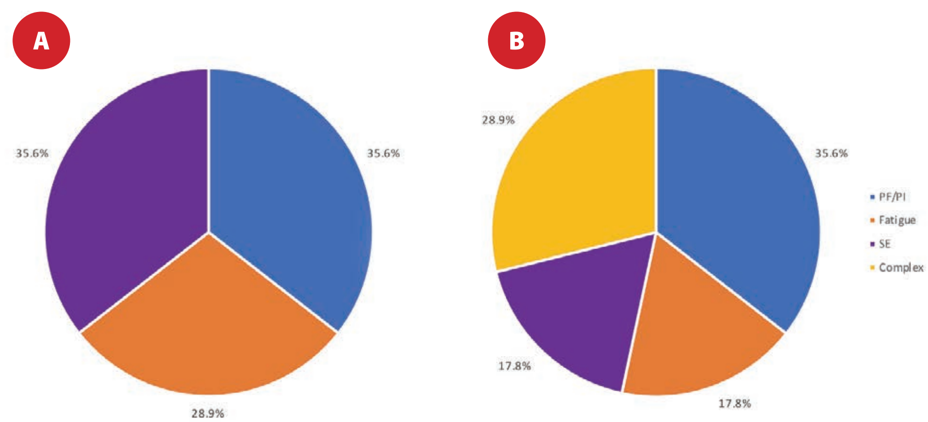
Convergent validity was strong for PF and PI scores (r = -.67) and lower for the other scales (Figure 5 and Table 3). Table 3 shows correlations among pairs of scales ranging from r = -.25 to -.67. Fatigue was significantly correlated to PF (r = -0.29, p = 0.05) and PI (r = 0.42, p < 0.01) but not to SE (r = -.25, p = 0.10). The SE scale was significantly correlated to PF (r = 0.31, p = 0.04) and PI (r = -0.55, p < 0.01).

Three specific cases are described, each linking a key health domain ascribed at the initial evaluation with a distinct approach to treatment. The PROMIS scores for these cases are listed in Table 4. For case #1, PF, PI was the key health domain identified at evaluation with the PROMIS PI score > 0.5 standard deviation worse than average. For this patient, the priority focused on remediating impairments and increasing physical activity. For case #2, the key health domain identified at evaluation was fatigue (PROMIS score >2 standard deviations worse than average). Hence, physical therapy treatment focused on improving aerobic capacity. Finally, for case #3, the key health domain identified at evaluation was SE (PROMIS score >1.5 standard deviations worse than average). This resulted in challenging the patient's fear and beliefs associated with the low back pain.



Abbreviations: WNL, within normal limits; PF, physical function; PI, pain interference; SE, self-efficacy of symptom management.

Figure 3. The proportion of patients classified as within normal limits, mild, and severe based on perceived problems for each generic health domain.



Abbreviations: PF, physical function; PI, pain interference; SE, self-efficacy; PROMIS, Patient-Reported Outcomes Measurement Information System

Figure 4. A, The proportion of patients fitting a particular key health domain descriptor, as identified by 4 generic health domain PROMIS scales. B, The proportion of patients when re-classifying as "complex" those with both Fatigue and SE scores > 0.5 standard deviation worse than normal.

CASE #1 – PF, PI

A 19-year-old female presented with chronic low back pain, hip pain, and anterior knee pain. She reported that her back was injured years ago in a quad runner all-terrain vehicle accident. Her presenting symptoms were of muscle tightness around her spine, and intermittent radicular type symptoms that lasted a couple days to a week at a time. Previous treatments included stretching, which did not diminish her symptoms. Her new role as a college student increased her sedentary time (lectures, studying, homework). Previously, she frequently played ultimate Frisbee and soccer. However, due to her pain symptoms she had to stop participation in these activities. She scored 6% disability "minimal disability" on the modified Oswestry Disability Index (ODI), aligning with her WNL score on the PROMIS PF scale. She scored at "low risk" (1/9) on the Keele STarT Back Screening Tool,[35] and 3/10 on the Visual Analog Scale (VAS) for pain.

Based primarily on her high PI score (fatigue and SE scores both WNL), treatment centered around progressive resistance and functional strengthening, focusing on returning her to recreational activity as soon as possible. Interventions included core and hip muscle strengthening, increasing range of motion, neural mobilization, and functional training specific to ultimate Frisbee movement demands.

This patient was seen for 3 visits, and she returned to ultimate Frisbee in a recreational league within 3 weeks, reporting minimal symptoms. All radicular symptoms resolved

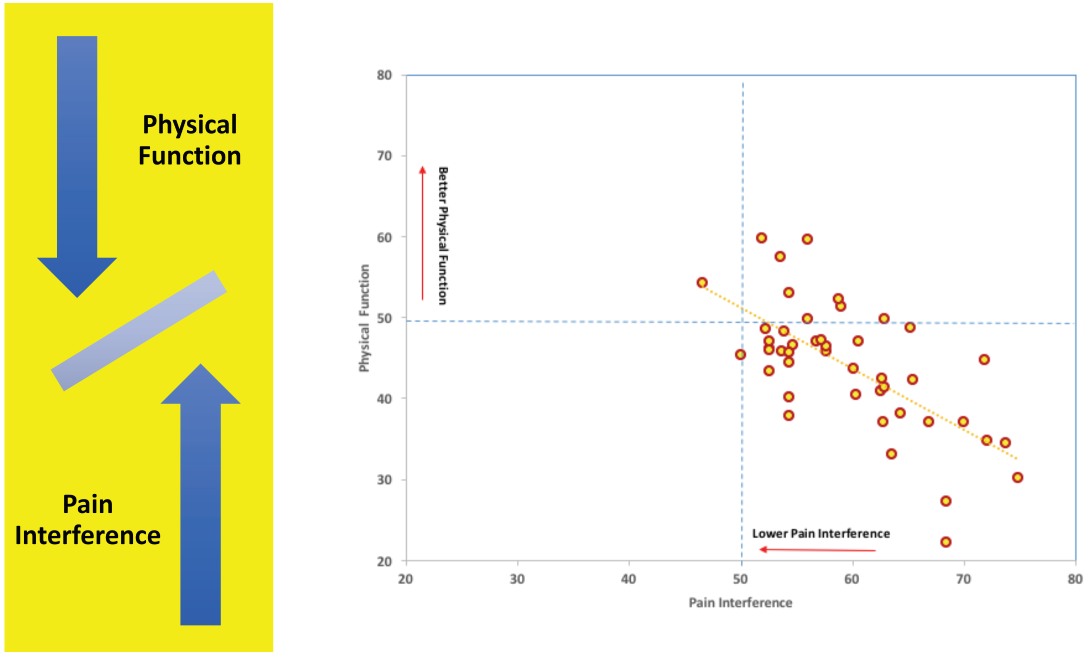


Figure 5. The scatter plot between Patient-Reported Outcomes Measurement Information System (PROMIS) Physical Function and Pain Interference scores shows a strong correlation (r = -0.67). As pain interference increases, physical function decreases. This correlation suggests these constructs are dependent and therefore can be considered together. The yellow area on the chart represents higher pain interference and lower physical function.

after the first visit. At her final assessment, PROMIS PF improved from 46 to 50 and PROMIS PI from 58 to 52, both close to normal values. The normal SE scores suggested the patient was confident in her ability to manage her symptoms and was more likely to engage in active treatments.[29] This encouraged the therapist to engage the patient in home exercises and independent training activities.

CASE #2 – FATIGUE

A 64-year-old female presented with recurrent low back pain 8 months status post laminectomy and recently a posterior fusion at L5-S1 two months ago. She also had multiple myeloma for several years with negative effects on her immune system as a result of infusion and chemotherapy. Prior to her surgeries, any physical therapy interventions were unsuccessful due to persisting uncontrollable pain. The patient also wore a back brace that she was reluctant to remove until the surgeon declared "full healing" of her spine. This contributed to her low initial PF score, because she self-limited all activities while in her brace. At initial evaluation, she arrived in the clinic waiting area severely winded after walking from the parking lot (< 500 feet). She scored 38% disability "moderate disability" on the ODI, a relatively functional score that did not align with her severe PF score of 37 (only 9% of the US population would be expected to score this low). She scored at "low risk" (3/9) on the Keele STarT Back Screening Tool, and 5/10 on VAS for pain.

Despite severe PF and PI self-ratings, her severe fatigue score (>2 standard deviations worse than average) reflected the most concerning generic health domain. Initial intervention centered around postsurgery strengthening exercises as prescribed by the surgeon. However, limited improvement was seen in fatigue and PF after 4 sessions, so focus of treatment switched to fatigue and graded aerobic exercise. Graded aerobic exercise included increasing daily activity through ambulation on treadmill and in the community, the latter providing real-life obstacles such as stairs, curbs, and inclines. Strengthening to increase cardiac endurance (eg, repeated sit-to-stand, lifting laundry bags filled with 10 lb to 30 lb weights, gardening simulation) were also implemented with success. Additionally, patient education regarding sleeping patterns was addressed (eg, consistent schedule, exercise timing during the day).

This patient was seen for 8 visits and made remarkable improvement. After targeting graded aerobic exercise over the last 4 visits, she was able to ambulate .75 miles with minimal complaints of tiredness. The patient's PROMIS fatigue score drastically improved decreasing by 10 points in the last few visits, and she completely weaned off her back brace. Having WNL PI and markedly improving fatigue and PF, she continued a home program and community ambulation, with one to two follow-up visits over the subsequent 6 weeks. Although her fatigue score remained high at 61, her normal SE score of 48 supported intermittent consultation and self-management.

CASE #3 – SE

A 41-year-old woman presented with an acute flare-up 4 days ago, an exacerbation from chronic low back pain of more than one-year duration. She voiced confidence and eagerness to resolve her pain in order to get back to tending her horses. However, she had a severe SE score of 34 and her PF and PI scores were also severe at 30 and 75, respectively. She described a history indicating high levels of pain-related fear and unhelpful beliefs. For example, in the prior year she relegated herself to a wheelchair for a period of time due to fear of reinjury. She scored a

Table 3. Pearson Correlation Coefficients (r) Between PROMIS Scale Pairs
***p value not significant**

	Pain Interference	Fatigue	Self-Efficacy
Physical Function	**r = -0.67 p < 0.01**	**r = -0.29 p = 0.05**	**r = 0.31 p = 0.04**
Pain Interference		**r = 0.42 p < 0.01**	**r = -0.55 p < 0.01**
Fatigue			r = -.25 p = 0.10*

Table 4. PROMIS Scores for Selected Case Descriptions

Key Health Domain	Initial PROMIS Scores	Final PROMIS Scores
Case #1 – PF, PI	PF = 46 ***PI = 58*** Fatigue = 54 SE = 50	PF = 50 PI = 52 Fatigue = 51 SE = 56
Case #2 – Fatigue	PF = 37 PI = 63 ***Fatigue = 71*** SE =48	PF = 43 PI = 53 Fatigue = 61 SE =54
Case #3 – SE	PF = 30 PI = 75 Fatigue = 45 ***SE =34***	PF = 56 PI = 39 Fatigue = 39 SE = 69

Abbreviations: PROMIS, Patient-Reported Outcomes Measurement Information System; PF, physical function; PI, pain interference; SE, self-efficacy

64% disability rating on the ODI, 6/9 on the Keele STarT Back Screening Tool, and 7/10 on the VAS for pain.

The patient's PROMIS SE score, supported by a Keele STarT Back score indicating risk for developing chronic low back pain, led to a focus on SE. As per clinical practice guidelines, initial treatment did include one manipulation on the first visit toward acute pain relief.[36] Psychologically informed physical therapy practices included guided behavioral experiments and theory informed counseling.[30,37-40] An upcoming vacation to Hawaii had increased the intensity of her fears around pain and limited function as she previously had cancelled a travel plan due to pain. The guided behavioral experiments included graded exposure to meaningful activities she had deemed unsafe.[37,38,41,42] This included challenging her belief that because she had a "blown disc" any strained or unexpected movement (eg, tasks tending to her horses, walking in sand) or prolonged sitting/standing as in an airplane would further injure her back. This was coupled with graded exposure to movements she identified as unsafe or threatening (ie, sustained lumbar flexion, squatting, lifting progressively more weight).[43] Theory informed counseling was used to encouraged her to engage in increased physical activity including stretching, regular unguarded movement, and exercise.[30] The impressions of the treating therapist was that she now believed in her ability to return to her prior level of function. This impression was reinforced by a 1.5 standard deviation increase in her self-efficacy.

This patient was seen for only two visits, following which she departed for her planned trip to Hawaii with her husband. A follow-up call to the patient 26 days after her last physical therapy session revealed a successful trip with minimal symptoms persisting to date. The patient requested no further physical therapy appointments. Remarkably, her PROMIS scores showed dramatic change, all improving by more than one standard deviation of 10 points.

DISCUSSION

The select set of generic health domains identified a high proportion of patients with problems outside of the typical PF, PI domains such as fatigue and SE. Convergent validity of the PF, PI scales supported grouping these scales into a single category. Fatigue and SE showed lower correlations supporting their application as separate key health domains. Identifying these generic health domains led to specific changes in the treatment approach that were significant for both the provider and patient. The selected cases illustrate how assessing this particular set of generic health domains leads to various approaches to patient care and offers a different way of interacting with patients regarding their health.

The participants in this study were attending a general orthopedic practice but were likely not representative of a general orthopedic practice. The sample was predominantly female and patients were split based on their regional complaints, 24 with spinal and 18 with lower extremity complaints. The average PROMIS scores were all greater than 0.5 standard deviation worse than normal for each scale (range 5.2-9.5). However, the range of scores suggest wide variability on each scale across patients. The PF, PI pair showed the strongest convergent validity (see Figure 5). No other PROMIS scale pairs were above r = 0.55 (see Table 3) suggesting these scales could be treated as independent generic health domains. On average, all 4 PROMIS scales detected patients in the WNL to severe range on each generic health domain.

The proportions of patients that were classified as mild or severe on the PROMIS scales showed that the 4 scales detected patient perceived problems at the physical therapy evaluation (see Figure 3). Unsurprisingly, 64.6% of patients scored in the moderate or severe category for PROMIS PI, indicating the primary patient concern was pain interfering with their life. Somewhat unexpectedly, the proportion of patients reporting as either mild or severe on the other 3 scales (PF, fatigue, and SE) showed relatively similar proportions to one another, varying from 44.7% to 47.9% with PF accounting for the smallest proportion of all scales. The selected generic health domains suggest that patients present with perceived problems that are not detected by current disease-specific measures that typically exclude fatigue and SE.

In a large proportion of patients, it was possible to classify them by one key health domain that was identified as their primary problem (see Figure 4A). The two key health domains ascribed most to patients were SE and PF/PI, each accounting for 35.6%. Recent studies have noted the importance of SE in patients with orthopedic problems.[31,44,45] What is new is the ability to track this health domain across a wide spectrum of patients.[29] Although fatigue is typically not measured during clinical care, it was the key health domain ascribed 28.9% of the time. Together fatigue and SE were high in 28.9% of patients, which may indicate depression (see Figure 4B). This data may illustrate when symptoms of depression, such as fatigue and low SE, interfere with treatment. Furthermore, the focus of treatment for patients with SE and fatigue might include graded aerobic exercise for cardiac endurance coupled with theory-informed counseling[30] and graded exposure to increase patient self-efficacy (see Figure 2).[37-40] Ultimately, only 35.6% of patients presented with their chief perceived problem consistent with disease-specific scale domains (PF, PI). The other 64.4% of patients identified fatigue or SE as their key problematic health domain.

The cases illustrate that assessing the selected generic health domains led to significant alterations in the treatment. Each case illustrates how treatment may target a specific key health domain identified by the generic health domain. These PROMIS scales allow for a clinically efficient procedure to identify each patient's key problematic health domains. This enables the therapist to interact with clients to address a particular generic health domain important to their health. This set of generic health domains were specifically chosen because of their link to current evidence-based treatment approaches (see Figure 2).

LIMITATIONS

The current sample is small and lacks representation of common problems in a general orthopedic clinic, for example, there are few patients with shoulder problems. The classifications mild and severe are supported by some clinical data characterizing PROMIS in various groups of patients.[33,34,46,47] However, this classification requires further validation for physical therapy applications. Also, the cases were hand-selected and therefore are simply models for proof of concept needing validation in larger samples. Whether this approach leads to better patient outcomes remains unvalidated.

CONCLUSIONS

The introduction of generic health domain assessment in orthopedic physical therapy represents a paradigm shift toward prioritizing treatment of patient-identified generic health problems. Although a majority of patients attend physical therapy for reasons associated with pain interfering with their lives, the majority of patients identified fatigue and/or SE as their primary problem. Therapists should consider exploring the use of generic health measures similar to PROMIS and refocusing care on patient-identified problems for specific generic health domains.

REFERENCES

1. Baumhauer JF. Patient-reported outcomes-are they living up to their potential? *N England J Med*. 2017;377(1):6-9. doi: 10.1056/NEJMp1702978.
2. Porter ME. What is value in health care? *N Engl J Med*. 2010;363(1):2477-2481. doi: 10.1056/NEJMp1011024. Epub 2010 Dec 8.
3. Porter ME, Larsson S, Lee TH. Standardizing patient outcomes measurement. *N Engl J Med*. 2016;374(6):504-506. doi: 10.1056/NEJMp1511701.
4. Blackburn S, Higginbottom A, Taylor R, et al. Patient-reported quality indicators for osteoarthritis: a patient and public generated self-report measure for primary care. *Res Involv Engagem*. 2016;2(1):5. doi: 10.1186/s40900-016-0019-x. eCollection 2016.
5. Grime J, Dudley B. Developing written information on osteoarthritis for patients: facilitating user involvement by exposure to qualitative research. *Health Expect*. 2014;17(2):164-173. doi: 10.1111/j.1369-7625.2011.00741.x. Epub 2011 Nov 10.
6. Hewlett SA. Patients and clinicians have different perspectives on outcomes in arthritis. *J Rheumatol*. 2003;30(4):877-879.
7. Riddle DL, Perera RA. Appropriateness and total knee arthroplasty: an examination of the American Academy of Orthopaedic Surgeons appropriateness rating system. *Osteoarthritis Cartilage*. 2017;25(12):1994-1998.
8. Bodenheimer T, Sinsky C. From triple to quadruple aim: care of the patient requires care of the provider. *Ann Fam Med*. 2014;12(6):573-576.
9. Broderick JE, DeWitt EM, Rothrock N, Crane PK, Forrest CB. Advances in patient-reported outcomes: the NIH PROMIS(®) Measures. *EGEMS (Wash DC)*. 2013;1(1):1015. doi: 10.13063/2327-9214.1015. eCollection 2013.
10. Cook KF, Jensen SE, Schalet BD, et al. PROMIS measures of pain, fatigue, negative affect, physical function, and social function demonstrate clinical validity across a range of chronic conditions. *J Clin Epidemiol*. 2016;73:89-102. doi: 10.1016/j.jclinepi.2015.08.038. Epub 2016 Mar 4.
11. Hung M, Baumhauer JF, Brodsky JW, et al. Psychometric comparison of the PROMIS Physical Function CAT with the FAAM and FFI for measuring patient-reported outcomes. *Foot Ankle Int*. 2014;35(6):592-599. doi: 10.1177/1071100714528492.
12. Papuga MO, Dasilva C, McIntyre A, Mitten D, Kates S, Baumhauer JF. Large-scale clinical implementation of PROMIS computer adaptive testing with direct incorporation into the electronic medical record. *Health Systems*. 2018;7(1):1-12.
13. Lai JS, Cella D, Choi S, et al. How item banks and their application can influence measurement practice in rehabilitation medicine: a PROMIS fatigue item bank example. *Arch Phys Med Rehabil*. 2011;92(10 Suppl):S20-S27. doi: 10.1016/j.apmr.2010.08.033.
14. Rose M, Bjorner JB, Gandek B, Bruce B, Fries JF, Ware JE. The PROMIS Physical Function item bank was calibrated to a standardized metric and shown to improve measurement efficiency. *J Clin Epidemiol*. 2014;67(5):516-526. doi: 10.1016/j.jclinepi.2013.10.024.
15. Brodke DS, Goz V, Voss MW, Lawrence BD, Spiker WR, Hung M. PROMIS PF CAT Outperforms the ODI and SF-36 Physical Function Domain in Spine Patients. *Spine (Phila Pa 1976)*. 2017;42(12):921-929. doi: 10.1097/BRS.0000000000001965.
16. Hung M, Baumhauer JF, Latt LD, Saltzman CL, Soohoo NF, Hunt KJ. Validation of PROMIS® Physical Function computerized adaptive tests for orthopaedic foot and ankle outcome research. *Clin Orthop Relat Res*. 2013;471(11):3466-3474. doi: 10.1007/s11999-013-3097-1.
17. Hung M, Franklin JD, Hon SD, Cheng C, Conrad J, Saltzman CL. Time for a paradigm shift with computerized adaptive testing of general physical function outcomes measurements. *Foot Ankle Int*. 2014;35(1):1-7. doi:

10.1177/1071100713507905. Epub 2013 Oct 7.
18. Papuga MO, Beck CA, Kates SL, Schwarz EM, Maloney MD. Validation of GAITRite and PROMIS as high-throughput physical function outcome measures following ACL reconstruction. *J Orthop Res*. 2014;32(6):793-801.
19. Papuga MO, Mesfin A, Molinari R, Rubery PT. Correlation of PROMIS physical function and pain CAT instruments with Oswestry Disability Index and Neck Disability Index in spine patients. *Spine (Phila Pa 1976)*. 2016;41(14):1153-1159. doi: 10.1097/BRS.0000000000001518.
20. Chen RE, Papuga MO, Voloshin I, et al. Preoperative PROMIS scores predict postoperative outcomes after primary ACL reconstruction. *Orthop J Sports Med*. 2018;6(5):2325967118771286 doi:10.1177/2325967118771286.
21. Schalet BD, Revicki DA, Cook KF, Krishnan E, Fries JF, Cella D. Establishing a common metric for physical function: linking the HAQ-DI and SF-36 PF subscale to PROMIS Physical Function. *J Gen Intern Med*. 2015;30(10):1517-1523. doi: 10.1007/s11606-015-3360-0.
22. Irrgang JJ, Anderson AF, Boland AL, et al. Development and validation of the international knee documentation committee subjective knee form. *Am J Sports Med*. 2001;29(5):600-613.
23. Martin RL, Irrgang JJ, Burdett RG, Conti SF, Van Swearingen JM. Evidence of validity for the Foot and Ankle Ability Measure (FAAM). *Foot Ankle Int*. 2005;26(11):968-983.
24. Chiarotto A, Maxwell LJ, Terwee CB, Wells GA, Tugwell P, Ostelo RW. Roland-Morris Disability Questionnaire and Oswestry Disability Index: which has better measurement properties for measuring physical functioning in nonspecific low back pain? systematic review and meta-analysis. *Phys Ther*. 2016;96(10):1620-1637.
25. Amtmann D, Cook KF, Johnson KL, Cella D. The PROMIS initiative: involvement of rehabilitation stakeholders in development and examples of applications in rehabilitation research. *Arch Phys Med Rehabil*. 2011;92(10Suppl):S12-S19. doi: 10.1016/j.apmr.2011.04.025.
26. Foucher KC, Cinnamon CC, Ryan CA, Chmell SJ, Dapiton K. Hip abductor strength and fatigue are associated with activity levels more than 1 year after total hip replacement. *J Orthop Res*. 2018;36(5):1519-1525. doi: 10.1002/jor.23783. Epub 2017 Nov 28.
27. Lyman S, Hidaka C. Patient-reported outcome measures-what data do we really need? *J Arthroplasty*. 2016;31(6):1144-1147. doi: 10.1016/j.arth.2016.01.073. Epub 2016 Mar 21.
28. Snekkevik H, Eriksen HR, Tangen T, Chalder T, Reme SE. Fatigue and depression in sick-listed chronic low back pain patients. *Pain Med*. 2014;15(4):1163-1170. doi: 10.1111/pme.12435. Epub 2014 Apr 9.
29. Gruber-Baldini AL, Velozo C, Romero S, Shulman LM. Validation of the PROMIS® measures of self-efficacy for managing chronic conditions. *Qual Life Res*. 2017;26(7):1915-1924. doi: 10.1007/s11136-017-1527-3. Epub 2017 Feb 26.
30. Ben-Ami N, Chodick G, Mirovsky Y, Pincus T, Shapiro Y. Increasing recreational physical activity in patients with chronic low back pain: a pragmatic controlled clinical trial. *J Orthop Sports Phys Ther*. 2017;47(2):57-66. doi: 10.2519/jospt.2017.7057.
31. Denison E, Åsenlöf P, Lindberg P. Self-efficacy, fear avoidance, and pain intensity as predictors of disability in subacute and chronic musculoskeletal pain patients in primary health care. *Pain*. 2004;111(3):245-252.
32. Hartley SM, Vance DE, Elliott TR, Cuckler JM, Berry JW. Hope, self-efficacy, and functional recovery after knee and hip replacement surgery. *Rehabil Psychol*. 2008;53(4):521-529.
33. Cella D, Lai JS, Jensen SE, et al. PROMIS fatigue item bank had clinical validity across diverse chronic conditions. *J Clin Epidemiol*. 2016;73:128-134. doi: 10.1016/j.jclinepi.2015.08.037. Epub 2016 Mar 3.
34. Amtmann D, Kim J, Askew RL, Park R, Cook KF. Minimally important differences for Patient Reported Outcomes Measurement Information System pain interference for individuals with back pain. *J Pain Res*. 2016;9:251-255.
35. Hill JC, Dunn KM, Lewis M, et al. A primary care back pain screening tool: identifying patient subgroups for initial treatment. *Arthritis Rheum*. 2008;59(5):632-641.
36. Delitto A, George SZ, van Dillen L, et al. Low Back Pain. Clinical Practice Guidelines Linked to the International Classification of Functioning, Disability, and Health from the Orthopaedic Section of the American Physical Therapy Association. *J Orthop Sports Phys Ther*. 2012;42(4):A1-57. doi: 10.2519/jospt.2012.0301. Epub 2012 Mar 30.
37. Caneiro JP, Smith A, Rabey M, Moseley GL, O'Sullivan P. Process of change in pain-related fear: clinical insights from a single-case of persistent back pain managed with cognitive functional therapy. *J Orthop Sports Phys Ther*. 2017;47(9):637-651. doi: 10.2519/jospt.2017.7371. Epub 2017 Jul 13.
38. Cañeiro JP, Ng L, Burnett A, Campbell A, O'Sullivan P. Cognitive functional therapy for the management of low back pain in an adolescent male rower: a case report. *J Orthop Sports Phys Ther*. 2013;43(8):542-554. doi: 10.2519/jospt.2013.4699. Epub 2013 Jun 11.
39. O'Sullivan PB, Caneiro JP, O'Keeffe M, et al. Cognitive functional therapy: an integrated behavioral approach for the targeted management of disabling low back pain. *Phys Ther*. 2018;98(5):408-423. doi: 10.1093/ptj/pzy022.
40. Vibe Fersum K, O'Sullivan P, Skouen JS, Smith A, Kvåle A. Efficacy of classification-based cognitive functional therapy in patients with non-specific chronic low back pain: a randomized controlled trial. *Eur J Pain*. 2013;17(6):916-928. doi: 10.1002/j.1532-2149.2012.00252.x. Epub 2012 Dec 4.
41. George SZ, Valencia C, Beneciuk JM. A Psychometric investigation of fear-avoidance model measures in patients with chronic low back pain. *J Orthop Sports Phys Ther*. 2010;40(4):197-205. doi: 10.2519/jospt.2010.3298.
42. O'Sullivan P, Caneiro JP, O'Keeffe M, O'Sullivan K. Unraveling the complexity of low back pain. *J Orthop Sports Phys Ther*. 2016;46(11):932-937.
43. George SZ, Valencia C, Zeppieri G, Robinson ME. Development of a self-report measure of fearful activities for

patients with low back pain: the fear of daily activities questionnaire. *Phys Ther*. 2009;89(9):969-979.
44. Costa Lda C, Maher CG, McAuley JH, Hancock MJ, Smeets RJ. Self-efficacy is more important than fear of movement in mediating the relationship between pain and disability in chronic low back pain. *Eur J Pain*. 2011;15(2):213-219. doi: 10.1016/j.ejpain.2010.06.014. Epub 2010 Jul 23.
45. Altmaier EM, Russell DW, Kao CF, Lehmann TR, Weinstein JN. Role of self-efficacy in rehabilitation outcome among chronic low back pain patients. *J Couns Psychol*. 1993;40(3):335-9.
46. Anderson MR, Houck JR, Saltzman CL, et al. Validation and generalizability of preoperative PROMIS scores to predict postoperative success in foot and ankle patients. *Foot Ankle Int*. 2018. 1071100718765225. doi: 10.1177/1071100718765225.
47. Ho B, Houck JR, Flemister AS, et al. Preoperative PROMIS scores predict postoperative success in foot and ankle patients. *Foot Ankle Int*. 2016;37(9):911-918. doi: 10.1177/1071100716665113. Epub 2016 Aug 16.

Asymmetry After Hip Fracture: A Multi-factorial Problem

Andrew Meszaros, PT, PhD[1]
Cynthia Zablotny, PT, DPT, NCS[1]
Paul Shew, PT, DPT[1]
Bret Reordan, PT, DPT[2]

[1]George Fox University, Newberg, OR
[2]Therapeutic Associates, Salem, OR

ABSTRACT

Background and Purpose: Sit-to-stand (STS) and static standing mechanics are related to fall risk and function after hip fracture. Often, these patients avoid weight bearing on the fracture side after rehabilitation. The purpose of this study was to use a novel clinically-relevant protocol to examine standing and STS vertical ground reaction force (vGRF) in light of perceptual measures of loading symmetry and muscle torque production in this population. **Methods:** A person post hip fracture performed 3 different STS conditions and 2 simple load-matching tasks. Motion, force plate, and perceptual data on weight distribution and load were collected. **Findings:** Standing and STS asymmetry were not explained by strength. A perceptual issue may be limiting performance progress in achieving symmetry. **Clinical Relevance:** Active task-specific training, augmented by attention to perception of movement, load, or strength, may assist in attaining symmetry in STS. **Conclusion:** Some patients may benefit when mechanical and perceptual performances are considered together.

Key Words: sit-to-stand, center-of-mass, loading, perception

BACKGROUND

Physical therapy practitioners working across many different practice settings are acutely aware of the significant public health issues resulting from the onset of a hip fracture and its sequelae. It has been estimated that on a worldwide basis, hip fracture impacts 1.6 million people annually; the majority are female.[1] Of those who sustain a hip fracture, approximately 18% to 30% will die within the first year post onset.[2,3] More than half of these individuals will fall at least one time in the year following initial fracture, and 28% will sustain more than one fall within this timeframe.[4] Nineteen percent will fall while moving from sit-to-stand (STS) or sit to walk.[5]

Activity-based Limitations

Activity-based limitations have been studied extensively.[3,6-8] Following fracture, approximately 34% to 59% of individuals will resume their pre-fracture basic activities of daily living (ADLs) function by 3 months, with this proportion increasing to 42% to 71% at 6 months.[6] In one prospective study of older adults followed pre- and post-fracture, the functional declines noted across time were 3 times larger in those who went on to fracture, compared to the non-fracture group.[9] An inability to attain pre-fracture functional status has been clearly evident in activities involving the use of the lower extremities, and this has led to new levels of dependency after fracture onset.[7] When individuals considered independent with basic mobility skills before fracture are assessed one year after this event, half will require assistance when rising from an armless chair or attempting to walk one block, more than two-thirds will need help with toileting and bathing transfers, and 90% will need help when climbing stairs. These values for dependency in lower extremity functional task completion do not improve significantly at the 2-year post-fracture mark.[7]

Sit-to-Stand Variables Following Hip Fracture

One of the lower extremity tasks that has been studied extensively in older adults and in those recovering from hip fracture is the STS transition.[3,10-15] This transition forms a necessary link to achieving independence in a wide variety of self-care and mobility-based ADLs. Even in those individuals who achieve an independent status in rising from STS post-hip fracture, research has shown that altered movement strategies are frequently adopted.[11-15] These movement modifications are initiated in the preparation phase of the STS transition, which begins before the buttocks are lifted from the support surface, and continue into the rising phase, which begins at the time of seat-off. Studies have shown that during the preparation phase, the rate of force development under the involved limb is 42% lower than the uninvolved limb.[11-13] Kneiss et al[13] report that during the rising phase of the transition, significantly lower peak involved side vertical ground reaction force (vGRF) has also been recorded, with reductions of 27% compared to the non-fractured side. Significantly lower peak hip and knee moments and powers have been recorded on the involved side also, when compared to the non-fractured limb. To insure continued independence in rising, compensations for this involved side force reduction are routinely made, and include a reduction in the speed of rising, coupled with a strong reliance on uninvolved side knee extensor moments and powers.

By manipulating initial STS task constraints and difficulty, researchers have gained significant insight into the movement strategies used to rise following hip fracture. This has been accomplished by asking subjects to rise independently with and without arm use.[12] When upper extremity use was permitted, individuals post-hip fracture demonstrated a significantly higher arm impulse, compared to non-fractured control subjects.[12] Despite this representing an easier task overall, arm use did not significantly diminish the preferential reliance on the uninvolved lower extremity. An asymmetric movement pattern persisted, with a lower rate of force development noted on the involved side during the STS preparation phase and a reduced vGRF measured during the rising phase. However, when required to perform a STS transition without arm use, these same individuals post-hip fracture demonstrated an ability to increase their involved side vGRF and rate of force development to a more reasonably functional level, yet still preferentially depended on the uninvolved limb's force production to rise. These findings suggest that the involved limb had the capacity to contribute in a more symmetric manner to the task of rising, and that it was capable of generating greater vGRF when a higher demand for use was imposed on it. The fact that an asymmetric movement strategy persisted, regardless of task difficulty, supports the concept that a pattern of learned non-use had been adopted by these individuals.

Achieving functional independence in transitioning from STS represents an important milestone in the rehabilitation of an individual post-hip fracture. However, it is possible that an emphasis on function over movement strategy may have a detrimental effect on the involved limb's ability to realize its maximal force-generating capacity during rising. Furthermore, physical therapists themselves lack accuracy in judging the magnitude of the involved limb's peak vGRF during rising, and this may limit how much emphasis is placed on remediating this learned non-use strategy. In a recent study of home health physical therapists who viewed videotapes of subject's post-hip fracture independently rising from STS, judgments of the involved limb's vGRF were made with a mean accuracy of just 39%.[16]

Implications of Sit-to-Stand Asymmetry Variables

To further understand the asymmetric STS movement pattern seen following hip fracture, investigators have sought to explain its value as a clinical finding.[11,13-15] Asymmetries in the involved limb's rate of force development during STS have been shown to have strong correlations with performance on the Berg Balance Scale (r = 0.80) and with gait speed (r = 0.81), while the peak vGRF of the involved limb also correlates well with gait speed (r = .72).[13] Sit-to-stand force asymmetry following hip fracture has also been shown to play a significant role in explaining performance on a timed stair climb test and that it may assist physical therapists in making accurate predictions of function in high level upright tasks, such as stair climbing, which rely on unilateral strength and control.[14] Moderate to high correlations have also been demonstrated between lower extremity symmetry measurements of muscle function (strength and power) and vGRF symmetry in STS (r= 0.58-0.76).[15]

Training Efforts to Reduce Sit-to-Stand Asymmetry

Although many investigations have provided insight into the magnitude of STS asymmetry following hip fracture, few have specifically addressed its clinical management. Briggs and co-workers[15] recently completed a longitudinal study to address asymmetry using multimodal training with activities such as high intensity strengthening, task specific training, and balance and gait training. An emphasis was placed on rising symmetry and regaining confidence during training. This intervention resulted in significantly greater symmetry of lower extremity vGRF variables during STS and improved knee extension strength and power on the involved limbs. Despite the rigors of this program and the gains that were realized, the asymmetry of specific STS variables and of muscle performance tests that remained post-training exceeded those that were previously measured in healthy older adults.[11,13,15] These findings may suggest that there may be another factor contributing to the asymmetry that was not addressed by this multimodal intervention approach.

Perception

Although significantly different etiologies prevail, the asymmetric rising patterns and learned non-use strategy noted following hip fracture have similar characteristics to that seen following stroke.[17] The nature of stroke, with its multiple body system involvement, has led investigators to consider the contributions of factors such as muscle strength and activation, sensation, and perception as some of the possible contributing factors to the pattern of asymmetric rising.[17] Different aspects of perception have been considered in research involving those with stroke, including perceptions of weight bearing load or force, level of effort, and verticality. In contrast, research involving those recovering from hip fracture revolves mainly around the musculoskeletal factors that interact, since this body system is clearly compromised in this situation. It is possible, however, that even in this population of patients, the motor strategies that emerge in STS transitions are dependent on the contributions of other body systems and functions, such as perception. To date, however, the concept of perceptual deficits contributing to asymmetry following hip fracture has not yet been explored.

CASE DESCRIPTION

The following patient was recruited as part of a larger ongoing study that seeks to identify the various mechanisms behind chronically asymmetric left/right loading during STS. There are several hypotheses: (1) Strength deficits will not fully account for loading asymmetries in some fully-rehabilitated patient's post-hip fracture. (2) These patients will not be able to accurately perceive their loading asymmetry, nor spontaneously fix it. (3) Asymmetric individuals will use perceived sense of effort, rather than actual sense of force, to determine load distribution through the feet.

This subject is a 74-year-old female who sustained a hip fracture of her dominant leg following a fall that was managed surgically with total joint arthroplasty. Beyond a mild postsurgical infection, the subject's rehabilitation was unremarkable; her health was otherwise stable. She successfully completed a standard course of physical therapy, and was tested in our motion analysis laboratory 6 months after surgery. She was able to rise from a standard height chair without using arms, to walk independently in the community, and attend a one-hour exercise class 3 times weekly. No sensory deficits existed.

METHODS

The broad goal was to integrate STS motor performance data with measures of strength, perceived effort of difficulty, perceived load, and perceived load distribution through the feet. Kinematic motion was analyzed using a Qualysis 3D system (10 cameras, 100Hz rate, 6Hz Butterworth filter) with two AMTI force plates (1,000 Hz), C-Motion Visual3D (with Dempster Hanavan for COM) and DataGraph software (Visual Data Tools Inc.). There were 3 STS conditions: (1) natural "self-selected," (2) a "50/50 fix" trial in which the subject was given feedback on her prior "self-selected" symmetry performance and then encouraged to concentrate on equal left-right weight distribution during another STS bout, and (3) "maximal excursion" STS trials in which the subject was asked to place as much weight as possible through one leg, without falling, while rising to stand (Figure 1). For STS, the subject was seated on a custom-built platform (armless and backless) that was adjusted to achieve the following start position: hip flexion 90°, thigh level with floor, feet even at shoulder's width, self-selected natural knee/ankle (up to 15° ankle dorsiflexion), and hands positioned with palms touching ("prayer position").

Perception during STS was assessed using a custom-built Visual Analog Scale (VAS) device. Immediately after each STS bout, the subject was asked to move a sliding marker from a centered position toward either the left or right (up to 3 inches each) to reflect the magnitude of her perceived left-right weight distribution during the rising (Figure 2). The experimenter then recorded marker position from a digital display (ie, 70/30).

Isometric knee extensor maximal strength was tested bilaterally in sitting, at 90°, with a load cell at each distal tibia (Kistler Force Link 9311B at 1,000 Hz, low pass filtered at 10Hz, 49.99 N/v). With this same arrangement, a force matching task was used to assess the individual's accuracy in perceiving submaximal muscle torque production. The subject was asked to generate a self-selected isometric knee extension torque on one side, then rest, then replicate the exact same torque on the contralateral side. The matching was performed twice, with the fractured and non-fractured limbs each having the opportunity to serve as the referenced standard for the other. The subject did not numerically assign a VAS estimate to the torque, because low efforts are difficult to meaningfully rate without a submaximal reference.

A matching task was also used to assess loading perception through the feet. From a static standing position, the subject was asked to shift a self-selected amount of weight toward one side, return to upright neutral, and then replicate the exact same load on the contralateral side (Figure 3). This was done twice, with each leg serving as the referenced standard. Immediately after each trial, the subject used the VAS device to offer her quantitative perception of the chosen load distribution through the feet (ie, 60/40).

FINDINGS

The subject had equal knee extensor muscle strength, with only 0.3% body weight (BW) difference between legs (Table 1). The accuracy of her extensor torque perception is excellent, with a small matching over-estimate of target torques by approximately 2% BW; this existed no matter which lower extremity served as the standard. This evidence suggests that neither knee extensor muscle weakness nor muscle torque perception account for asymmetries in sit-to-stand and matching tasks while standing.

During self-selected STS, the subject avoided loading the fracture leg, resulting in a vGRF asymmetry of approximately 12% (Table 2; Figure 4*). The subject sensed that she was asymmetric. Her VAS perceptual load rating was excellent in the non-fracture leg for both the STS and static standing tasks (within 3-5%); loading perception for the fractured leg was more accurate for the static standing task (4% error) than the STS task (13% error) (Table 2). After the actual magnitude of left-right vGRF asymmetry was disclosed to the subject as summary feedback, she was able to minimize the left-right difference to approximately 2% BW. To achieve this improvement, the subject's strategy was to pre-load the fracture-side's foot prior to standing, while still sitting (Figure 4+). She also successfully moved the center-of-mass closer to midline during STS (Figure 5+). However, during static standing, after the rise was complete, she was unable to maintain the center of mass (COM) at midline (Figure 5++).

During static standing, the subject had a significant load distribution asymmetry between the fractured side (31% BW) and non-fractured side (68% BW) (Table 2; Figure 4**). This 37% difference was reduced to 11% after summary feedback was given (Figure 4++).

The STS maximal excursion tests revealed a large difference in motor performance between the left and right sides (Figure 1). The COM excursion from midline was 32% less on the fracture side (not shown). The non-fracture side accepted 27% more BW than the fracture side (Table 2; Figure 6*) despite the two sides having nearly equal knee extensor strength. The subject's VAS score suggests that she had an accurate perception of this difference during maximal load. As observed earlier, the subject's strategy to improve STS weight bearing on the fracture side was by pre-loading it in sitting, prior to rising (Figure 6+). Interestingly, after the subject was required to bear that large load on the fracture side during STS, she showed nearly perfect symmetry in static standing (48/50, Table 2; Figure 6++).

Figure 1. Subject performing right side maximal excursion during a sit-to-stand maneuver. See also Figure 6.

Figure 2. Subject offering an estimate of her left-right sit-to-stand loading symmetry, using a custom-built digital visual analog scale device.

The VAS perceptual ratings of the magnitude of a standing lateral shift were quite accurate for both the fracture and non-fracture sides (5-7%), (Table 3; Figure 3). Based upon this, one might expect the subject to be highly accurate at matching loads between sides. Interestingly, this was not the case. The subject had a persistent residual mismatch of approximately 20% BW that seemed to be embedded in the fracture side (Table 3). When the fractured leg was used to produce the referenced standard, the match target was over-shot by 18% (Figure 7**). When the fracture leg was used to produce the match, it was under-shot by 22%. Similarly, COM excursion was reduced by approximately 17% when the fracture side set the standard for matching (Figure 8). A contributing factor to the poor matching could have been the asymmetric vGRF loading observed during quiet standing, at the start of each matching task.

CLINICAL RELEVANCE

In summary, these findings offer support to the clinically important concept that strength deficits alone do not fully explain loading asymmetry after hip fracture.[15] Despite our subject's ability to accurately perceive movement and torque limitations, she was still unable to spontaneously correct loading asymmetries without being given quantified summary feedback prior to prac-

Figure 3. Example of a subject performing the lateral weight-shift matching task. In this case, after the person loaded his left side, he attempted to replicate the exact same load on the right side. See also Figures 7 and 8.

ticing the task. That practice likely required her to make complex perceptual adjustments to recalibrate senses of effort and force. Maximal weight bearing on the fractured side during STS led to improvements in vGRF symmetry during STS and static standing. Matching tasks may be a useful clinical tool for addressing loading symmetry.

Limitations

The results of this case are limited by several factors due to the study design. The findings are not generalizable, based upon a single subject. We chose "strength" to be represented by isometric knee extension torque. However, other muscles also contribute to COM control during STS. For example, during the middle "transition" phase of STS, biceps femoris and gluteus maximus have been shown to play a key role.[18] During matching tasks, we allowed the subject to self-select her own load or excursion. However, it may be that perceptual estimates are magnitude sensitive. For example, it may be easier to perceive symmetry differences at 80/20 (left/right) than at 65/35. Finally, our paradigm addressed motor performance and not motor learning.

CONCLUSIONS

In the rehabilitation of an individual post-hip fracture, there is potential clinical benefit to be found in the integration of standard motion and force data with data from perceptual-heavy tasks such as VAS rating, load matching during weight bearing, torque matching during isometrics, and maximal excursion during STS.

REFERENCES

1. International Osteoporosis Foundation. Facts and statistics—Hip Fracture. www.iofbonehealth.org/facts-statistics. Accessed June 15, 2018.
2. Brauer CA, Coca-Perraillon M, Cutler DM, Rosen AB. Incidence and mortality of hip fractures in the United States. *JAMA*. 2009;302(14):1573-1579. doi: 10.1001/jama.2009.1462.
3. Magaziner J, Fredman L, Hawkes W, et al. Changes in functional status attributable to hip fracture: a comparison of hip fracture patients to community-dwelling aged. *Am J Epidemiol*. 2003;157(11):1023-1031.
4. Lloyd BD, Williamson DA, Singh NA, et al. Recurrent and injurious falls in the year following hip fracture: a prospective study of incidence and risk factors from the sarcopenia and hip fracture study. *J Gerontol A Biol Sci Med Sci*. 2009;64(5):599-609. doi: 10.1093/gerona/glp003. Epub 2009 Mar 5.

Table 1. Summary of Isometric Knee Extension Torque

	KE force (mean %BW)			**VAS rating of KE force** (% max)	
Lower Extremity:	ok	fx	Δ	ok	fx
TASK					
KE MVIC:	17.9	17.6	0.3	(100)	(100)
Match a self-selected KE using…					
…fx-side as the standard:	12.8	10.6	over-shot by 2.2	-	-
…ok-side as the standard:	8.6	10.9	over-shot by 2.3	-	-

Abbreviations: KE, knee extension; BW, body weight; VAS, visual analog scale; max, maximum; fx, fracture; ok, non-fractured; Δ, difference between legs; MVIC, maximum voluntary isometric contraction.

Table 2. Summary of Sit-to-Stand With Perceptual Ratings

lower extremity:	VAS rating of STS loading (% max)		Actual STS peak vGRF (%BW)		Actual vGRF of static standing, after rising (mean %BW)	
	ok	fx	ok	fx	ok	fx
TASK						
STS self-selected:	65	35	60[4] (* green)	48[4] (*red)	68[4] (**green)	31[4] (**red)
STS trying 50/50 fix:	(50)	(50)	53[4]	55[4]	55[4] (++green)	44[4] (++red)
STS max excursion to…						
… side with the ok LE:	80	20	87[6]	37[6]	66[6]	33[6]
… side with the fx LE:	40	60	38[6]	60[6]	48[6]	50[6]

Abbreviations: VAS, visual analog scale; STS, sit-to-stand; vGRF, vertical ground reaction force; max, maximum; BW, body weight; fx, fracture; ok, non-fractured; LE, lower extremity;

Key: * green = see the * icon near the figure's green line; superscript [6] = see Figure 6

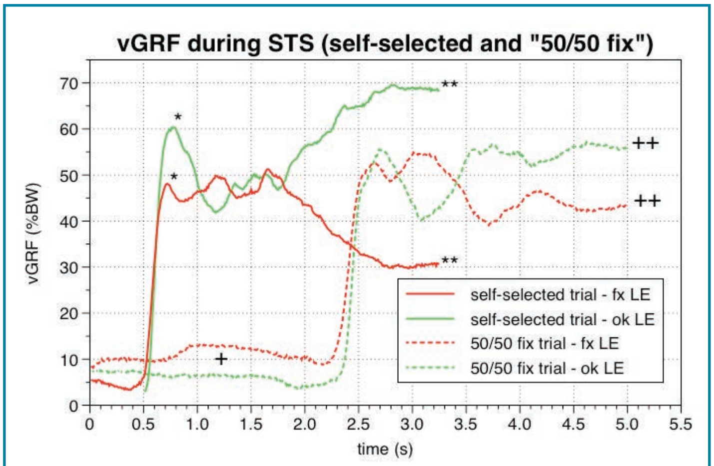


Figure 4. Vertical ground reaction force data for two discontinuous sit-to-stand trials: (1) solid lines = natural self-selected weight distribution; (2) hatched lines = after feedback, when the subject was focused on STS symmetry. Red = fractured leg. Green = non-fractured leg. See also Table 2, Figure 5.

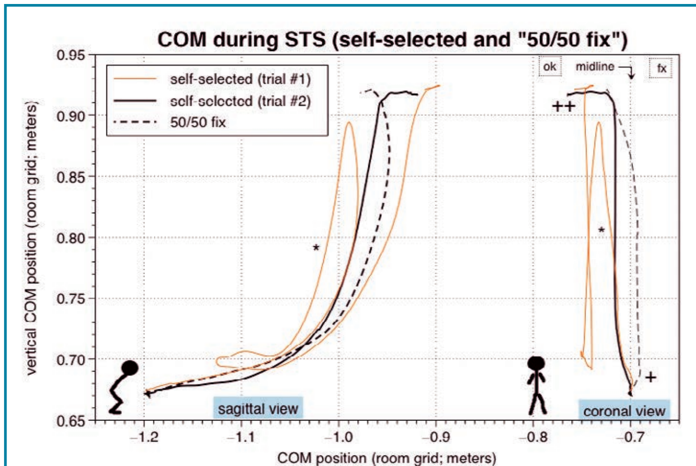


Figure 5. Center of mass data for three sit-to-stand trials. Orange = first natural self-selected trial, with the subject nearly unsuccessful. Black solid = second natural self-selected trial. Black hatched = after summary feedback was offered, with encouragement to fix asymmetries and rise with a 50/50 distribution. See also Figure 4.

5. Leavy B, Byberg L, Michaelsson K, Melhus H, Aberg AC. The fall descriptions and health characteristics of older adults with hip fracture: a mixed methods study. *BMC Geriatr*. 2015;15:40. doi: 10.1186/s12877-015-0036-x.
6. Dyer SM, Crotty M, Fairhall N, et al. A critical review of the long-term disability outcomes following hip fracture. *BMC Geriatr*. 2016;16:158. doi: 10.1186/s12877-016-0332-0.
7. Magaziner J, Hawkes W, Hebel JR, et al. Recovery from hip fracture in eight areas of function. *J Gerontol A Biol Sci Med Sci*. 2000;55(9):M498–M507.
8. Mangione KK, Palombaro KM. Exercise prescription for a patient 3 months after hip fracture. *Phys Ther*. 2005;85(7):676-687.
9. Bentler SE, Liu L, Obrizan M, et al. The aftermath of hip fracture: discharge placement, functional status change, and mortality. *Am J Epidemiol*. 2009;170(10):1290-1299. doi: 10.1093/aje/kwp266. Epub 2009 Oct 4.
10. Schot PK, Knutzen KM, Poole SM, Mrotek LA. Sit-to-stand performance of older adults following strength training. *Res Q Exerc Sport*. 2003;74(1):1-8.
11. Houck J, Kneiss J, Bukata SV, Puzas JE. Analysis of vertical ground reaction force variables during a sit to stand task in participants recovering from a hip fracture. *Clin Biomech (Bristol, Avon)*. 2011;26(5):470-476. doi: 10.1016/j.clinbiomech.2010.12.004. Epub 2010 Dec 31.
12. Kneiss JA, Houck JR, Bukata SV, Puzas JE. Influence of upper extremity assistance on lower extremity force application symmetry in individuals post-hip fracture during the sit-to-stand task.

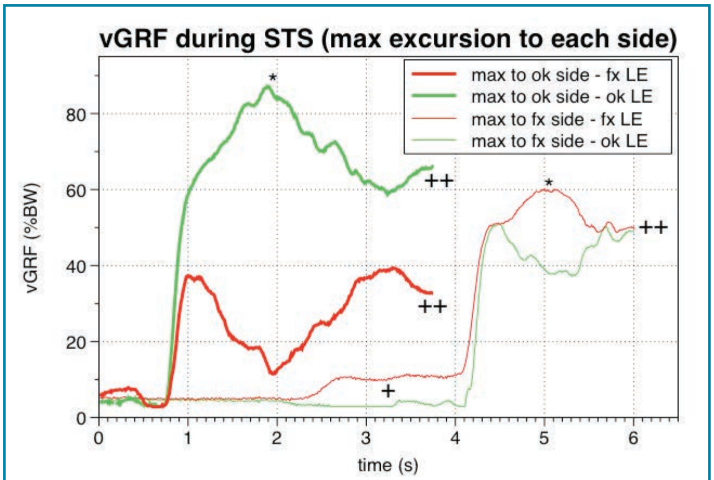


Figure 6. Vertical ground reaction force data for two discontinuous sit-to-stand trials: (1) thick lines = maximal excursion to the non-fractured "ok" side, (2) thin lines = maximal excursion to the fractured side. Red = fractured leg. Green = non-fractured leg. See also Table 2, Figure 1.

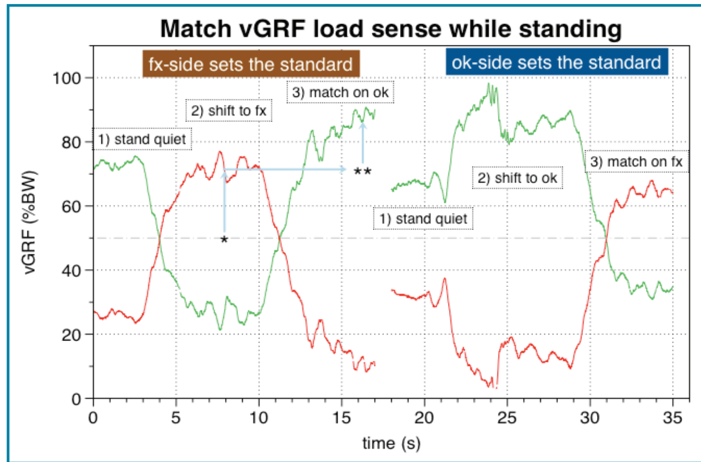


Figure 7. Vertical ground reaction force data for two discontinuous trials of matching lateral load shifts in standing. The subject was asked to stand quietly, shift weight to one side (the standard), then replicate that load on the contralateral side (the match). (1) brown half = when the fractured leg served as the reference standard; (2) blue half = when the non-fractured "ok" leg was the reference standard. Red = fractured leg. Green = non-fractured leg. See also Table 3, Figures 3, 8.

Table 3. Summary of Matching Trials With Perceptual Ratings

TASK	vGRF of initial shift (%BW)	vGRF of shift match %BW)	success of vGRF match (%BW)	VAS rating of shift match (% max)
Match a self-selected standing lateral shift when using…				
…fx-side as standard: (midline change)	71[7] (+21) (*)	89[7] (+39) (**)	over-shot by 18%	84 (+34)
…ok-side as standard: (midline change)	87 (+37)	65 (+15)	under-shot by 22%	72 (+22)

Abbreviations: vGRF, vertical ground reaction force; VAS, visual analog scale; BW, body weight; max, maximum; fx, fracture; ok, non-fractured

Key: * = see the * icon in the figure; [7] = see Figure 7.

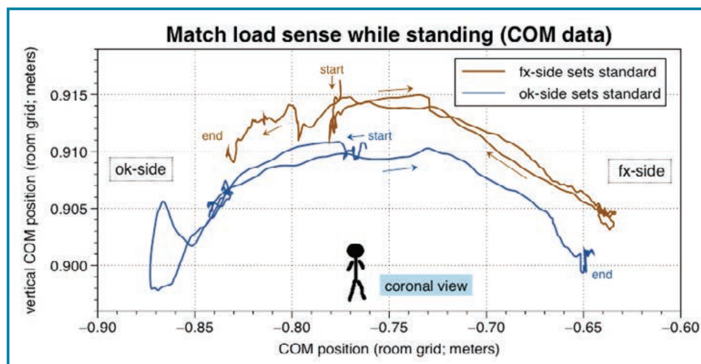


Figure 8. Center of mass data for two standing matching trials. The subject was asked to stand quietly, shift weight to one side (the standard), then replicate that load on the contralateral side (the match). (1) brown = when the fractured leg served as the reference standard; (2) blue = when the non-fractured "ok" leg was the reference standard. See also Figures 3, 7.

J Orthop Sports Phys Ther. 2012;42(5):474-481. doi: 10.2519/jospt.2012.3562. Epub 2012 Apr 30.

13. Kneiss JA, Hilton TN, Tome J, Houck JR. Weight-bearing asymmetry in individuals post-hip fracture during the sit to stand task. *Clin Biomech (Bristol, Avon)*. 2015;30(1):14-21. doi: 10.1016/j.clinbiomech.2014.11.012. Epub 2014 Nov 29.
14. Briggs RA, Houck JR, Drummond MJ, Fritz JM, LaStayo PC, Marcus RL. Asymmetries identified in sit-to-stand task explain physical function after hip fracture. *J Geriatr Phys Ther*. 2017; doi: 10.1519/JPT.0000000000000122. [Epub ahead of print]
15. Briggs RA, Houck JR, LaStayo PC, Fritz JM, Drummond MJ, Marcus RL. High-intensity multimodal resistance training improves muscle function, symmetry during a sit-to-stand task, and physical function following hip fracture. *J Nutr Health Aging*. 2018;22(3):431-438. doi: /10.1007/s12603-017-0977-1.
16. Zablotny C, Hilton T, Riek L, Kneiss J, Tome J, Houck J. Validity of visual assessment of sit to stand after hip fracture. *J Geriatr Phys Ther*. 2018. doi: 10.1519/JPT.0000000000000197. [Epub ahead of print]
17. Boukadida M, Piotte F, Dehail P, Nadeau S. Determinants of sit-to-stand tasks in individuals with hemiparesis post stroke: a review. *Ann Phys Rehabil Med*. 2015;58(3):167-172. doi: 10.1016/j.rehab.2015.04.007. Epub 2015 May 23.
18. Millington PJ, Myklebust BM, Shames GM. Biomechanical analysis of the sit-to-stand motion in elderly persons. *Arch Phys Med Rehabil*. 1992;73(7):609-617.

What Maximum Ankle Torque is Appropriate for Training Patients with Non-insertional Achilles Tendinopathy?

Tyler Cuddeford, PT, PhD[1]
Jeff Houck, PT, PhD[1]
Derek Palmer, PT, DPT[1]
Jason Beilstein, PT, DPT[1]
Jordan Visser, PT, DPT[1]

[1]*George Fox University, Newberg, OR*

ABSTRACT

Background and Purpose: The capacity of the Achilles tendon during a 1-repetition eccentric maximum contraction is largely unknown. This study examined the maximum ankle torque during a concentric/eccentric heel raise/lowering task and while running in healthy individuals and participants with chronic Achilles tendinopathy. These findings were applied to a 10-week training program for a patient with chronic Achilles tendinopathy. **Methods:** A total of 13 subjects (9 healthy and 4 with Achilles tendinopathy) participated in this study. Subjects were asked to perform a maximum eccentric contraction wearing a weighted vest while collecting 3-dimensional biomechanical variables. Subjects also ran along an instrumented runway to assess torque at the ankle joint. All participants completed VISA-A **Outcomes:** On the VISA-A, subjects with Achilles tendinopathy (AT) scored on average 28 points less than the healthy controls and were 27% weaker. The peak ankle torque during a single leg lowering task and running was 3.1 Nm/kg and appeared similar between controls and participants with chronic AT. Findings of the study when applied in a 10-week high load eccentric rehabilitation program demonstrated improved tendon characteristics and VISA-A score. **Conclusion:** Unhealthy tendons likely can tolerate high loads during rehabilitation and AT programs should consist of progressive resistive exercises instead of movements that emphasize repetitions.

Key Words: exercise, progressive resistance exercise, strength training

INTRODUCTION

Chronic mid-portion Achilles tendinopathy (AT) is characterized by pain, localized tendon thickening, and results in degeneration of the tendon, changes in collagen, and activity limitation.[1,2] With the use of diagnostic musculoskeletal ultrasound, additional pathoanatomical features include hypoechoic areas and a decrease in stiffness.[3,4] Although the incidence of AT primarily occurs in athletic populations that include novice and elite running, soccer, and rock climbing, other sedentary individuals are susceptible as well.[5-11]

Eccentric exercise is the most common type of rehabilitative treatment for AT but with various levels of success.[10,12-14] The scientific literature is replete with the Alfredson protocol that consists of up to 180 repetitions daily, and as appropriate additional weight could be added via a backpack.[15] A few studies cite using a backpack. In the clinic, performing an eccentric exercise with a backpack in excess of 20 Kg requires significant therapist oversight. This may be one reason most studies only use bodyweight with high repetitions. In a 5-year follow-up study comparing eccentric exercise to active rest for patients with AT, Silbernagel et al[12] demonstrated that 65% of the participants rated themselves as painfree. This included participants in the active rest only group. All-in-all, only about 50% of patients with AT respond to eccentric exercise. Similarly, in an 8-year follow-up study, 29% of patients went on to have surgery and 41% began having problems with the noninjured tendon after returning to previous activity.[10]

The precise cause of AT is still unclear, is likely multifactorial, and is the failure of the body's ability to adapt to the stress applied. For appropriate adaptation of the tendon to occur, significant mechanical loading is required.[16-19] Performing 180 eccentric ankle dorsiflexion repetitions may not effectively load the tendon high enough to produce the appropriate collagen synthesis necessary for tendon healing and remodeling. Interestingly, collagen synthesis may be irrespective of the type of load applied.[19,20] Arampatzis et al[19] conducted a 14-week study comparing high and low strain isometric plantar flexion strengthening exercises and discovered that high load provides a coordinated muscle-tendon unit adaptation to the plantar flexor group, whereas low load only showed positive adaptations to the muscle. This suggests that tendons require high strain activities to achieve collagen remodeling and a positive change in tendon thickness and stiffness. In a randomized controlled trial, Beyer et al[21] demonstrated a significant reduction in tendon thickness and symptoms in both the concentric and eccentric exercise groups. This particular protocol progressively loaded the tendon over a 12-week period with the highest loads and lowest repetitions occurring in weeks 9 to 12. Specifically, weeks 9 to 12 consisted of 4 sets of 6 repetition maximums. The higher loads consisted of using either a leg-press or barbell weight system. This essentially achieves the same outcome as the Alfredsen protocol which requires 180 repetitions, with higher load and dramatically fewer repetitions. Although the load was higher in the Beyer et al[21] study, subjects performed 3 different types of 2-legged exercises that may not have loaded the tendon high enough for full remodeling to occur.

The full capacity of the AT is also unknown and current strengthening programs may potentially under dose the necessary strain/stress needed for collagen remodeling. Achilles tendon rehabilitation programs seldom calculate either a 1-repetition maximum concentrically or eccentrically and likely stress the tendon around one-third of its maximum output.[20] As an example, the peak ankle plantar flexion moment during running is between 2-3 Nm/kg, depending upon the speed. In contrast, a single-leg (body weight only) heel rise is between 1.2 and 1.6 Nm/kg.[20,22] In addition, during a squat jump, the ankle moment can reach as high as 5-6 Nm/kg.[23] Although Alfredsen protocol does not reach these loads despite the heavy slow resistance program using one maximal concentric contraction, higher load is likely achievable using one maximal eccentric contraction. The first purpose of this current study was to determine single-leg 1-repetition concentric and eccentric maximums for healthy controls and subjects with a past history of AT. Secondly this study aimed to compare the ankle joint planar flexion moment during running with a single-leg heel rise during a maximal eccentric contraction. Finally, the study attempted to determine whether a 10-week maximum tendon-loading eccentric exercise program produced changes in tendon characteristics.

METHODS

Nine healthy subjects (5 male and 4 female) and 4 subjects with AT (2 male and 2 female) participated in this study. Subjects in the AT group had a history of chronic Achilles tendinopathy for greater than 1-year. Participants were recruited from the university and consisted of students and staff and ranged in age from 23-44 years. Exclusion criteria was current AT symptoms or previous surgery. All subjects read and signed a university approved consent prior to the testing. Subjects were then instructed to complete the Victorian Institute of Sport Assessment – Achilles (VISA-A) form as well as a questionnaire regarding their activity and training habits. All participants consented to participate and the procedures described here were approved by a university committee overseeing human subjects' research.

Kinematic and Kinetic Measurements

To obtain ankle joint kinematic and kinetic data, prior to testing, reflective markers were placed on key anatomical landmarks to define a 2-segment biomechanical model of the ankle and shank (Figure 1). Three-dimensional ground reaction force was captured using an AMTI (Advanced Mechanical Technology Inc., Watertown MA) 400mm X 600mm force plate sampled at 1000 Hz. Ten infrared cameras were used to calculate ankle kinematics. During the heel-rise trial, data was collected at 60 Hz while during the running trial, data was collected at 120 Hz. Ankle kinematics were defined by foot motion relative to tibial motion. Kinematic and kinetic data were synchronized through Visual 3-D software (C-Motion Research Biomechanics) and ankle joint moments were then calculated using inverse dynamics.

Musculoskeletal Ultrasound Measurements

Tendon thickness (longitudinal and cross-section) was measured before and after a 10-week pilot eccentric exercise program. Images were determined using a Hitachi-Aloka (Alpha6-PD2,) musculoskeletal ultrasound with a linear array probe at a frequency of 10-12 MHz. All image measurements were analyzed using the accompanying onboard Hitachi-Aloka software.

Procedure

Subjects were asked to perform one double limb calf raise on a 7-cm block to assess their maximum dorsiflexion and plantar flexion range of motion. In order to estimate their 1-repetition eccentric maximum,

Figure 1. Reflective markers defining the 2-segment biomechanical model of the lower leg and foot.

a 1-repetition concentric maximum plantar flexion was accomplished with the use of weighted vests. Each subject started with approximately 150% of their body weight. For example, if a subject weighed 75 Kg, the weighted vest consisted of 37.5 Kg. Subjects were instructed to perform a single-leg heel rise and achieve full plantar flexion, even if they felt minimal pain. They were instructed to stop if they thought the pain was either moderate or severe. If any of the subjects needed additional support for balance, a platform was available for them to lightly stabilize themselves. Subjects were able to achieve their 1-repetition concentric maximum within 2 to 3 trials. Once this was achieved a starting point of an additional 40% was added to the vest. Using the example above, an additional 15 Kg was added to the weight vest. The subjects were then instructed to rise up with both feet, then to remove one foot, and attempt to eccentrically lower themselves in a controlled manner using only the remaining foot. Subjects were visually assessed as achieving a slow controlled motion by the examiner watching their movement. If the subject reported the trial felt too easy, more weight was added and the subject tried again. Most subjects were able to find their maximum eccentric weight within 2 to 3 repetitions. Following the single-leg heel lowering task, subjects removed the weighted vest and performed 3 running trials on the force plate.

Pilot Eccentric Exercise Program

A single male subject who had chronic Achilles tendinopathy for 15 years participated in the pilot study. To maximally load the tendon, an eccentric exercise program was developed whereby in a single session, the total repetitions did not exceed 24 (3 sets of 6-8 repetitions). Since performing an eccentric exercise with a backpack or weight vest in excess of 90 Kg requires significant therapist oversight, a leg-press weight machine was used for the exercise protocol. The subject was supervised during their exercise session and was asked to increase their weights when they could reach 8 repetitions. Each session's weight program and repetitions were documented. This pilot eccentric exercise program was investigated on a single subject. Analysis

Concentric and eccentric 1-repetition maximum for each subject was recorded and group means were calculated. VISA-A was recorded for both groups prior to testing. Statistical analysis was not performed because of the small sample size. Descriptive data is provided to support each hypothesis. For the subject with the 15-year history of tendinopathy, tendon thickness was taken before and after the 10-week pilot eccentric exercise progressive resistive exercise program.

OUTCOMES

Results displayed in Table 1 demonstrate the 1-repetition maximum eccentric and concentric contractions between the 2 groups. The AT group demonstrated less capacity and was unable to eccentrically or concentrically load the tendon as much as the healthy group. The differences were more profound during the eccentric contraction condition, resulting in 27% lower output.

Results presented in Table 2 demonstrate the VISA-A scores across both the healthy group and the AT group. All of the healthy participants scored 100 while the AT group scored much less. The average score for the AT group was 72.

Table 3 shows the average peak ankle joint moment (torque) during a maximally weighted single-leg eccentric movement and during running. Both conditions and groups yielded similar results with average peak (ankle torque) values ranging between 2.9 and 3.1 Nm/kg.

This data was used to motivate a maximum load (or 80% 1 rep max) pilot eccentric training program for a patient with chronic AT. This particular subject was a 40-year-old

Table 1. Average 1-repetition Maximum Concentric and Eccentric Contraction Between the Healthy Group and Subjects with Achilles Tendinopathy Expressed as a Percentage of Body Weight

Subjects		Concentric Maximum	Eccentric Maximum
Healthy	S1	155%	201%
	S2	147%	223%
	S3	167%	217%
	S4	179%	209%
	S5	150%	229%
	S6	181%	230%
	S7	144%	233%
	S8	134%	215%
	S9	162%	220%
	Average (SD)	**157% (SD=15.9)**	**218% (SD=10.9)**
Achilles Tendinopathy	S1	144%	189%
	S2	157%	196%
	S3	143%	198%
	S4	155%	183%
	Average (SD)	**149% (SD=7.3)**	**191% (SD=6.9)**

Table 2. VISA-A Scores in Healthy Subjects and in the Achilles Tendinopathy Group

Subjects		VISA-A
Healthy	Subjects 1-9	100
Achilles Tendinopathy	S1	68
	S2	72
	S3	74
	S4	74
	Average (SD)	**72 (2.8)**

Table 3. Average Peak Ankle Joint Moments (Nm/kg) During a Maximally Weighted Single-leg Lowering Task and While Running

	Single-leg Lowering	Running
Healthy	3.0 Nm/kg	3.1 Nm/kg
Achilles Tendinopathy	2.9 Nm/kg	3.0 Nm/kg

male with a 15-year history of chronic AT who did not respond to traditional eccentric exercise protocols (using body weight and high repetitions). His initial VISA-A was 76, starting eccentric load was 240 pounds, and pre-exercise Achilles thickness was 0.63 cm. The progressive resistive exercise program consisted of 3 sets of 6 to 8 repetitions lasting 10 weeks in length and the subject was instructed to increase weight as soon as they could perform 8 repetitions. Following the 10-week program, VISA-A was 100, ending eccentric load was 320 pounds, and tendon thickness was 0.48 cm. Figure 2 demonstrates a reduction in tendon thickness and a decrease in hypoechoic areas following the exercise program. There was a 0.15 cm reduction in tendon thickness resulting in a 24% decrease in overall thickness and the VISA-A score improved by 24 points.

DISCUSSION

The current study shows that the capacity of the AT is much higher than most of the AT rehabilitation programs used in the clinic or in research articles.[21] Effective treatment for AT depends upon how much remodeling occurs in the tendon and traditional AT programs may not load the tendon high enough for reorganization of collagen.[19] There is a clear difference in the eccentric strength (Table 2) of subjects with AT compared to controls. Although the AT groups did not complain of pain during the testing, the differences could be accounted for because of discomfort during the task. However, this still supports the notion that most AT rehabilitation programs do not load the tendon to capacity. In addition, strength deficits of nearly 30% indicate that the muscle/tendon complex may not be strong or stiff enough to overcome the force required during athletic tasks without injuring the tendon. Although this was just a pilot study, the data may prompt clinicians to review AT protocols and encourage therapists to include maximal tendon loading as part of the training. Consistent comments from runners with AT is that if they want to increase their mileage or pace, this results in increased symptoms. This phenomenon may also be the result of a weak or less stiff muscle/tendon. It is hypothesized that because of the limited number of fibroblasts in a tendon, collagen synthesis is best accomplished with higher loads, which might be the basis of a "set point" before remodeling happens.[19] Since higher loads on muscle and tendons result in higher blood flow and oxygenation, it may be in order for adequate protein synthesis to occur at the tendon, the exercises required need to be maximized.[24] While strength gains occur within just a few weeks as a result of neuromuscular effects, it is well known that muscle tissue adaptation to progressive resistive exercise occurs only after 6 weeks; keeping in mind that progressive loading is necessary for muscle adaptation. It may be that current AT programs are not adequate in length as well as load for tendon adaptation to materialize. Interestingly, recent studies suggest that it is not the type of load (eccentric, concentric, or isometric) that produces an effect, but the amount of load.[19,21]

Musculoskeletal ultrasound provides a visual and quantifiable description of tendon morphology and can differentiate between healthy and unhealthy tissue.[25] Unhealthy tendons exhibit hypoechoic areas surrounded by areas of consistent or homogenous tissue. In a recent study, intra- and inter-reliability measures of tendon thickness was determined to be excellent with Interclass Correlation Coefficients (ICC) of 0.98.[26] The unhealthy tendon in this study demonstrated greater thickness (longitudinal) and hypoechoic areas compared to their uninjured healthy tendon. In addition, following the 10-week maximal loading exercise program, the tendon demonstrated a 24% reduction in localized thickness as well as a more homogenous appearance (Figure 2). Although many studies demonstrate improvement with more traditional rehabilitation programs,[10,12,27] as introduced by Alfredson et al,[15] many studies have inconsistent effects across subjects. It may simply be that the tendon requires higher loads for remodeling to occur. Structural changes,

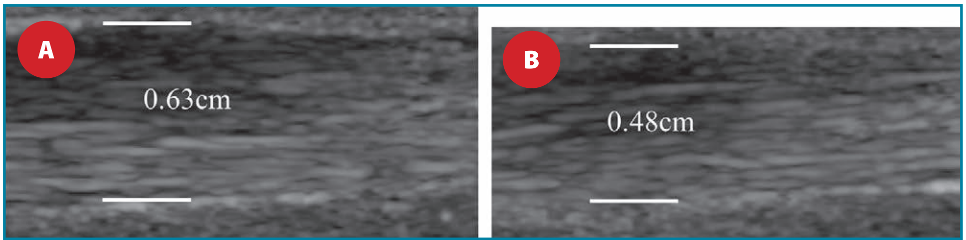


Figure 2. Tendon thickness in an unhealthy Achilles tendon. A, before and B, after a 10-week maximal eccentric loading program.

such as tendon thickness, following exercise was evident in this current study but not all studies agree that changes in collagen occur nor is abnormal tendon structure related to symptom severity. Interestingly, it may be that studies which demonstrated no changes in tendon structure did not load the tendon adequately enough. Although the Beyer et al[21] study achieved a 1-repetition maximum, the contraction type was concentric and the subjects performed all exercises with 2 legs. Both of these protocols had similar outcomes, likely because they did not load the tendon maximally. However, based on the data of this current study, it appears that performing a maximum eccentric contraction may load the tendon 40% to 60% more than a concentric contraction, which is what therapists may need to prescribe for better outcomes.

The Alfredson protocol requires subjects to achieve a total of 180 single-leg body weight only heel lowering exercises.[15] The load applied to the tendon during a single-leg body weight only heel lowering task is 2 to 3 times less than the load during running. A body-weight only exercise program minimally loads the tendon compared to the tendon's total capacity that may not produce enough positive change in the tendon. The concentric maximum during a heel rise was 61% and 42% lower than the eccentric maximum heel rise in the controls and participants with AT, respectively (Table 1). This suggests a heavy slow resistance protocol using a concentric 1-repetition maximum would result in significantly lower loads as compared to an eccentric lowering program. And, the ankle joint moment during a 1-repetition eccentric maximum (weighted vest) is comparable to running and matching the load required during a sport task. However, running requires a high number of repetitions and high load (in excess of 2000 steps per mile) which many patients with AT may not tolerate. An important concept may be to control repetitions of high loads, using short bouts of running in conjunction with the weighted vest or a leg press machine to return patients to running.

Using the protocol described above, a single participant with a 15-year history of AT improved his VISA-A score to 100 and reduced his tendon thickness on ultrasound. The case study participant started at an eccentric 1-repetition maximum of 240 pounds (141% of BW). At completion of the program the eccentric 1-repetition maximum increased to 320 pounds (188% of BW) an increase of 33% from their starting eccentric 1 repetition maximum. This case illustrates the practical application of the eccentric 1-repetition maximum protocol. Although it is certain not all patients will have a similar response, the positive response of this patient with long standing AT suggests the potential for a therapeutic effect with high load and low repetition protocols.

Limitations

This was a pilot study and consisted of a low number of overall subjects. The data is more useful in planning larger studies and describing likely overall capacity of healthy participants and participants with AT. Because the sample size of the AT groups was very small, and likely not representative of a large diverse set of participants with AT, general inferences should be avoided until studies with larger sample sizes are completed.

CLINICAL RELEVANCE

With further testing and additional subjects, this topic of investigation has significant clinical relevance. The literature suggests that between 45% and 50% of subjects with AT benefit from rehabilitation. This data suggests with significantly greater tendon loading, more collagen remodeling may be achieved. It is also worth noting that unhealthy tendons can tolerate higher loads during rehabilitation and AT programs should consist of progressive resistive programs instead of programs that emphasize repetitions.

CONCLUSIONS

This study supports the need for higher tendon loading during AT rehabilitation programs. Although the mode that was used in this study was an eccentrically derived training program, the type of load is likely inconsequential. In addition, both the healthy and the unhealthy tendon can tolerate significantly more load than most current studies employ.

REFERENCES

1. Magnan B, Bondi M, Pierantoni S, Samaila E. The pathogenesis of Achilles tendinopathy: a systematic review. *Foot Ankle Surg*. 2014;20(3):154-159. https://doi.org/10.1016/j.fas.2014.02.010.
2. Lorimer AV, Hume PA. Stiffness as a risk factor for Achilles tendon injury in running athletes. *Sports Med*. 2016;46(12):1921-1938. https://doi.org/10.1007/ s40279-016-0526-9.
3. Comin J, Cook JL, Malliaras P, et al. The prevalence and clinical significance of sonographic tendon abnormalities in asymptomatic ballet dancers: a 24-month longitudinal study. *Br J Sports Med*. 2013;47(2):89-92. https://doi.org/10.1136/bjsports-2012-091303.
4. Aubry S, Nueffer JP, Tanter M, Becce F, Vidal C, Michel F. Viscoelasticity in Achilles tendonopathy: quantitative assessment by using real-time shear-wave elastography. *Radiology*. 2015;274(3):821-829.
5. Magnussen RA, Dunn WR, Thomson AB. Nonoperative treatment of midportion Achilles tendinopathy: a systematic review. *Clin J Sport Med*. 2009;19(1):54-64. https://doi.org/10.1097/JSM.0b013e31818ef090.
6. Kujala UM, Sarna S, Kaprio J. Cumulative incidence of Achilles tendon rupture and tendinopathy in male former elite athletes. *Clin J Sport Med*. 2005;15(3):133-135.
7. Gajhede-Knudsen M, Ekstrand J, Magnusson H, Maffulli N. Recurrence of Achilles tendon injuries in elite male football players is more common after early return to play: an 11-year follow-up of the UEFA Champions League injury study. *Br J Sports Med*. 2013;47(12):763-768. https://doi. org/10.1136/bjsports-2013-092271.
8. Nielsen RO, Rønnow L, Rasmussen S, Lind M. A prospective study on time to recovery in 254 injured novice runners.

PLoS One. 2014;9(6):e99877. https://doi.org/10.1371/journal.pone.0099877.
9. Buda R, Di Caprio F, Bedetti L, Mosca M, Giannini S. Foot overuse diseases in rock climbing: an epidemiologic study. *J Am Podiatr Med Assoc*. 2013;103(2):113-120. https://doi.org/10.7547/1030113.
10. Paavola M, Kannus P, Paakkala T, Pasanen M, Jarvinen M. Long-term prognosis of patients with Achilles tendinopathy. An observational 8-year follow-up study. *Am J Sports Med*. 2000;28(5):634-42.
11. Sobhani S, Dekker R, Postema K, Dijkstra PU. Epidemiology of ankle and foot overuse injuries in sports: a systematic review. *Scand J Med Sci Sports*. 2013;23(6):669-686. https://doi.org/10.1111/j.1600-0838.2012.01509.x.
12. Silbernagel KG, Brorsson A, Lundberg M. The majority of patients with Achilles tendinopathy recover fully when treated with exercise alone: a 5-year follow-up. *Am J Sports Med*. 2011;39(3):607-613. https://doi.org/10.1177/0363546510384789.
13. Stevens M, Tan CW. Effectiveness of the Alfredson protocol compared with a lower repetition-volume protocol for midportion Achilles tendinopathy: a randomized controlled trial. *J Orthop Sports Phys Ther*. 2014;44(2):59-67. https://doi.org/10.2519/jospt.2014.4720.
14. Sayana MK, Maffulli N. Eccentric calf muscle training in non-athletic patients with Achilles tendinopathy. *J Sci Med Sport*. 2007;10(1):52-58.
15. Alfredson H, Pietila¨ T, Jonsson P, et al. Heavy-load eccentric calf muscle training for the treatment of chronic Achilles tendinosis. *Am J Sports Med*. 1998;26(3):360-366.
16. Kjaer M. Role of extracellular matrix in adaptation of tendon and skeletal muscle to mechanical loading. *Physiol Rev*. 2004;84(2):649-698. http:// dx.doi.org/10.1152/physrev.00031.2003.
17. Kjaer M, Langberg H, Miller BF, et al. Metabolic activity and collagen turnover in human tendon in response to physical activity. *J Musculoskelet Neuronal Interact*. 2005;5(1):41-52.
18. Kjær M, Langberg H, Heinemeier K, et al. From mechanical loading to collagen synthesis, structural changes and function in human tendon. *Scand J Med Sci Sports*. 2009;19(4):500–510. doi: 10.1111/j.1600-0838.2009.00986.x.
19. Arampatzis A, Albracht K, Karamanidis K. Adaptations responses of the human Achilles tendon by modulation of the applied cyclic strain magnitude. *J Exper Bio*. 2007;210(1):2743-2753.
20. Chaudhry S, Morrissey D, Woledge R, Bader D, Screen H. Eccentric and concentric exercise of the triceps surae: an in vivo study of dynamic muscle and tendon biomechanical parameters. *J Appl Biomech*. 2015;31(2):69-78.
21. Beyer R, Kongsgaard M, Hougs Kjaer B, Øhlenschlæger T, Kjaer M, Magnusson SP. Heavy slow resistance versus eccentric training as treatment for Achilles tendinopathy: a randomized controlled trial. *Am J Sports Med*. 2015;43(7):1704-1711. https://doi.org/10.1177/0363546515584760.
22. de David A, Carpes F, Stefanyshyn D. Effects of changing speed on knee and ankle joint load during walking and running. *J Sports Sci*. 2015;33(4):391-397. DOI: 10.1080/02640414.2014.946074.
23. Finni T, Komi PV, Lepola V. In vivo human triceps surae and quadriceps femoris muscle function in a squat jump and counter movement jump. *Eur J Appl Physiol*. 2000;83(4-5):416-426.
24. Boushel R, Langberg H, Green S, Skovgaard D, Bülow J, Kjaer M. Blood flow and oxygenation in peritendinous tissue and calf muscle during dynamic exercise. *J Physiol*. 1999;524(1):305-313.
25. Smith J, Finnoff J. Diagnostic and interventional musculoskeletal ultrasound: Part 1. Fundamentals. *PM&R*. 2009;1(1):64-75.
26. del Bano-Aledo ME, Martinez-Paya JJ, Dios-Diaz J, et. al. Ultrasound measures of tendon thickness: intra-rater, inter-rater and inter-machine reliability. *Muscles Ligaments Tendons J*. 2017;7(1):192-199. doi: 10.11138/mltj/2017.7.1.192. eCollection 2017 Jan-Mar.
27. Martin R, Chimenti R, Cuddeford T, et al. Achilles pain, stiffness, and muscle power deficits: midportion Achilles tendinopathy revision 2018. *J Orthop Sports Phys Ther*. 2018;48(5):5 A1-A38. doi: 10.2519/jospt.2018.0302.

Wooden Book Reviews

Rita Shapiro, PT, MA, DPT
Book Review Editor

Book reviews are coordinated in collaboration with Doody Enterprises, Inc.

Documentation Basics for the Physical Therapist Assistant, 3rd Edition, Slack Incorporated, 2018, $62.95
ISBN: 9781630914028, 166 pages, Soft Cover

Author: Erickson, Mia L., PT, EdD, CHT, ATC; McKnight, Rebecca, PT, MS

Description: This update of a 2012 documentation book incorporates changes addressing the evolving profession of physical therapy and the documentation it requires. The authors consider all documentation factors relevant to current standards of compliance, reimbursement, and electronic health records. They also incorporate the ICF language structure and disablement concepts, and reference APTA documents. **Purpose:** This is intended as a guide and reference to enable the effective provision of ethical, legal, and compliant documentation in physical therapy. The purpose is to present the commonly used/accepted documentation formats along with up-to-date requirements from reimbursement sources, liability issues, and protection of the value of physical therapy services. The book can function as an initial source for education of students or to improve or refine the documentation of already established clinicians. **Audience:** The intended audience is physical therapist assistant students, physical therapist assistant educators, and clinicians. It also would be of interest to physical therapists who use physical therapist assistants (PTAs), because the book addresses the PTA interpretation of the evaluation. The book references clinical roles and how PTAs' documentation should complement treatment collaboration and support the plan of care and goals set by physical therapists. Both authors are physical therapists with extensive education and experience as physical therapy educators. Their awareness of the up-to-date needs in the profession for evidence-based practice and the importance of documenting outcomes is evident in the book's content. **Features:** The first section presents the language structure of the disablement model and acknowledges the shift from the biomedical to the biopsychosocial approach to care. The structure of the method of documentation is consistent with this format and ICF language. Each chapter begins with a list of key terms and abbreviations as well as a list of objectives. Chapters conclude with a list of review questions that provide a summary of key points. Several chapters also have application exercises, giving readers the opportunity to consider case presentation examples and to apply what was presented. An entire chapter is dedicated to electronic medical records. The WebPT software screen shots are used as an example of structure, templates, and dropdown menus for a common EMR system. Each chapter is appropriately referenced, with many references to publications and documents generated by the APTA. Chapters 8-10 are dedicated to the SOAP documentation format. The authors emphasize the value of daily treatment notes, linking back to the initial evaluation and reflecting the status of patient goals. A discussion of the appropriate types of information and their placement, logical organization of information, and the relationship of documentation to decision-making strategies and reimbursement are part of the SOAP format. Legal and ethical topics, including recognizing fraud and abuse, risk management, and federal legislation on privacy and HIPPA are also covered. **Assessment:** This book is thorough and well organized. It presents concepts supported with practical examples and scenarios. Documentation guides can easily be updated annually given the rate at which the profession continues to change, and much has changed since the previous edition. With CMS, APTA, and ICF as dominant sources for this book's documentation structure, readers can be confident that the book is relevant and the information accurate.

Jason R. Oliver, PTA
McLeod-Trahan-Sheffield Physical Therapy Services

Biomechanics of Training and Testing: Innovative Concepts and Simple Field Methods, Springer, 2018, $239
ISBN: 9783319056326, 314 pages, Hard Cover

Editor: Morin, Jean-Benoit; Samozino, Pierre

Description: This book presents methods of evaluating movement and performance in sport and their application to training. It focuses on the biomechanical analysis of cycling, ballistic movements of the upper and lower limbs, and running. **Purpose:** The authors state their purpose is to present innovative, simple methods for accurate and effective training and testing in sport and the theoretical basis for such testing. The authors also explain how to interpret the data and the factors influencing performance in testing. Translating cumbersome methods of testing that require expensive laboratory equipment into simpler, less expensive methods that can be available to trainers and sports medicine practitioners is needed, and the book accomplishes this challenge. In the introduction, the authors note the importance biomechanical analysis of movement has in physical therapy and injury prevention. There is some discussion in some chapters about the impact of certain analyses on the risk of certain conditions, but this is brief and the focus is more on the theory of analysis, gold standards of analysis, validated simpler methods of analysis, and data interpretation as it relates to performance. **Audience:** The book is intended for coaches, physical therapists, and sports medicine practitioners. Physical therapists specializing in sports care would be most interested in this book. The authors are published researchers in the field of sports biomechanics. **Features:** The book is organized into three parts, covering cycling, ballistic movements of the upper and lower limbs, and running. The authors discuss measurements of stiffness, force, velocity, and power as they relate to these topics. Most of the 13 chapters address running. Each chapter begins with an abstract and is then divided into sections with an introduction to the testing measures, biomechanical models of basis, laboratory measurements, and proposed simpler forms of measurement. Chapters include figures, tables, and charts to help clarify concepts. This is particularly helpful as this topic is complex. The authors present multiple ways to perform testing in the clinic and provide simpler means than what was required by the original research. For example, they discuss the availability of specific apps, cameras, and other devices that coaches and sports medicine practitioners can access for minimal cost. However, the equations in the book are lengthy and can be difficult to follow, and readers must page back and forth to refer back to other figures for abbreviations. **Assessment:** This book does a good job of providing the background for biomechanical models and analysis of movement in sports, while offering less expensive and simpler ways to perform testing. Physical therapists pride themselves on being experts in movement analysis, and this book benefits physical therapists who specialize in sports. Clinical researchers looking to answer questions about the impact of biomechanics in sports on injuries and injury prevention will appreciate the information presented in this book and the practical approach to testing.

Monique Serpas, PT, DPT, OCS
Southeast Louisiana Veterans Health Care System

Motor Control and Learning: A Behavioral Emphasis, 6th Edition, Human Kinetics, 2019, $119
ISBN: 9781492547754, 532 pages, Hard Cover

Author: Schmidt, Richard A., PhD; Lee, Timothy D., PhD; Winstein, Carolee J., PhD, PT; Wulf, Gabriele, PhD; Zelaznik, Howard N., PhD

Description: This book explores human movement based on behavior and performance, with a focus on cognitive, motivational, neurological, and biomechanical processes that influence complex movements. This edition, with three additional authors, provides updated evidence and information compared to the 2011 fifth edition. A web resource linked to the book provides supplemental material for each chapter. **Purpose:** A major goal is to present principles and theories of motor performance, control, and learning. The authors support or refute theories using research evidence. Sidebars and the website offer more details for improved understanding. Sidebars in previous editions highlighted research issues. The authors reduced some material to improve clarity and expanded the book with new science. **Audience:** This is an excellent resource for undergraduate and graduate students. The book also targets practitioners who work with human movement directly and indirectly. **Features:** The book is organized into three parts. The first part includes definitions, scientific methods, models for processing information, and how attention affects motor behavior. Part II explains sensory and central contributions, speed and accuracy principles, and coordination with respect to motor control. Part III describes motor learning, including principles of learning, the importance of feedback and specifically augmented feedback, how practice conditions affect learning, the process of learning and stages of motor learning, and retention and transfer of learned behavior to later performance. Each chapter is strongly supported by research and concludes with student assignments and notes. Graphs and various diagrams illustrate the text, and some chapters include activities for readers to improve understanding and provide a break from reading. **Assessment:** This book provides a blend of current literature and classic studies in motor control and learning, and the authors cite advantages and limitations for the research. I found part III the most thought-provoking and applicable to my practice of physical therapy, particularly chapter 10, which discusses how conditions of practice influence motor learning. The book comprehensively examines human movement and performance.

Karin J Edwards, MSPT
Providence Health & Services

Observational Gait Analysis: A Visual Guide, Slack Incorporated, 2018, $71.95
ISBN: 9781630910402, 230 pages, Spiral Cover

Author: Adams, Janet M., PT, MS, DPT; Cerny, Kay, PT, PhD

Description: This well-illustrated book on normal and abnormal gait covers kinetics and kinematics gait characteristics along with functional gait measures and case studies. An accompanying website has videos that correspond to the case studies as well as videos of normal gait, along with the graphs from the book. **Purpose:** The authors' intent is to "address all aspects of analyzing walking in one comprehensive teaching text. Since observational gait is an acquired skill requiring practice and feedback, we have included videos of persons with and without gait deviations for the student and clinician to observe." The book meets these worthy objectives, and the website is an excellent, comprehensive learning tool to analyze gait. **Audience:** As the authors state in the introduction, this book is intended for all clinicians and students. The authors developed the observational gait analysis (OGA) and created the first edition of the Rancho OGA manual. Dr. Adams is a professor at California State University, Long Beach, where Dr. Cerny has taught. **Features:** The book introduces terminology related to gait, then presents normative values of gait characteristics (walking speed, walking categories), temporal and spatial characteristics throughout the gait cycle, and kinematic information in table and illustration format. It also describes gait kinetics for each joint throughout the phase of gait in text and pictures, and gait by using results from electromyography (EMG). Functional gait measures are also described in detail including normal values for different populations, ages, genders, etc. Pathological gait is covered in the case study section as well as in the website videos. **Assessment:** This is an invaluable source of information about gait, with excellent physical, graphical, and visual presentations that can assist in applying this information to patient problems. There is no other book like it. It is an invaluable resource for all new and experienced clinicians.

Christopher D. Blessing, MS, MPT, OCS, CSCS
University Medical Center of Princeton at Plainsboro

Who We Are, Where We Are, What We Do

Terri DeFlorian
Executive Director

Description of Duties: I am responsible for personnel management, administration, finances, coordinating and attending Board of Director and finance meetings, attending CSM and AOM, building/property maintenance, and tenants.

Years of Service: **30 years**

Hobbies: I enjoy working with our horse trainer who has been training me how to train my horse.

Tara Fredrickson
Executive Associate

Description of Duties: I oversee the Academy's website; I plan the Academy offsite educational offerings and Board Meetings; I manage the Academy's Special Interest Groups and assist the Academy's Committees wherever necessary; I work with the Executive Director on Board-related tasks and initiatives.

Years of Service: **25 years**

Hobbies: I enjoy spending time with family, golfing, and relaxing whenever I can!

Leah Vogt
Executive Assistant

Description of Duties: I am the first contact for members via phone calls and 'contact us' forms. I assist with meeting preparations for CSM and the Annual Meeting. I also perform many different administrative tasks for the office.

Years of Service: **3 years**

Hobbies: I love musical theatre and opera and enjoy seeing Broadway musicals and opera productions whenever I get the chance.

Sharon Klinski
Managing Editor

Description of Duties: I am responsible for all stages of production, advertising sales, marketing plans, and author-related interactions for journals and newsletters and independent study courses.

Years of Service: **28 years**

Hobbies: I love to work in my flower gardens, read, and have play dates with our first grandchild.

Laura Eichmann
Publishing Assistant

Description of Duties: I assist in all publishing responsibilities for journals and newsletters and independent course studies.

Years of Service: **2 years**

Hobbies: I enjoy running, biking, and being on the river.

Brenda Johnson
ICF-based Clinical Practice Guideline Coordinator

Description of Duties: I support the wonderful volunteers that create the Academy's Clinical Practice Guidelines (CPGs). Any CPG questions, suggestions, or if you want to volunteer to help, I'm your gal!

Years of Service: **2.5 years**

Hobbies: My hobbies are having fun and anything that is outdoors. I love golfing with my family, being up at the lake, and eating spicy food.

Avery Gerstenberger
Marketing Intern

Description of Duties: I focus on social media managing as well as advertising, promotion, and graphic design.

Years of Service: **since June 2018**

Hobbies: In my free time I enjoy hiking, cycling, and spending time with loved ones.

Feel free to reach out to us at any time. We are here to help you!

PRESIDENT'S MESSAGE

Lorena Pettet Payne, PT, MPA, OCS

Your special interest group has been busy. If you have not had a chance, check out "Current Concepts in Occupational Health" a group of informational articles housed on the OHSIG web page at www.orthopt.org. The newest documents, *Functional Capacity Evaluation and Prevention and Ergonomics* are sure to assist you in providing function-based services.

Plan to attend the Combined Sections Meeting, January 23-26, 2019, in Washington, DC. The OHSIG will present: *"Thinking Outside the Box: Improving Worker Health with Ergonomics."* Come learn from experts in the field of ergonomic assessment and intervention. Participate in the activities of your special interest group by attending the membership meeting. Watch for further information to be posted on the OHSIG Facebook page and delivered to your e-mail from the Academy of Orthopaedic Physical Therapy.

"Sincerity of Effort" Testing in Functional Capacity Evaluations: The Preponderance of Evidence Does Not Support Commonly-Used Functional Testing Methods

Steve Allison, PT, DPT, OCS

A functional capacity evaluation (FCE) is a comprehensive performance-based medical assessment of an individual's physical and/or cognitive abilities to safely participate in work and other major life activities.[1]

Functional capacity evaluations are commonly used in cases involving workers' compensation, personal injury, long-term disability, and social security disability claims. In nearly all of these cases, financial compensation as it relates to functional limitations and work restrictions due to medically determinable impairments is at stake.

It has been a common practice over the past 30 years for FCE examiners to use some form of sincerity of effort testing methods in FCEs such as comparing an individual's performance from static (isometric) lift strength testing to their performance during incremental dynamic lift testing, 5-rung grip strength testing, rapid exchange grip strength testing, and using the coefficient of variance statistical measure with static lift strength testing and hand grip strength testing.[1-27]

However, the preponderance of evidence from a review of the literature does not support the use of the term sincerity of effort nor the use of these testing methods alone for opining about an individual's performance or effort level.[1-27]

The term "sincerity" means the quality or state of being sincere which has been defined as being honest, pure, and true. Effort has been defined as a conscious exertion of power, a serious attempt, and something produced by exertion or trying.[28]

Therefore, it seems logical to conclude that a sincere effort would mean an honest attempt, or a pure conscious exertion of power, or a true exertion. In contrast, an insincere effort would mean a dishonest attempt, an impure conscious exertion of power, or an untrue exertion. Many well-trained professionals across multiple disciplines including physicians, physical therapists, occupational therapists, medical case managers, vocational counselors, attorneys, and claims examiners often equate insincere effort with malingering.

Malingering is the purposeful production of falsely or grossly exaggerated physical or psychological complaints with the goal of receiving a reward. These may include money, insurance settlement, drugs, or the avoidance of punishment, work, jury duty, release from incarceration, the military or some other kind of service. Malingering is no longer considered a mental disorder or a psychiatric diagnosis by the American Psychiatric Association, and there is specific guidance provided in the Desk Reference to the Diagnostic Criteria from DSM-5 for identifying this condition.[29]

Based on the evidence presented thus far, do you think that it is more probable than not that an individual who provided an insincere effort during functional testing is a malingerer?

In my opinion, the answer to this question is an unequivocal no. It is certainly possible that the individual was a malingerer, but it is also more probable than not that the results were due to other factors such as undiagnosed psychological disorders, invalid and/or unreliable testing protocols, test instrument calibration, and FCE examiner bias.

Functional capacity evaluation examiners should instead rely on objective physiological variables such as heart rate and respiration rate, and clinically observable biomechanical signs of physical exertion such as muscle recruitment and muscle fatigue during functional testing to reach a conclusion that is more probable than not about an individual's performance or effort level.[1,30]

In conclusion, FCE examiners do not measure an individual's honesty of effort, pureness of effort, or the trueness of their effort. Therefore, the use of the term sincerity of effort and the use of sincerity of effort testing discussed in this article is inappropriate and, in my opinion, should be avoided. However, FCE examiners who choose to continue to perform this type of testing should understand the proper use and limitations of the "sincerity of effort" testing methods, and use caution when applying these methods to make a determination about an individual's performance or effort level.[1]

REFERENCES

1. Allison S, Galper J, Hoyle D, Mecham J. Current concepts in functional capacity evaluation: a best practices guideline. https://www.orthopt.org/content/special-interest-groups/occupational-health/current-concepts-in-occ-health. Occupational Health Special Interest Group, Academy of Orthopaedic Physical Therapy. Adopted April 30, 2018.
2. Lechner D, Bradbury S, Bradley L. Detecting sincerity of effort: a summary of methods and approaches. *Phys Ther*. 1998;78(8):867-888.
3. Sindhu BS, Shechtman O, Veazie PJ. Identifying sincerity of

effort based on the combined predictive ability of multiple grip strength tests. *J Hand Ther*. 2012;25(3):308-318; quiz 319. doi: 10.1016/j.jht.2012.03.007.
4. Robinson ME, Geisser ME, Hanson CS, O'Connor PD. Detecting submaximal efforts in grip strength testing with the coefficient of variation. *J Occup Rehabil*. 1993;3(1):45-50. doi: 10.1007/BF01076741.
5. Wachter NJ, Mentzel M, Hutz R, Gulke J. Reliability of the grip strength coefficient of variation for detecting sincerity in normal and blocked median nerve in healthy adults. *Hand Surg Rehabil*. 2017;36(2):90-96. doi: 10.1016/j.hansur.2016.12.003.
6. Ashford RF, Nagelburg S, Adkins R. Sensitivity of the Jamar Dynamometer in detecting submaximal grip effort. *J Hand Surg Am*. 1996;21(3):402-405.
7. De Smet L, Londers J. Repeated grip strength at one month interval and detection of voluntary submaximal effort. *Acta Orthop Belg*. 2003;69(2):142-144.
8. Dvir Z. Coefficient of variation in maximal and feigned static and dynamic grip efforts. *Am J Phys Med Rehabil*. 1999;78(3):216-221.
9. Fairfax AH, Balnave R, Adams RD. Variability of grip strength during isometric contraction. *Ergonomics*. 1995;38(9):1819-1830.
10. Fishbain DA, Cutler R, Rosomoff HL, Rosomoff RS. Chronic pain disability exaggeration/malingering and submaximal effort research. *Clin J Pain*. 1999;15(4):244-274.
11. Goldman S, Cahalan TD, An KN. The injured upper extremity and the JAMAR five-handle position grip test. *Am J Phys Med Rehabil*. 1991;70(6):306-308.
12. Gutierrez Z, Shechtman O. Effectiveness of the five-handle position grip strength test in detecting sincerity of effort in men and women. *Am J Phys Med Rehabil*. 2003;82(11):847-855.
13. Hamilton A, Balnave R, Adams R. Grip strength testing reliability. *J Hand Ther*. 1994;7(3):163-170.
14. Hoffmaster E, Lech R, Niebuhr BR. Consistency of sincere and feigned grip exertions with repeated testing. *J Occup Med*. 1993;35(8):788-794.
15. Niebuhr BR, Marion R. Detecting sincerity of effort when measuring grip strength. *Am J Phys Med*. 1987;66(1):16-24.
16. Niebuhr BR, Marion R. Voluntary control of submaximal grip strength. *Am J Phys Med Rehabil*. 1990;69(2):96-101.
17. Shechtman O. The coefficient of variation as a measure of sincerity of effort of grip strength, Part II: sensitivity and specificity. *J Hand Ther*. 2001;14(3):188-194.
18. Shechtman O. The coefficient of variation as a measure of sincerity of effort of grip strength, Part I: the statistical principle. *J Hand Ther*. 2001;14(3):180-187.
19. Shechtman O, Anton SD, Kanasky WF, Jr., Robinson ME. The use of the coefficient of variation in detecting sincerity of effort: a meta-analysis. *Work*. 2006;26(4):335-341.
20. Shechtman O, Gutierrez Z, Kokendofer E. Analysis of the statistical methods used to detect submaximal effort with the five-rung grip strength test. *J Hand Ther*. 2005;18(1):10-18.
21. Shechtman O, Taylor C. How do therapists administer the rapid exchange grip test? A survey. *J Hand Ther*. 2002;15(1):53-61.
22. Shechtman O, Taylor C. The use of the rapid exchange grip test in detecting sincerity of effort, Part II: validity of the test. *J Hand Ther*. 2000;13(3):203-210.
23. Taylor C, Shechtman O. The use of the rapid exchange grip test in detecting sincerity of effort, Part I: administration of the test. *J Hand Ther*. 2000;13(3):195-202.
24. Tredgett M, Pimble LJ, Davis TR. The detection of feigned hand weakness using the five position grip strength test. *J Hand Surg Br*. 1999;24(4):426-428.
25. Tredgett MW, Davis TR. Rapid repeat testing of grip strength for detection of faked hand weakness. *J Hand Surg Br*. 2000;25(4):372-375.
26. Westbrook AP, Tredgett MW, Davis TR, Oni JA. The rapid exchange grip strength test and the detection of submaximal grip effort. *J Hand Surg Am*. 2002;27(2):329-333.
27. Townsend R, Schapmire DW, St James J, Feeler L. Isometric strength assessment, Part II: Static testing does not accurately classify validity of effort. *Work*. 2010;37(4):387-394. doi: 10.3233/WOR-2010-1092.
28. Merriam-Webster Dictionary. Sincerity, sincere, effort. Accessed July 17, 2018.
29. American Psychiatric Association: Desk Reference to the Diagnostic Criteria from DSM-5. Philadephia, PA: American Psychiatric Publishing; 2013:866-868.
30. Morgan MV, Allison S, Duhon D. Heart rate changes in functional capacity evaluations in a workers' compensation population. *Work*. 2012;42(2):253-257.

President's Letter

Annette Karim, PT, DPT, PhD
Board-Certified Orthopaedic Clinical Specialist
Fellow of the American Academy of Orthopaedic Manual Physical Therapists

I hope your summer was restful, with time for planning and thinking about your impact on our profession. One way to develop a foundation for your impact is to connect with others and develop a vision together by learning. Connect. Learn. These are the foci of CSM 2019, which is just around the corner! Please note that CSM will be in January this year. Details can be found at: http://www.apta.org/CSM/

The PASIG has a preconference course! The Performing Arts Special Interest Group and the Academy of Orthopaedic Physical Therapy, APTA will be jointly sponsoring a 2-day course in Washington, DC entitled *"Musculoskeletal Sonography of the Lower Limb Focused in Sport & Performing Arts."* Presenters will include Megan Poll, Doug White, Marika Molnar, and Scott Epsley, who have extensive experience in use of real time ultrasound imagery augmenting the clinical examination in athletes and performing artists. Registration is open!

At CSM, the **PASIG main educational session** will be *"Olympian to Novice: Using Evidenced-based Screening for the Performing Artist,"* presented by Kristen Schuyten, who was the physical therapist who traveled to PyeongChang for the 2018 Olympics with Team USA for Figure Skating.

Stay tuned for updates on PASIG programming, dancer screening, fellowship, and membership in the monthly citation blasts and in our social media leading up to CSM. To belong to our Facebook page, contact Dawn (Muci) Doran, and please tweet about performing arts with us @PT4PERFORMERS.

It is with great pleasure that I introduce Caryn Pierce et al and their research. Thank you all for sharing your study on playing-related musculoskeletal pain in collegiate musicians.

Playing-related Musculoskeletal Pain Among College-level Music Students Before and After an Informative Lecture by a Physical Therapist

Caryn Pierce, PT, DScPT, JSCC, BCSI, MTC; Lori Walton, PT, DPT, PhD, MPH(s); Elizabeth Oakley, PT, DPT, DHSc; Rose Caceres, PT, DPT; Hilary Sadow, PT, DPT; Kirstin Yoder, PT, DPT

INTRODUCTION

In 2012 the National Association of Schools of Music (NASM) published a new standard requiring accredited schools to provide education regarding musculoskeletal health and safety.[1] This was based on recommendations from the Performing Arts Medicine Association (PAMA) after years of research documented a high prevalence of playing-related musculoskeletal disorders (PRMDs) among student[2] and professional musicians. A systematic review of prevalence studies published from 1980 to 1996 showed that 39% to 87% of musicians reported PRMDs, depending on definition.[3] Little changed until a more recent study where 84% reported playing-related pain at some point in their career, 50% had current pain, and 28% had taken at least one day off in the past season due to pain[4]; other studies noted most musicians' pain lasted > 3 months and some reported prolonged breaks from playing due to pain.[5] Pain was primarily reported in the neck and upper extremities but also in the upper and lower back.[6] It is most common for piano and strings followed by wind and brass instruments.[3,4] Risk factors for PRMDs have been identified. A history of previous upper quadrant injury, small hand size, female gender, increasing age, and subjective measures of stress have been measured and correlated statistically with pianists' playing-related pain.[7] Environmental factors such as lights, seating, ambient temperature, hearing, and use of spectacles are also thought to contribute to playing-related pain as are changes in technique, instrument, or playing time.[8] Heavier instruments or a mismatch between body stature and instrument dimensions may also provide additional challenges, especially in the presence of faulty biomechanics.[9,10] At the time of this study, performance anxiety and sleep disorders had been associated with playing-related pain in musicians,[11,12] but effects of nutrition and fitness had not been assessed. Many musicians have found it difficult to access or navigate health care successfully.[5,13] Education has been shown to be an effective means of prevention and treatment.[14,15] Body awareness and knowing limitations, self-care, yoga, and exercise are topics that have proven valuable to musicians. While interventions such as adding a prevention course to the curriculum,[16] physical therapist-led onsite triage,[17] or customized exercise prescriptions[18] have decreased pain prevalence by as much as 75%, the effect of a single lecture has not been studied. The purpose of this study was to assess the effect of an informative lecture by a physical therapist on playing-related pain among college-level music students. The research hypothesis was that pain prevalence, frequency, duration, intensity, and related disability would decrease among students who received the education.

METHODS

Researchers obtained Institutional Review Board approval and subjects' informed consent before proceeding with this study. A convenience sample of music students 18 to 50 years of age was recruited from a university music department. Paper surveys were administered during class or rehearsal time in the spring semester, 2 weeks before and 2 ½ months after a 50-minute lecture (Figure 1) delivered by a physical therapist, who was also a violinist. Optional attendance (at the discretion of the music program) was used as a grouping variable in the subsequent analysis. Eighty-one subjects completed pretest surveys; 46 completed both pre- and posttest surveys. Of those who completed both surveys, 11 attended the lecture and 35 did not attend. More than 11 students attended the lecture, but not all of them were study participants. Logistical difficulties related to tight rehearsal/performance schedules and classes not meeting near the end of the semester contributed to the high attrition rate.

The surveys included demographics and two symptom questionnaires–the Standardized Nordic Questionnaire (SNQ) and Musculoskeletal Pain Questionnaire for Musicians (MPQM). Though not useful for clinical diagnosis and treatment, the SNQ and several modified versions have been validated against physical examination for the surveillance of occupational injuries with a sensitivity range of 66% to 100% and specificity of 51% to 88%; it is also highly repeatable > 0.90.[19] The SNQ asks 3 yes/no questions about body parts highlighted on a diagram.[20] The questions were modified (in italics) by the researchers to make it more relevant to this study: have you had trouble (ache, pain, or discomfort) during *fall semester (pretest)? spring semester (posttest)?* has it affected *playing your instrument?* and have you had trouble in the past 7 days? The MPQM, developed from the Chronic Graded Pain Questionnaire (CGPQ) and QuickDASH performing arts module, has been validated specifically for use in musicians with a Cronbach's alpha of 0.768 for internal consistency and overall correlation with the CGPQ of 0.65 ($p < 0.01$). It asks subjects to rate pain frequency, duration, and intensity on a numeric scale and quantifies playing-related disability for a more nuanced description of pain but without reference to body parts.[21] This study attempted to link the two questionnaires by asking subjects to identify up to 3 most troublesome body parts they reported on the SNQ and relate responses on the MPQM to each of those body parts on separate lines. However, most subjects did not clearly indicate which body parts they were referring to on the MPQM. Responses from the first line of the MPQM were analyzed without reference to a specific body part, assuming subjects would likely report their most painful and disabling problem there; other lines were ignored. The total number of troublesome body parts from the SNQ was calculated for each subject.

The SPSS 21.0 was used to analyze the data. Change scores indicating sizes of the pre- to posttest differences were calculated for the MPQM variables. Though raw data were used for analysis, pain prevalence from the SNQ is expressed as percentages in this paper, since groups were of unequal size. Nonparametric Wilcoxon and Mann-Whitney tests were used to make statistical comparisons within and between groups with a significance level set at $\alpha = 0.05$.

FINDINGS

Demographics

Of 46 subjects, 22 were male and 24 were female; sex remained evenly distributed after division into groups. Forty subjects were between the ages of 18 and 25; six were older. Eighteen played violin, 12 piano, 4 cello, and 12 other instruments.

Standardized Nordic Questionnaire

Fall semester pain prevalence for the entire sample ranged from 49% to 54% for the pretest, depending on body part, and did not change significantly on the spring semester posttest (Figure 2). However, when the sample was divided into groups by lecture attendance, a higher prevalence of pain was noted on the pretest among those who chose to attend the lecture (Figure 3), especially when considering reports of symptoms within 7 days of taking the surveys (Figure 4). This difference was statistically significant for upper back pain at 91% for the lecture group and 17% for the no-lecture group ($Z = -3.744$, $p < .001$) as well as lower back pain at 64% and 23%, respectively ($Z = -2.230$, $p = 0.027$). On the posttest, there were significant decreases in upper and lower back pain prevalence among the lecture group—91% to 45% ($Z = -2.000$, $p = 0.046$) for upper back and 64% to 27% ($Z = -2.000$, $p = 0.046$) for lower back. However, the prevalence of upper back pain on the posttest remained higher among those who attended the lecture at 45% compared to 15% among those who did not attend ($Z = -2.108$, $p = 0.035$). There was no significant change in pain prevalence among students who did not attend the lecture. About half of all students who reported pain indicated it affected their playing (Figure 5).

Musculoskeletal Pain Questionnaire for Musicians

Students rated frequency of pain on a scale of 1 to 4 where 1 indicates never, 2 a few performances, 3 most performances, and 4 every performance. On the pretest, those who attended the lecture reported a mean frequency of 2.55 while those who did not attend the lecture reported a frequency of 1.73. This difference was statistically significant ($Z = -1.971$, $p = 0.049$). Frequency decreased from 2.55 on the pretest to 2.09 on the posttest for the lecture group ($Z = -2.236$, $p = 0.025$) but did not change for those who did not attend (Figure 6). Duration of pain was rated on a

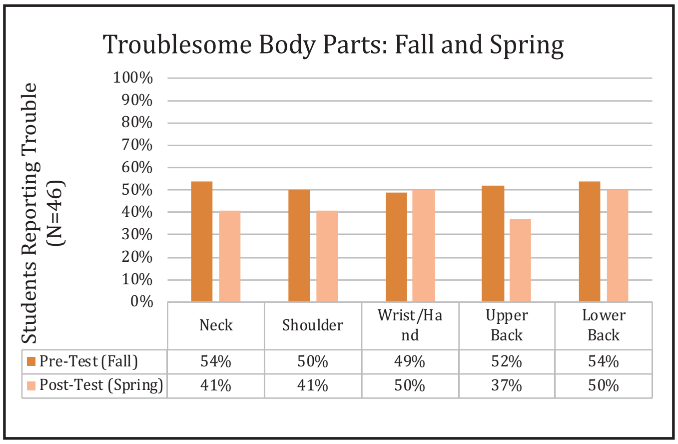
"Keeping your Body as Finely Tuned as your Instrument"

Playing-related Pain
- Prevalence and Impact
- Risk Factors
- Posture and Body Mechanics
- Accessing Healthcare
- Personal Responsibility

Prevention is Key!

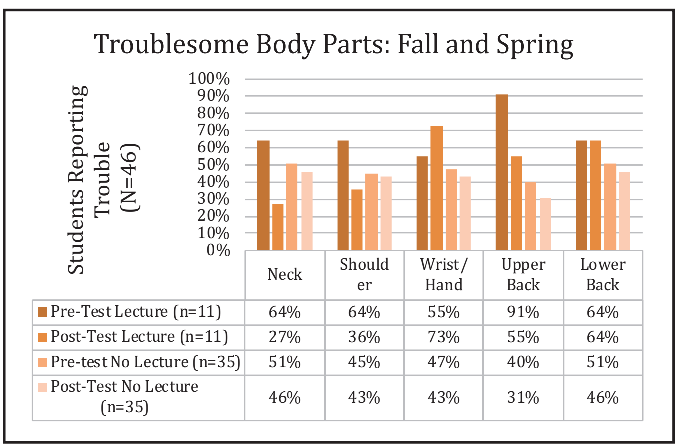
Figure 1. Lecture outline.

scale of 1 to 4 where 1 indicates minutes, 2 hours, 3 days, 4 all the time. Mean duration on the pretest was 1.73 for the lecture group and 1.61 for those who did not attend. This difference was not significant, and there were no changes for either group on the posttest (Figure 6). Pain intensity included ratings for pain now, worst pain, least pain, and average pain on a scale of 1 to 10 where 1 is "not intense at all" and 10 is "as intense as it could be." On the pretest there were significant differences between the lecture and non-lecture groups for pain now—3.55 and 2.22 respectively (Z = -2.059, p = 0.039)—and average pain—4.64 and 2.5 (Z = -2.493, p = 0.013). Worst pain decreased 6.18 to 4.82 on the posttest among those who attended the lecture (Z = -2.354 p = 0.019), and the size of the change, 1.36, was significantly larger than that of the no-lecture group, 0.19 (Z = -2.155 p = 0.031). (Figure 7). Disability included 4 items related to playing music—technique, instrument, quality, and time—rated on a 4-point scale where 0 indicated no difficulty, 1 mild difficulty, 2 moderate difficulty, and 3 severe difficulty as well as an overall disability rating expressed as a percent disability. The pretest difference between groups was significant for quality at 2.27 and 1.69, respectively (Z = -1.986, p = 0.047). None of the pre- to posttest differences were significant, and neither were the change scores, but there was no longer a difference between groups on the posttest (Figure 8).



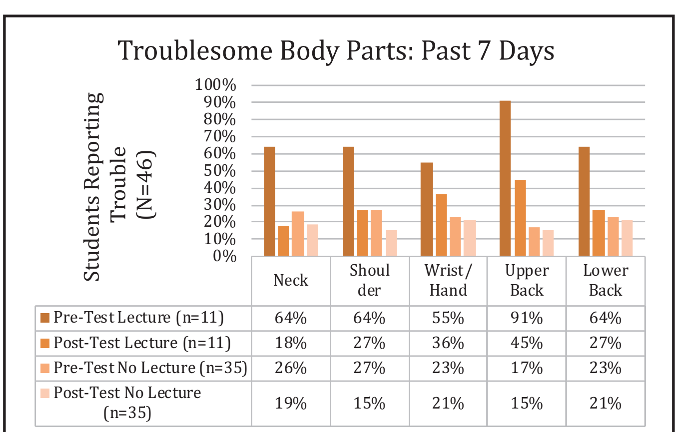
	Neck	Shoulder	Wrist/Hand	Upper Back	Lower Back
Pre-Test (Fall)	54%	50%	49%	52%	54%
Post-Test (Spring)	41%	41%	50%	37%	50%

Figure 2. Pain prevalence fall and spring semesters for entire sample.



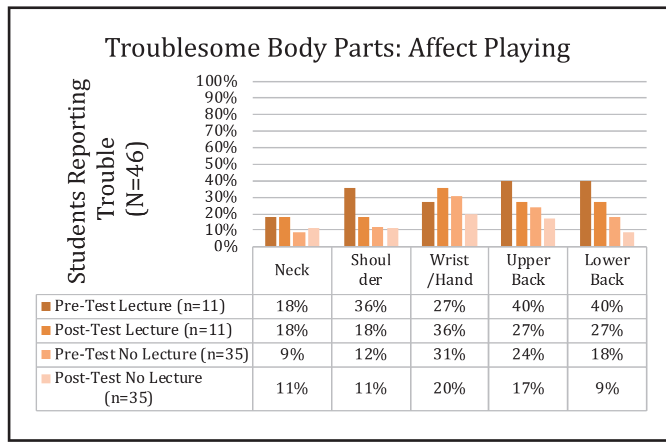
	Neck	Shoulder	Wrist/Hand	Upper Back	Lower Back
Pre-Test Lecture (n=11)	64%	64%	55%	91%	64%
Post-Test Lecture (n=11)	27%	36%	73%	55%	64%
Pre-test No Lecture (n=35)	51%	45%	47%	40%	51%
Post-Test No Lecture (n=35)	46%	43%	43%	31%	46%

Figure 3. Pain prevalence fall and spring semesters divided into groups by attendance.



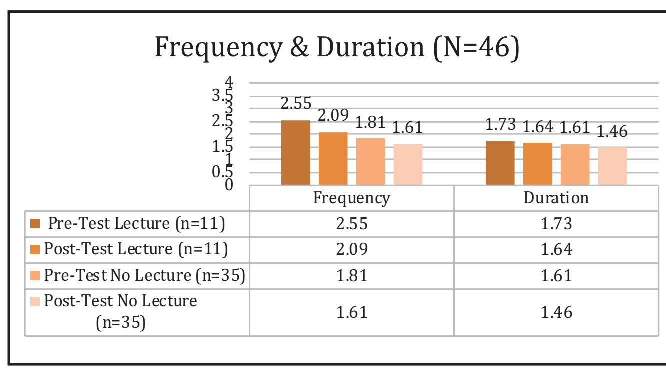
	Neck	Shoulder	Wrist/Hand	Upper Back	Lower Back
Pre-Test Lecture (n=11)	64%	64%	55%	91%	64%
Post-Test Lecture (n=11)	18%	27%	36%	45%	27%
Pre-Test No Lecture (n=35)	26%	27%	23%	17%	23%
Post-Test No Lecture (n=35)	19%	15%	21%	15%	21%

Figure 4. Current pain prevalence, divided into groups by attendance.



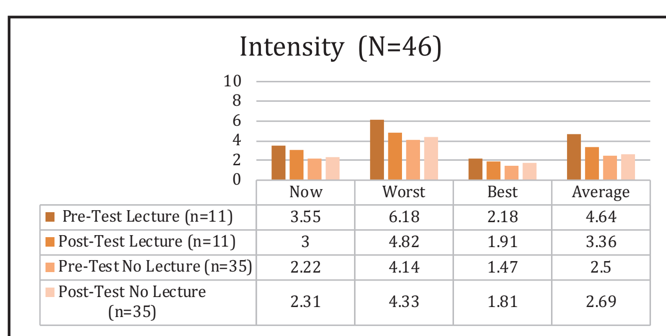
	Neck	Shoulder	Wrist/Hand	Upper Back	Lower Back
Pre-Test Lecture (n=11)	18%	36%	27%	40%	40%
Post-Test Lecture (n=11)	18%	18%	36%	27%	27%
Pre-Test No Lecture (n=35)	9%	12%	31%	24%	18%
Post-Test No Lecture (n=35)	11%	11%	20%	17%	9%

Figure 5. Prevalence of pain affecting playing.



	Frequency	Duration
Pre-Test Lecture (n=11)	2.55	1.73
Post-Test Lecture (n=11)	2.09	1.64
Pre-Test No Lecture (n=35)	1.81	1.61
Post-Test No Lecture (n=35)	1.61	1.46

Figure 6. Pain frequency and duration.



	Now	Worst	Best	Average
Pre-Test Lecture (n=11)	3.55	6.18	2.18	4.64
Post-Test Lecture (n=11)	3	4.82	1.91	3.36
Pre-Test No Lecture (n=35)	2.22	4.14	1.47	2.5
Post-Test No Lecture (n=35)	2.31	4.33	1.81	2.69

Figure 7. Pain intensity.

Students in the lecture group reported a mean of 3.3 (range 2-6) troublesome body parts on the pretest while the no-lecture group reported a mean of 2.6 (range 0-8) body parts. This was significantly different (Z = -2.027, p = 0.043). The lecture group exhibited a significant decrease in troublesome body parts to 2.09 (range 0-4) on the posttest (Z = -2.21, p = 0.026).

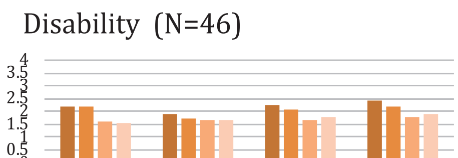
DISCUSSION

This study identified a high pain prevalence among college-level music students as reported in previous studies.[2,3] About half of students who reported pain indicated it affected playing. Understandably, more symptomatic students chose to attend an optional lecture on the topic. Improvements were noted among them after the lecture but not among those who did not attend. This supported the research hypothesis regarding the positive effect of education. Mandatory attendance may have produced a greater effect on the entire music program. However, the fact that it was optional allowed researchers to make comparisons between students who received the education and those who did not.

Alternative explanations for improvements noted in the lecture group include natural regression to the mean and maturation. A significant difference between groups for “worst pain” intensity change scores indicates more improvement than simply a natural regression to mean for this variable. The lack of improvement among students who did not attend the lecture is further indication that symptoms in the lecture group did not just get better on their own. Students may have received other interventions. Students who attended the lecture were instructed how and when to seek professional help; two accessed health care. This was part of the intended effect. Limitations to this study included small sample size, high attrition rate, and self-selection into groups, which potentially allow responses from a few unique individuals to skew results, limiting generalizability. Yet it is more difficult to achieve statistical significance in a low powered study like this, so the lecture most likely had a real effect on students who attended.

To determine clinical importance, effect size was compared with studies validating the CGPQ,[22,23] QuickDASH,[24,25] and Numeric Pain Rating Scale (NPRS)[23] from which MPQM was derived. An effect size of 0.30 to 0.40 or more on an individual item indicates a clinically important change. Changes in pain frequency as well as “worst” and “average” intensity reached the level of clinical importance for the lecture group with effect sizes ranging from 0.51 to 0.66.

The NASM and PAMA published a joint advisory statement for music schools regarding content to be covered in the required health and safety education one year after this study was conducted.[26] The lecture featured in this study was a good match. There are no studies for comparison of the effects of a single informative lecture. However, a 3-credit prevention course added to the curriculum at a conservatory in Spain increased body awareness and decreased injuries 78%.[16] Onsite triage by physical therapists who provided screening, education, and referrals was rated as helpful or very helpful by 79% of musicians who used it.[17] Customized exercise prescriptions decreased pain and perceived exertion among orchestra musicians.[18]



	Technique	Playing	Quality	Time
Pre-Test Lecture (n=11)	2.18	1.91	2.27	2.45
Post-Test Lecture (n=11)	2.18	1.73	2.09	2.18
Pre-Test No Lecture (n=35)	1.64	1.67	1.69	1.78
Post-Test No Lecture (n=35)	1.58	1.67	1.78	1.92

Figure 8. Performance disability—technique, instrument, quality, amount of time.

Clinical Relevance

As movement specialists, physical therapists are uniquely qualified to address PRMDs prevalent among musicians. With increasing emphasis on direct access, cash-based practice, community outreach, and wellness services, the physical therapy profession is poised to engage creatively with performing artists to meet their needs. An informative lecture such as the one featured in this study, could be an effective way for physical therapists to introduce themselves to musicians while helping music schools meet their accreditation requirements.

Future Research

Recommendations for further research include ongoing peer review of materials and methods for education provided by physical therapists in music schools and data collection at multiple sites to determine the effect of this education on pain and disability as well as behavior change. An overall score for the MPQM or similar tool would be helpful in consistent surveillance of PRMDs. Though not specific to musicians, using the DASH or QuickDASH would allow direct comparison with other studies.

CONCLUSION

Some improvements in playing-related pain among symptomatic students who chose to attend an optional lecture by a physical therapist were observed. Although a single lecture may not be enough, this study suggests that education provided by physical therapists may be an effective part of an overall strategy to address PRMDs among college-level music students.

REFERENCES

1. National Association of Schools of Music. *Standards for Accreditation*. In. NASM Handbook 2012-13. Reston, VA: National Association of Schools of Music; 2012.
2. Barton R, Kallian C, Bushee M, Tetrault K. Occupational performance issues and predictors of dysfunction in college instrumentalists. *Med Probl Perform Art*. 2008;23(2):72-78.
3. Zaza C. Playing-related musculoskeletal disorders in musicians: a systematic review of incidence and prevalence. *CMAJ*. 1998;158(8):1019-1025.
4. Ackermann B, Driscoll T, Kenny DT. Musculoskeletal pain and injury in professional orchestral musicians Australia. *Med Probl Perform Art*. 2012;24(4):181-187.
5. Ackermann BJ, Kenny DT, Fortune J. Incidence of injury and attitudes to injury management in skilled flute players. *Work*. 2011;40(3):255-259. doi: 10.3233/WOR-2011-1227.
6. Engquist K, Oerbaek P, Jakobsson K. Musculoskeletal pain and impact on performance in orchestra musicians and actors. *Med Probl Perform Art*. 2004;19(2):55-61.
7. Bragge P, Bialocerkowski A, McMeeken J. A systematic review

of prevalence and risk factors associated with playing-related musculoskeletal disorders in pianists. *Occup Med (Lond)*. 2005;56(1):28-38.

8. Rietveld A, Macfarlane J, de Haas G. Some thoughts on the prevention of complaints in musicians and dancers. *Clin Rheumatol.* 2013;32(4):449-452. doi: 10.1007/s10067-013-2195-5. Epub 2013 Mar 7.
9. Kaufman-Cohen Y, Ratzon N. Correlation between risk factors and musculoskeletal disorders among classical musicians. *Occup Med (Lond)*. 2011;61(2):90-95. doi: 10.1093/occmed/kqq196. Epub 2011 Jan 26.
10. Ackermann B, Adams R. Physical characteristics and pain patterns of skilled violinists. *Med Probl Perform Art*. 2003;18(2):65-71.
11. Steinmetz A, Scheffer I, Esmer E, Delank K, Peroz I. Frequency, severity and predictors of playing-related musculoskeletal pain in professional orchestral musicians in Germany. *Clin Rheumatol*. 2015;34(5):965-973. doi: 10.1007/s10067-013-2470-5.
12. Leaver R, Harris E, Palmer T. Musculoskeletal pain in elite professional musicians from British symphony orchestra. *Occup Med (Lond)*. 2011;61(8):549-555. doi: 10.1093/occmed/kqr129.
13. Guptill C, Golem MB. Case study: Musicians' playing-related injuries. *Work*. 2008;30(3):307-310.
14. Guptill C, Zaza C. Injury prevention: What music teachers can do. *Music Educators J*. 2010;96(4):28-34.
15. Guptill C. The lived experience of working as a musician with an injury. *Work*. 2011;40(3):269-280. doi: 10.3233/WOR-2011-1230.
16. López TM, Martínez JF. Strategies to promote health and prevent musculoskeletal injuries in students from the high conservatory of music of Salamanca, Spain. *Med Probl Perform Art*. 2013;28(2):100-106.
17. Chan C, Driscoll T, Ackermann B. The usefulness of on-site physical therapy-led triage services for professional orchestral musicians–a national cohort study. *BMC Musculoskelet Disord*. 2013;14:98.
18. Chan C, Driscoll T, Ackermann BJ. Effect of a musicians' exercise intervention on performance-related musculoskeletal disorders. *Med Probl Perform Art*. 2014;29(4):181-188.
19. Descatha A, Roquelaure Y, Chastang JF, et al. Validity of Nordic-style questionnaires in the surveillance of upper-limb work-related musculoskeletal disorders. *Scand J Work Environ Health*. 2007;33(1):58-65.
20. Kuorinka I, Jonsson B, Kilbom A, et al. Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. *Appl Ergon*. 1987;18(3):233-237.
21. Lamontagne V, Belanger C. Development and validation of a questionnaire on musculoskeletal pain in musicians. *Med Probl Perform Art*. 2012;27(1):37-42.
22. Von Korff M, Ormel J, Keefe FJ, Dworkin SF. Grading the severity of chronic pain. *Pain*. 1992;50(2):133-149.
23. Hawker GA, Mian S, Kendzerska T, French M. Measures of adult pain: Visual analog scale for pain (VAS Pain), numeric rating scale for pain (NRS Pain), mcgill pain questionnaire (MPQ), short-form mcgill pain questionnaire (SF-MPQ), chronic pain grade scale (CPGS), short form-36 bodily pain scale (SF-36 BPS), and measure of intermittent and constant osteoarthritis pain (ICOAP). *Arthritis Care Res*. 2011;63(Suppl 11):S240-S252. doi: 10.1002/acr.20543.
24. Franchignoni F, Vercelli S, Giordano A, Sartorio F, Bravini E, Ferriero G. Minimal clinically important difference of the disabilities of the arm, shoulder and hand outcome measure (DASH) and its shortened version (QuickDASH). *J Orthop Sports Phys Ther.* 2014;44(1):30-39. doi: 10.2519/jospt.2014.4893.
25. Polson K, Reid D, McNair PJ, Larmer P. Responsiveness, minimal importance difference and minimal detectable change scores of the shortened disability arm shoulder hand (QuickDASH) questionnaire. *Man Ther*. 2010;15(4):404-407. doi: 10.1016/j.math.2010.03.008.
26. National Associatin of Schools of Music. NASM-PAMA Advisories on Neuromusculoskeletal and Vocal Health. In National Associatin of Schools of Music Brochures and Advisory Papers. Reston, Virginia: National Association of Schools of Music; 2014.

Summer 2018 was a busy one for the FASIG as we traveled to Boston to participate in the American Orthopedic Foot and Ankle Society (AOFAS) summer meeting. Connecting and collaborating with other groups that share the FASIG mission for improving foot and ankle care is a thrilling and productive time. Our visit to Boston was, in-part, to co-host a session on foot strengthening with a series of platform talks followed by a panel discussion. In addition to this session, FASIG members presented work throughout the meeting. Topics included:

- *The midfoot contributes to power and work during the single-limb heel rise*
- *Does total ankle arthroplasty preserve midfoot function and mitigate excessive adjacent joint loading?: A biomechanical gait analysis*
- *Does ankle muscle performance mirror improved pain following total ankle arthroplasty?*
- *Midfoot power during walking and stair ascent in healthy adults*
- *Identifying foot and ankle patients at risk to fall based on patient reported outcomes assessments*
- *Subtle Cavus deformities: Is isolated lateral ankle ligament reconstruction enough for improved patient-reported outcomes?*
- *Can foot exercises and going barefoot improve function, muscle size, foot pressure during walking, and qualitative reports of function in people with flat feet?*
- *Can patient reported outcomes guide therapy needs in foot and ankle patients?*
- *Can understanding provider expectations improve provider adoption of patient reported outcomes?*
- *Can women live with more symptoms than men?: Defining gender differences in the patient acceptable symptom state (PASS) is orthopaedic foot and ankle surgery*
- *Does identifying provider expectations improve adoption of patient reported outcomes*
- *Midfoot power during walking and stair ascent in healthy adults*
- *Tendon morphology in stage II posterior tibial tendon dysfunction is associated with a clinical measure of deep posterior compartment strength?*
- *Forefoot striking is more effective in reducing loadrates than increasing cadence in runners*
- *Midfoot strikers are different than forefoot strikers, but similar to rearfoot strikers: Lessons from a marathon*
- *A comparison of foot strengthening versus minimal footwear use on intrinsic muscle size and strength*
- *Increased foot and tibial angles at footstrike decrease vertical loadrate in runners*
- *Midfoot angles at footstrike decease vertical loadrate in runners*
- *Midfoot angle changes during running after an 8-week foot strengthening program*
- *The relationship between vertical loadrates and tibial acceleration across footstrike patterns*
- *A comparison of kinesiology and athletic taping on ankle range of motion*

Overall, the summer AOFAS meeting was a great opportunity to connect with colleagues, present, and listen to great work on foot and ankle care and develop partnerships for future research and clinical practice. Those from across the Academy of Orthopedic Physical Therapy and the FASIG should consider attending next year if you share an interest in this practice area. Further, the AOFAS has an "Associate Member" category that is available for those interested in joining this group. The FASIG welcomes the opportunity to continue to plan, share, and develop educational opportunities with the AOFAS including beginning to plan presentations for next year's summer AOFAS meeting, to be held in Chicago, September 12-15, 2019.

Eric Folmar, DPT, asking a question during a session.

Clinical Practice Symposium Panel: Samuel Adams Jr, MD; James Holmes, MD; John Anderson, MD; Irene Davis, PT, PhD; Eric Folmar, DPT; Thomas Hearty, MD, DPT; and Christopher Neville, PT, PhD.

Jeffrey Houck, PT, PhD, FASIG Vice Chair.

John G. Anderson, MD, answering questions for the panel discussion.

Panel discussion with Eric Folmar, DPT; Thomas Hearty, MD, DPT; and Christopher Neville, PT, PhD.

Questions with Jeff Houck, PT, PhD; Irene Davis, PT, PhD; and Mark T. Olsen, MS.

Irene Davis, PT, PhD, answering questions.

FASIG members with outgoing AOFAS President, Thomas H. Lee, MD (Chris Neville, Rob Sigler, Marcie Keefer-Hutchison, Thomas Lee, Frank DiLiberto, Jeff Houck).

President's Message

Carolyn McManus, MPT, MA

There is lots of news in the world of physical therapy and pain! For those not yet aware of the decision by the House of Delegates in June, I am excited to report that the motion proposed by the Florida Chapter recommending that the APTA endorse and promote the integration of the Interprofessional Pain Competencies and International Association for the Study of Pain (IASP) Physical Therapy Curriculum Guidelines into education, practice, and research initiatives, where feasible, passed unanimously. I want to extend thanks to all those who put time and energy into making this happen and especially acknowledge PMSIG member, Mery Alappattu, DPT, PhD, for her leadership throughout this process. This accomplishment is a first step toward establishing consistent standards in pain curriculum across DPT programs in the United States. The Pain Management SIG member, Marie Hoeger Bement, MPT, PhD, is the lead author of an informative article discussing the application of the core competencies within a DPT curriculum. This article can be found at:

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4023081/

The IASP Curriculum Outline on Pain for Physical Therapy can be found at:

https://www.iasp-pain.org/Education/CurriculumDetail.aspx?ItemNumber=2055

The opioid epidemic shows no sign of abating and, at the national level; the APTA continues to be an active voice promoting physical therapy to address this crisis. Their efforts include producing a white paper, *Beyond Opioids: How Physical Therapy Can Transform Pain Management to Improve Health Care*, which can be found at: http://www.apta.org/uploadedFiles/APTAorg/Advocacy/Federal/Legislative_Issues/Opioid/APTAOpioidWhitePaper.pdf. This document examines the history of opioid use in pain treatment and an in-depth discussion of how physical therapists can play a major role in helping patients reduce or eliminate opioid use. The Pain Management SIG Board members contributed recommendations that were included in the final paper. In addition, the Healthcare Leadership Council (HLC), a coalition of chief executives from hospitals, pharmaceutical companies, health insurers, and other organizations including the APTA developed "A Roadmap for Action," which can be found at: https://www.hlc.org/app/uploads/download.php?dl=app/uploads/2018/06/Opioid-Roadmap-FINAL.pdf

This document identifies and suggests best practices, solutions, and policy reforms necessary to collectively address the opioid crisis. The PMSIG members may find the APTA white paper and HCL roadmap useful resources for gaining awareness of national initiatives, advocacy, and public education efforts.

To meet the need for pain education programming, under my leadership and Vice President and Education Chair, Mark Shepherd, PT, DPT, OCS, FAAOMPT, the PMSIG is launching a Current Topics in Pain webinar series. This quarterly webinar series will offer ongoing opportunities to learn from leaders in the field and have your questions answered on pertinent pain topics. Kicking off this series in the fall of 2018 will be Kathleen Sluka, PT, PhD, FAPTA, presenting, *Mechanism-based Approach to Physical Therapy Pain Management*. Future planned topics include teaching patients the science of pain with Brett Nielsen, DPT, OCS, FAAOMPT, and assessing chronic pain risk and tailoring treatment for the patient in pain with Katie McBee, DPT, OCS, MS. Keep an eye out for PMSIG emails or check the website for further information about the Current Topics in Pain webinar series programming.

As a follow-up to a process that began at CSM 2018, select PMSIG Board members and additional leaders in the field of pain continued working together through the summer to revise the PMSIG strategic plan. A final plan was completed and we received the Academy of Orthopaedic Physical Therapy Board approval in late July. The updated plan can be found at the PMSIG website and will be presented to the membership at CSM 2019.

Heads up! A proposal submitted by Derrick Sueki, DPT, PhD, OCS, for CSM 2019, *"Pain Talks: Conversations with Pain Science Leaders on the Future of the Field,"* was accepted. This session will bring together Steve George, PT, PhD; Kathleen Sluka, PT, PhD, FAPTA; Carol Courtney, PT, PhD; Adriaan Louw, PT, PhD; and me to discuss the future of physical therapy in pain treatment, education, research, and advocacy and address your comments and questions. The panel will be moderated by PMSIG Board members, Mark Shepherd and Derrick Sueki. CSM 2019 will be held January 23-26 in Washington, DC. Don't miss this opportunity to hear from and share your ideas with leaders in the field!

Our membership grew from 605 in February 2018 to 711 as of August 20, 2018. To continue expanding our membership, Membership Committee Chair, Michelle Finnegan, DPT, OCS, is looking for volunteers to help her with new initiatives. If contributing to these efforts to reach more colleagues and increase our membership is of interest to you, please contact Michelle at: mbfpt77@gmail.com.

I would now like to introduce you to Megan Pribyl, MPT, who I met at the PMSIG's CSM 2018 preconference course on pain. When her presentation on nutrition and pain received rave reviews, I approached her with a request to write an article and was thrilled when she welcomed the opportunity. Megan is on staff at Olathe Health in Olathe, Kansas. Prior to becoming a physical therapist, Megan completed a 5-year undergraduate degree in Nutrition & Exercise Sciences, including a bachelor of science degree in Foods and Nutrition. As a clinician with 18 years of experience treating diverse populations with complex diagnoses, she specializes in orthopedic manual therapy, pelvic rehabilitation, and the integration of nutrition into health care. Megan presents nationally on this topic and is an instructor for Herman & Wallace Pelvic Rehabilitation Institute, teaching *Nutrition Perspectives*, a course for clinicians wishing to integrate nutrition into their practice. Thank you, Megan for your time and expertise!

Nutrition and Pain: Building Resilience through Nourishment

Megan Pribyl, PT, CMPT

The need for mindful incorporation of Hippocrates' wisdom is great in today's health care landscape. As conversation of nutrition broadens into the physical therapy scope of practice, his wisdom resonates: first, "we must make a habit of two things; to help; or at least to do no harm." Second, "let food be thy medicine and let medicine be thy food." And finally, physical therapists will do well to be guided by his insight that "all disease starts in the gut." Hippocrates' keen observations during his time, modern science is confirming, hold keys to the plight of our times as we seek to find better ways to treat complex conditions such as chronic pain.

As physical therapists caring for patients with pain conditions, we are well aware of the crisis of pain and opioids. The statistics are alarming. In 2016 there were 32,445 deaths involving prescription opioids, equivalent to about 89 deaths per day. This was an increase from approximately 22,598 in 2015.[1] As the nation comes to grips with the pain and opioid crisis, a greater understanding and appreciation of the multiple factors that impact a patient's experience of pain is required. This has led to the emphasis on the biopsychosocial model of pain; a once-neglected piece of this model now generating urgent interest is the role of nutrition in chronic pain conditions.

NUTRITION AND OUR SCOPE OF PRACTICE

Nutrition has been identified by the American Physical Therapy Association (APTA) as a component of the professional scope of practice for physical therapists. The APTA identifies "the role of the physical therapist to screen for and provide information on diet and nutritional issues to patients, clients, and the community within the scope of physical therapist practice."[2] However, each state has its own jurisdictional scope of physical therapy practice so physical therapists need to check with their state practice act and state laws governing nutritional practice before introducing dietary guidelines and nutrition information to patients.

WHY NUTRITION MATTERS

It is well established that Americans rely heavily on industrially processed foods as a foundation of dietary intake. The acronym S.A.D. has been widely used to describe the Standard American Diet and its inclusion of processed foods including carbonated drinks, margarines and spreads, cookies, crackers, breakfast cereals, energy bars, energy drinks, prepared pies, pizzas, meat nuggets, and pre-packaged or "ready meals."[3] These "foods" tend to be high in empty calories with an abundance of unhealthy fat, refined carbohydrates, salt, and chemicals such as pesticides, stabilizers, antibiotics, and preservatives. Such a diet is poor in fiber, micronutrients, antioxidants and is pro-inflammatory.[4]

Studies are also confirming that industrialized food additives are not just 'bad for us', but in fact, damage our gut by killing helpful gut bacteria and damaging intestinal wall integrity.[5] This damage can lead to a phenomenon called intestinal permeability. If the intestinal barrier is damaged or inflamed, the selective sorting and absorption mediated by a complex gut-associated immune-regulated process becomes disrupted. Intestinal permeability, coined the "hidden epidemic," allows any molecule passing through the intestine to permeate the gut and have access to the circulation leading to a host of disturbances including systemic inflammation and blood brain barrier disruption.[6,7] It is through this mechanism that the health status of the gut can affect the experience of pain and amplify nociceptive activity.

THE BRAIN-GUT CONNECTION

Understanding the contributing role of maladaptive neuroplastic changes in the central nervous system (CNS) to chronic pain conditions has transformed physical therapy treatment strategies. Nutrition is also associated with the function and health of the CNS and can impact a patient's pain experience. There is a growing understanding of the relationship between microorganisms that inhabit the gut, termed "gastrointestinal microbiota" and the CNS.[8] It is through what is called the microbiota-tight junction-gut-brain axis that our body maintains homeostasis.[9] This axis contains tissues and organs including the brain, glands, gut, immune cells, and gastrointestinal microbiota that mediate the complex communications with local and distant side effects.[10]

Disruptions in gastrointestinal microbiotas can lead to a disruption in homeostasis and contribute to a broad range of physiological effects including hypothalamic-pituitary-adrenal (HPA) axis (stress response) activation and altered activity of neurotransmitter systems and immune function. Evidence suggests that dysfunction of stress and immune systems may be dependent on the diversity and complexity of gastrointestinal microbiota. In addition, our amygdala-dependent brain functions including pain sensitivity and emotion regulation may be impacted by gut microbiota. To further connect the gut to the brain, evidence supports that "healthy brain function and modulation are dependent upon the microbiota's activity on the vagus nerve."[11]

With the gut microbiota impacting the HPA axis, the amygdala, and the vagus nerve, it is critical to recognize the scaffolding that supports this entire system: the enteric nervous system (ENS). The ENS is a dense collective of 200 to 600 million neurons in our gut commonly referred to as our "second brain." This second brain serves as a storage reservoir and production site of neurotransmitters. While research into the role of the microbiota-tight junction-gut-brain axis in pain processing is in its infancy, preliminary insights are compelling. "By direct routes or indirectly, through the gut mucosal system and its local immune system, microbial factors, cytokines, and gut hormones find their ways to the brain, thus impacting cognition, emotion, mood, stress resilience, recovery, appetite, metabolic balance, interoception, and pain." In other words, what we eat will sooner or later affect our brain and its processing, for better or for worse.

WHAT FOODS CAN HELP PATIENTS WITH CHRONIC PAIN CONDITIONS?

Richness and diversity in wholesome, properly prepared, nourishing foods, including cultured foods, are the pinnacle of a healthy microbiome and a nourished nervous system. A thorough description of these foods is beyond the scope of this article; however, critical points of nutritional emphasis are important for those suffering from chronic pain. Cultured foods, also known as probiotic foods, provide living organisms into the digestive tract to contribute to the microbiome and help it perform its numerous functions.[12] Cultured foods include but are not limited to kefir, kombucha, and fermented vegetables such as kimchi or fermented sour kraut.[13-15]

Living organisms within the gastrointestinal tract thrive when the diet also contains prebiotic foods. Prebiotic foods include fruits, vegetables, herbs, and spices, which provide 'food and fodder' or non-digestible fiber to these microorganisms, particularly in the colon. Specifically but not exclusively, pomegranate, raspberries, blackberries, and strawberries have been shown to modulate intestinal inflammation and help feed the gut microbiota.[16]

A healthy gut also requires a healthy collagenous turnover of epithelial cells.[17] This is supported by foods such as bone broth and gelatin from healthy animals eating traditional diets.[18,19] Especially during stress or illness states including chronic pain, the burden of digestion can be greatly eased by the inclusion of accessible protein.

Individual nutrients have also been studied for their role in pain conditions and are also tied to gut health. Many patients suffering from chronic pain have low vitamin D status. Vitamin D3 supplementation alone has been shown to reduce pain symptoms.[20] Vitamin D3 supplement of 2000 IUs is generally regarded as safe and is a point of reference for clinicians. The best source of vitamin D is the action of sunlight on the skin in the presence of cholesterol.

Magnesium, vitamin C, selenium, zinc, glutamine, omega-3 fatty acids, and B-vitamins are also beneficial nutrients that have been examined in the context of pain.[21-26] As a nourishing, nutrient-dense diet is high in all these listed vitamins and minerals, physical therapists may consider suggesting to patients a diet rich in diverse whole unprocessed foods properly prepared to maximize nutritive value and gut integrity. The power of a diverse diet of organic, non GMO*, whole foods along with filtered water* cannot be underestimated.

WHAT FOODS SHOULD PATIENTS AVOID?

Recalling Hippocrates' wisdom including 'do no harm', the advice on what to avoid is critically relevant in the discussion of food. It is important for physical therapists to relay the gut-brain-microbiota connection to patients in the context of why nutrition matters. It is also important to share that processed foods, and especially popular diet soda, truly harm the gut and can undermine other efforts within the biopsychosocial model of pain management.[27] These harmful foodstuffs can prevent healing in someone struggling with chronic pain due to their damaging effects on the microbiota and ensuing sequelae.

According to a recent study, a significant proportion of patients with chronic pain reported daily consumption of aspartame, a common sweetener in diet sodas.[28] Many also demonstrated poor eating behaviors and excess intake of calories, including substances high in added sugars, unhealthy fats, processed sodium, and caffeine. Additionally, daily intakes were low in neuro-protective vitamins and minerals including vitamin D, vitamin E, and magnesium.

It is also well established that many factors in our modern lifestyles can harm the microbiota and intestinal barrier and are best avoided or kept to a minimum. Processed foods, alcohol, nonsteroidal anti-inflammatory drugs, antibiotics, stress, and sugar all damage the microbiota. Processed foods typically contain food additives that have been shown to cause a marked reduction in microbial diversity and induce epithelial inflammation in the gut leading to development of ulceration and inflammatory infiltrates.[29] Specific food additives including glucose, refined salt, organic solvents, gluten (see below), microbial transglutaminase, and nanoparticles have similar effects. Glucose, or sugar, feeds harmful bacteria in the gut. Highly processed sugar or industrialized fructose (also known as high fructose corn syrup or HFCS) has been linked to fructose-induced neurotransmitter changes in the CNS and more aggressive malignancy in cancer. Consumers beware: high fructose corn syrup is also called "natural sweetener" on food labels.[30] Bottom line is food processing has profound implications on chronic conditions through their direct and harmful action on the gut.[31]

Gluten and its role in pain must also be elucidated. To simplify a lengthy and complex discussion, it is important to recognize that wheat varieties grown today are high in gluten content and are subject to drastic processing techniques rendering ultra-processed food products containing gluten very difficult to digest. This strain on the digestion contributes to intestinal inflammation.[32] Further, gluten itself stimulates additional molecular activity leading to intestinal permeability, a root cause of systemic inflammation.[33] Gluten is linked to both local inflammation within the intestine as well as systemic inflammation. Chronic pain sufferers would do well to eliminate gluten or consume it in moderation if properly prepared by soaking, sprouting, or sour fermenting the wheat grains before consumption. Interestingly, prior to industrialization, wheat and other grains were regularly soaked, sprouted, or sour fermented prior to consumption.

HOW SHOULD PHYSICAL THERAPISTS BEGIN THE CONVERSATION OF NUTRITION?

We simply must have a "willingness to stretch [ourselves] into new intellectual territory."[34] In addition to encouraging patients to avoid or minimize processed foods, additives, and sweeteners, physical therapists can promote inclusion of richness and diversity available in real, wholesome, properly prepared nourishing foods. One simple tool provides patients the opportunity to take a "50 food challenge" to answer the question "how varied is your diet?." The rationale is to motivate patients to vary the foods they have everyday so they increase their micronutrient diversity and feed different classes of gut microbes. This tool can create momentum in the right direction through direct, yet lighthearted discussion. In asking our patients about their nourishment habits, we not only validate the importance of nutrition, but we acknowledge that we are in the midst of a paradigm shift, one that supports the concept that we can, through food, nourish the nervous system and build resilience to pain, one delicious and nourishing bite at a time.

REFERRALS TO INTEGRATIVE OR FUNCTIONAL MEDICINE PRACTITIONERS

It is always important to recognize when you lack the knowledge and skills to provide the nutritional information and counseling needed by a patient. Integrative and functional medicine practitioners are trained in the use of food as medicine. You can find out more at:

- https://nutritionspecialists.org,
- https://www.integrativenutrition.com or
- http://nourishingtraditions.com.

The author also teaches courses for Physical Therapy professionals with nutrition-related content:

- https://hermanwallace.com/continuing-education-courses/nutrition-perspectives-for-the-pelvic-rehab-therapist.

*important topics of discussion beyond the scope of this article

REFERENCES

1. Centers for Disease Control and Prevention. https://www.cdc.gov/drugoverdose/data/overdose.html. Accessed August 10, 2018.
2. APTA House of Delegates Packet I. http://www.apta.org/uploadedFiles/2015PacketI.pdf. Accessed August 10, 2018.
3. Toribio-Mateas M. Harnessing the power of microbiome assessment tools as part of neuroprotective nutrition and lifestyle medicine interventions. *Microorganisms*. 2018;6(2):pii:E35. doi: 10.3390/microorganisms6020035.
4. Tick H. Nutrition and pain. *Phys Med Rehabil Clin N Am*. 2015;26(2):309-320. doi: 10.1016/j.pmr.2014.12.006.
5. Lerner A, Matthias T. Changes in intestinal tight junction permeability associated with industrial food additives explain the rising incidence of autoimmune disease. *Autoimmun Rev*. 2015;14(6):479-489. doi: 10.1016/j.autrev.2015.01.009.
6. Michel L, Prat A. One more role for the gut: microbiota and blood brain barrier. *Ann Transl Med*. 2016;4(1):15. doi: 10.3978/j.issn.2305-5839.2015.10.16.
7. Lerner A, Neidhofer S, Matthias T. The gut microbiome feelings of the brain: A perspective for non-microbiologists. *Microorganisms*. 2017;5(4):pii:E66. doi: 10.3390/microorganisms5040066.
8. Rea K, Dinan TG, Cryan J F. The microbiome: A key regulator of stress and neuroinflammation. *Neurobiol Stress*. 2016;4:23-33.
9. Collins S, Reid G. Distant site effects of ingested prebiotics. *Nutrients*. 2016;8(9).pii:E523. doi: 10.3390/nu8090523.
10. Cowan CSM, Hoban AE, Ventura-Silva AP, Dinan TG, Clarke G, Cryan JF. Gutsy moves: The amygdala as a critical node in microbiota to brain signaling. *Bioessays*. 2018;40(1). doi: 10.1002/bies.201700172.
11. Turna J, Grosman-Kaplan K, Anglin R, Van Ameringen, M. "What's bugging the gut in OCD?" A review of the gut microbiome in obsessive-compulsive disorder. *Depress Anxiety*. 2016;33(3):171-178. doi: 10.1002/da.22454. Epub 2015 Dec 2.
12. Balakrishnan M, Floch MH. Prebiotics, probiotics and digestive health. *Curr Opin Clin Nutr Metab Care*. 2012;15(6):580-585. doi: 10.1097/MCO.0b013e328359684f.
13. Carasi P, Racedo SM, Jacquot C, Romanin DE, Serradell MA, Urdaci MC. Impact of kefir derived lactobacillus kefiri on the mucosal immune response and gut microbiota. *J Immunol Res*. 2015;2015:361604. doi: 10.1155/2015/361604.
14. Chilton SN, Burton JP, Reid G. Inclusion of fermented foods in food guides around the world. *Nutrients*. 2015;7(1):390-404. doi: 10.3390/nu7010390.
15. Nguyen NK, Dong NT, Nguyen HT, Le PH. Lactic acid bacteria: promising supplements for enhancing the biological activities of kombucha. *Springerplus*. 2015;4:91. doi: 10.1186/s40064-015-0872-3
16. Basson A, Trotter A, Rodriguez-Palacios A, Cominelli F. Mucosal interactions between genetics, diet, and microbiome in inflammatory bowel disease. *Front Immunol*. 2016;7:290. doi: 10.3389/fimmu.2016.00290.
17. Porth CM. *Essentials of Pathophysiology: Concepts of Altered Health States*. Philadelphia, PA: Lippincott Williams and Wilkins; 2014.
18. Dallas DC, Sanctuary MR, Qu Y, et al. Personalizing protein nourishment. *Crit Rev Food Sci Nutr*. 2017;57(15):3313-3331. doi: 10.1080/10408398.2015.1117412.
19. Morell SF, Daniel KT. *Nourishing Broth: an Old-Fashioned Remedy for the Modern World*. New York, NY: Grand Central Publishing; 2014.
20. de Torrente de la Jara G, Pecoud A, Favrat, B. Musculoskeletal pain in female asylum seekers and hypovitaminosis D3. *BMJ*. 2004;329(7458):156-157.
21. Pickering G, Morel V, Simen E, et al. Oral magnesium treatment in patients with neuropathic pain: a randomized clinical trial. *Magnes Res*. 2011;24(2):28-35. doi: 10.1684/mrh.2011.0282.
22. Chen HL, Tung YT, Chuang CH, et al. Kefir improves bone mass and microarchitecture in an ovariectomized rat model of postmenopausal osteoporosis. *Osteoporos Int*. 2015;26(2):589-599. doi: 10.1007/s00198-014-2908-x.
23. Barros-Neto JA, Souza-Machado A, Kraychete DC, et al. Selenium and zinc status in chronic myofascial pain: serum and erythrocyte concentrations and food intake. *PLoS One*. 2016;11(10):e0164302. doi: 10.1371/journal.pone.0164302.
24. Wang B, Wu G, Zhou Z, et al. Glutamine and intestinal barrier function. *Amino Acids*. 2015;47(10):2143-2154. doi: 10.1007/s00726-014-1773-4.
25. Sandhu KV, Sherwin E, Schellekens H, Stanton C, Dinan TG, Cryan JF. Feeding the microbiota-gut-brain axis: diet, microbiome, and neuropsychiatry. *Transl Res*. 2017;179:223-244. doi: 10.1016/j.trsl.2016.10.002
26. De Gregori M, Muscoli C, Schatman ME,et al. Combining pain therapy with lifestyle: the role of personalized nutrition and nutritional supplements according to the SIMPAR Feed Your Destiny approach. *J Pain Res.* 2016;9:1179-1189.
27. Soffritti M, Padovani M, Tibaldi E, et al. The carcinogenic effects of aspartame: The urgent need for regulatory re-evaluation. *Am J Ind Med*. 2014;57(4):383-397. doi: 10.1002/ajim.22296.
28. Meleger AL, Froude CK, Walker J 3rd. Nutrition and eating behavior in patients with chronic pain receiving long-term opioid therapy. *PM R.* 2014;6(1):7-12.e1. doi: 10.1016/j.pmrj.2013.08.597.
29. Csaki KF. Synthetic surfactant food additives can cause intestinal barrier dysfunction. *Med Hypotheses*. 2011;76(5):676-681. doi: 10.1016/j.mehy.2011.01.030.
30. Yerlikaya A, Dagel T, King C, et al. Dietary and commercialized fructose: Sweet or sour? *Int Urol Nephrol*. 2017;49(9):1611-1620. doi: 10.1007/s11255-017-1544-8.
31. Fardet A, Rock E, Bassama J, et al. Current food classifications in epidemiological studies do not enable solid nutritional recommendations for preventing diet-related chronic diseases: the impact of food processing. *Adv Nutr.* 2015;6(6):629-638. doi: 10.3945/an.115.008789.
32. Fardet A. Wheat-based foods and non celiac gluten/wheat sensitivity: Is drastic processing the main key issue? *Med Hypotheses*. 2015;85(6):934-939. doi: 10.1016/j.mehy.2015.09.007.
33. Fasano A. Zonulin and its regulation of intestinal barrier function: the biological door to inflammation, autoimmunity, and cancer. *Physiol Rev*. 2011;91(1):151-175. doi: 10.1152/physrev.00003.2008.
34. Pelletier D. Food and nutrition policy: a biological anthropologist's experiences from an academic platform. *Am J Hum Biol*. 2015;27(1):16-26. doi: 10.1002/ajhb.22523.

START PREPARING FOR CSM 2019: EDUCATIONAL SESSION

This may sound a little premature, but Combined Sections Meeting 2019 is almost one month earlier than it typically occurs. Consequently, every preparatory step is also moved up earlier.

The Imaging SIG has an outstanding educational session planned to build upon the advocacy with imaging initiated with the 2018 educational session in New Orleans. As you may recall, that session featured Scott Rezac, Aaron Keil, Connie Kittleson, and Kip Schick with assistance from APTA staff members, Bill Boissonnault and Angela Shuman presenting, *Referral for Imaging in Physical Therapist Practice: A Pragmatic Vision*. This session informed attendees on how best to plan and execute strategies toward developing imaging privileges in their individual jurisdictions.

The Imaging SIG sponsored session for 2019 is entitled, *Referral for Imaging: Autonomy and Accountability* will include presenters Aaron Keil, PT, DPT, OCS; Amma Maurer, MD; Scott Rezac, PT, DPT, OCS, FAAOMPT; Daniel Watson, PT, DPT, OCS, SCS; and Connie Kittleson, PT, DPT; and will be moderated by Jim Elliott, PT, PhD. This session focuses on the communication between the physical therapist and radiologist before and after the imaging procedure and the subsequent management decisions arising from the imaging results. Notably, Dr. Amma Maurer will describe the perspective of radiologists in accepting referrals from physical therapists and the communication therein. The physical therapists on the panel will share their imaging referral experiences and recommendations along with presenting data from past referrals for imaging. While physical therapists often gain training and education in the technical aspects of imaging and the clinical reasoning associated with imaging, the professional communications with radiologists and imaging services are often only learned with on-the-job training. This session will allow physical therapists to understand the essential components of that communication and also understand that communication from the perspective of radiologists.

CANNOT MISS PRECONFERENCE COURSE

The Imaging SIG is jointly sponsoring with the Performing Arts SIG a two-day preconference course on using ultrasound imaging to assist in diagnosis and management of performing artists and athletes with musculoskeletal disorders. *Musculoskeletal Sonography of the Lower Limb Focused in Sport & Performing Arts* features presenters Megan Poll, PT, DPT, OCS, RMSK; Doug White, PT, DPT, RMSK; Scott Epsley, PT, Grad Cert. Sports Physio, SCS, RMSK; and Marika Molnar, PT, LAc. Megan and Doug are well-known for their clinical and teaching expertise with ultrasound. Scott brings the experience of working with elite athletes from his role with the Philadelphia 76ers professional basketball team. Marika Molnar is internationally renowned as she is presently the director of physical therapy services to the New York City Ballet and also director of physical therapy services for the School of American Ballet in New York. This fabulous blend of individuals is highly skilled in clinical practice and the use of ultrasound to assist in clinical decision-making. This course is targeted for those seeking to add ultrasound to their clinical practice as well as the practitioner with some experience but seeking a greater depth of knowledge.

Please keep in mind there may be a limited number of slots available in this course. Registering early is strongly recommended. Registering early also contributes to assuring the course will take place, which is particularly important with CSM happening so early in the 2019 calendar year.

STRATEGIC PLAN

Teams led by George Beneck, Jim Elliott, and Chuck Hazle continue to work on elements of the Imaging SIG's strategic plan.

In the research domain, George Beneck, Greg Dedrick, Murray Maitland, Meg Sions, Lena Volland, and Mathew Wyland are participating. We are addressing two strategic plan items in the research domain. The first is to establish a collaborative relationship between the Imaging SIG and the Academy of Orthopaedic Physical Therapy's Research Committee to review publications and grant applications. Thus far, discussions have occurred with Dan White (Academy of Orthopaedic Physical Therapy Research Committee Chair) as to how the SIG could be more involved. The second is to create an "Expert Mentors" webpage with names listed of content experts in specific areas of imaging. Thus far, a spreadsheet of various potential mentor organized under body region and imaging modality has been created.

The group working on the practice domain, consisting of Steve Kareha, Marie Corkery, Dale Gerke, Christa Nelson, and Todd Telemeco, have initiated efforts to gather information on what is being done in residencies in regards to imaging education. The effort will be to determine what is and is not being included in orthopaedic residencies and fellowships and perhaps suggesting guidelines for inclusion at some point. Assistance with patient education pertaining to imaging is also underway.

In the education domain, Jim Elliott is facilitating the group consisting of Katie O'Bright, Kimiko Yamada, Bryon Smith, and Jennifer Reft. They are addressing 3 strategic plan items in the education domain. These include (1) Develop tools to identify learners' strengths and challenges related to imaging need (yes/no), modality selection, interpretation, and evaluation associated with patient presentation. (2) Provide educators, instructors, and learners resources to assist with learning objectives. (3) Expand resource list on the Orthopaedic Academy website. Those involved on that front include Katie O'Bright, Jennifer Reft, and Bryon Smith.

ULTRASOUND WEBINARS IN ASSOCIATION WITH AIUM

Since the last newsletter, two more ultrasound webinars have occurred by physical therapists for the American Institute for Ultrasound in Medicine.

On June 11, Gregory E. Fritz, PT, RMSK, and Colin Rigney, PT, DPT, OCS, RMSK, presented a webinar entitled, *Musculoskeletal Ultrasound Assessment of Tendinopathy*. This webinar is available at AIUM's YouTube channel at *https://youtu.be/rWrhn_h8_wI*. This session was so successful, a follow-up was being discussed. On July

(Continued on the inside back cover)

ORFSIG Members,

I hope everyone has had a delightful summer enjoying some time with family and friends. As summer winds to an end, it reminds us how quickly our annual Combined Sections Meeting (CSM) in Washington, DC will be here. As CSM schedules begin to fill up we want to make sure everyone puts our preconference course on their calendar. **Please save the date January 22nd, 2019, for**

Clinical Excellence and Quality Standards in Residency/ Fellowship Education

We are excited to have Kirk Bentzen, Kathleen Geist, Tara Jo Manal, Eric Robertson, Aimee Klein, and our ORFSIG officers assist programs in understanding the new Quality Standards that will go in effect in 2020. This will be a highly interactive session with breakout sessions so all current and developing programs can work toward creating further excellence in their residency and fellowship education.

Additionally, mark your calendar for **Thursday, January 24, 2019 at 7:00 a.m.** for our annual business meeting. Here we will be unveiling our new Mission, Vision, Goals, and Objectives for the ORFSIG. The location is yet to be determined so be sure to review the CSM programming schedule for details.

We look forward to seeing everyone in Washington, DC. Take a look below at some of the other current updates on some ongoing projects.

Thank you,
Matt Haberl,
President, ORFSIG

Strategic Planning

The ORFSIG received a $1000 grant from the Academy of Orthopaedic Physical Therapy to undergo a strategic planning initiative. To help facilitate planning, Janet Bezner, PT, DPT, PhD, FAPTA, was hired to direct the members of our strategic planning group. So far, the group has met on 3 different occasions with a goal to reveal our new strategic plan at CSM 2019.

We want to send a special thank you to those members who have devoted their time and talents

Board Liaison: Aimee Klein
Practice Committee Chair: Kathy Cieslak
Residency and Fellowship: Molly Malloy
Section Office Staff: Tara Fredrickson
ORFSIG Leadership/VP/Education Chair: Kathleen Geist
Nominating Committee: Chair–Matt Stark; Members–Mary Derrick, Melissa Dreger
Strategic Planning:
Members–Chris Gaines, Chrysta Lloyd, Darren Calley, Megan Frazee, Kirk Bentzen, Kris Porter, Matthew Thomason, Mary Kate McDonnell, Sarah Nonaka, Stephen Kareha

Free Webinars

We recently co-hosted a free webinar regarding "Mentoring to Mentor." Thank you to Kris Porter, Arlene McCarthy, Carol Jo Tichenor, and Kathleen Geist for their tremendous work and time in presenting to a record number 72 attendees. Recordings and materials from these webinars can be found on our website at:

- https://www.orthopt.org/content/special-interest-groups/residency-fellowship/communication-whats-happening

Do not miss our follow-up webinar reviewing case examples of the annual mentor observation and mentor growth plan on **November 15, 2018 at 7:30 - 8:45 p.m. CST.**

Free Membership SWAG

Mary Derrick and Matt Stark have been developing some great promotional items for our members to represent the ORFSIG. Make sure to come to the ORFSIG business meeting at CSM or swing by the Academy of Orthopaedic Physical Therapy's booth to check out these great items.

Orthopaedic Residency & Fellowship SIG Chair Committee

The second meeting of the APTA Sections' Residency & Fellowship SIG Chairs occurred on August 2. Each Section representative provided updates regarding that group's recent activities related to residency and fellowship education and accreditation. APTA Residency/Fellowship staff reviewed information from the recently published June 2018 ABPTFE Newsletter.

Residency/Fellowship Education HUB Community

One key element for all programs to be aware of is the transition of information to the Residency/Fellowship Education HUB Community. All APTA members now have access to this community and the community is no longer limited to program directors. The goal of the HUB community is to improve communication and decrease some of the clutter on the ABPTRFE webpage.

Therefore, reference information such as the ABPTRFE newsletters, historical ABPTRFE Annual Aggregate Data Reports (the current year report will be on the website with a reference to access previous reports on the HUB), the Annual Continuous Improvement Report Template (programs will now complete their annual report using the Accreditation Management System (AMS), the template is simply provided for convenience so programs know its content before accessing the AMS), and the Substantive Change Forms (again, like the program annual report, these are simply templates as the substantive change forms will be completed within the AMS) will be located on the HUB community within organized file folders.

All other materials will continue to stay on the ABPTRFE website.

Accreditation Management System (AMS)

The APTA launched the updated residency and fellowship program directory pages (https://accreditation.abptrfe.org/#/directory) on the ABPTRFE website. Since February, programs have been using the AMS for submission of accreditation and re-accreditation documentation. Beginning in January 2019, all programs will use the AMS for submission of all accreditation documentation (eg, Annual Continuous Improvement Report [formerly known as the Annual Report], Substantive Changes, etc). Copies of all documentation templates are located on either the ABPTRFE website or the Residency/Fellowship Education HUB Community site.

(Continued on the inside back cover)

President's Message

Kirk Peck, PT, PhD, CSCS, CCRT, CERP

CSM 2019 - Washington, DC

Get ready for an explosion of excitement, education, and collegiality at CSM 2019 to be held at the downtown convention center, Washington, DC, January 23-26. The ARSIG is already gearing up for another fun year of programming following the annual *"ARSIG Member Meeting."* As a friendly reminder, the membership meeting is open to all licensed practitioners and students alike who currently treat or are interested in getting involved in the practice of animal rehabilitation and wellness.

The topic for the two-hour ARSIG programming is entitled, *Manual Therapy for Equine and Canine Clients: Different Species, Same Concepts!* The idea is to demonstrate through use of video and narration from a panel of experts the similarities and differences encountered when performing manual therapy techniques on horses and dogs in comparison to the human counterpart. Of note, the original title I wanted to use for the programming was, *"What…You Can Really Do That to a Horse and a Dog? Manual Therapy Interventions to Restore Functional Movement in the Equine and Canine Client,"* but unfortunately the ScholarOne submission site has restrictions on the number of characters authors can use for program titles. Personally I thought the original title was more indicative of content the program we will actually cover so now you at least have a taste of what the future will bring if you can join the gathering at CSM.

APTA House of Delegates: RC 26-18

During the 2018 APTA House of Delegates (HOD) held in Orlando, Florida, RC 26-18 was moved for debate, and ultimately passed with a unanimous vote. This particular RC is important for the practice of animal rehabilitation in that it provides a much needed update in reference to two prior APTA position statements. RC 26-18 can now be used for political advocacy and educational purposes, especially when addressing questions about physical therapists establishing working relationships to enhance animal practice. The final language of RC 26-18 reads as follows:

RC 26-18 AMEND: VETERINARIANS: COLLABORATIVE RELATIONSHIPS (HOD P06-03-23-20)

COLLABORATIVE RELATIONSHIPS BETWEEN PHYSICAL THERAPISTS AND VETERINARIANS

"The American Physical Therapy Association supports the collaborative relationships of physical therapists and veterinarians and the evolution of specialized practice by physical therapists who are addressing the rehabilitation needs of animals. Where allowable by state law and regulation, and consistent with a physical therapist's knowledge and skills, physical therapists may establish collaborative, collegial relationships with veterinarians for the purposes of providing professional consultation and expertise in movement impairment, fitness, and conditioning for animals."

Implicit Value of Research & Expertise

Not long ago I was conversing with a physician who specializes in interventional radiology, and who now works in obstetrics and gynecology. I informed my colleague that I happen to work with two physical therapy women's health experts at my institution. In response the physician immediately inquired, *"Are these faculty of yours published? You can only claim expertise if their names are found in the literature?"* His question immediately intrigued my interest in something often left unspoken…the perception of expertise in the medical professions is largely hinged on the volume and quality scientific discovery regardless of discipline. It is never enough to just claim you are an expert in a medical discipline; you must possess some level of validation that the expertise is warranted. A brief lesson from a significant landmark event in medical history may best illustrate my point.

In 1543 one of the greatest medical books in history was published, *"De humani corporis fabrica libri septem,"* by Andreas Vesalius. The title itself is Latin for, "On the fabric of the human body in seven books." It was, and still is, a literal masterpiece on many levels. Vesalius, for the first time in history, created an inaugural publication on anatomy based on actual human dissection. Prior to his teachings at the University of Padua, Italy, the "Bible" of anatomy as taught for over 1400 years was based largely from animal dissections as performed by Claudius Galen (129-210 AD), from Pergamon. Although Vesalius would later be accused of dissecting a human body thought to still be alive, and subsequently sent to the Holy Land as part of repentance by the Catholic Church, his publication was so impactful that it rendered him an everlasting title in history as, "The Father of Anatomy." But, as they often say, the story does not end there.

Had a different and now famous individual from the Renaissance period taken the time to locate a printing press for the pleasure of disseminating his own miraculous drawings on the human body based on actual dissections, the Father of Anatomy would not bear the name Vesalius, but rather medical historians would have branded the name Leonardo Da Vinci. Vesalius was born in 1514 and was only 5 years old when Da Vinci died in 1519, but for unknown reasons, Leonardo never published his now famous artwork on the human form. Instead of enlightening society with some of the most accurate renditions of the human body ever created on canvas, Da Vinci's art lied dormant for over 200 years prior to bearing witness to the public eye.

To put things in context for the present day, much like Vesalius did in the 16th century, the profession of physical therapy must actively strive to create and disseminate discoverable knowledge in the science of animal rehabilitation if physical therapists are to truly earn a reputation as experts in the field. Yes, the profession certainly has its share of highly competent practitioners who advance clinical practice on a daily basis, but without the dissemination of research to substantiate interventions and outcomes, the profession will flounder, and others who are willing to labor in the work of scholarship will take their rightful place in history.

Contributory Acknowledgment

In this edition of *OPTP,* Amy Rogato, PT, DPT, CCRT, has presented a fantastic plan of care for an Italian Greyhound diagnosed with an unusual case of aortic thromboembolism. The article provides in-depth perspectives on how to progress a long-term plan of physical rehabilitation with successful outcomes.

"What!! … Of course I'm big enough to basket dive for my own toys"

"Luna" The Fearless Chorkie
Photo Courtesy of Kirk Peck

Contact:
Kirk Peck, President ARSIG
Office (402) 280-5633
Email: kpeck@creighton.edu

International Vet Rehab Symposium

Stevan Allen, PT, CCRT
Vice President ARSIG

The ARSIG was a major sponsor for the 10th International Association of Veterinary Rehabilitation and Physical Therapy (IAVRPT), held in Knoxville, Tennessee from July 30-August 3, 2018. Over 200 physical therapist, veterinarians, and veterinarian technicians attended representing over 20 different countries including, Japan, England, South Africa, Italy, Romania, Brazil, Norway, Sweden, Croatia, and the United States. The IAVRPT follows an Olympic format, meeting in the United States every 4 years, and staggers every 2 years outside of the United States. The 4 previous meetings were in Vienna; Corvallis, Oregon; Sweden; and most recently, Knoxville, TN. The symposium offered a great opportunity to share rehabilitation knowledge with physical therapists and veterinarians from around the world.

There were two educational tracks, one for Canine and one for Equine. Some of the programming included:

Canine Track:
- Dry needling and trigger points
- Kinesiotaping
- How to train the neuro-musculoskeletal system for proprioception; motor control; and muscle, skeletal, and joint strength
- Core conditioning of the canine athlete
- Acupuncture for the sports medicine and rehabilitation patient

Equine Track:
- Therapeutic exercises – how to design the best exercise protocol – short and long term, preventive training
- Horse & rider interaction and its effect on sport performance
- Adaptation of cardiovascular tissue to different training regimens
- Poor performance due to metabolic conditions
- Training the neuromuscular system for strength and proprioception – from juvenile to aged equine athletes

Keynote speakers included:

Kevin Wilk, PT – Rehabilitation of the elite athlete (human) and how we can use those concepts in the canine/equine athlete.

Barry Switzer – two-time coach of the NCAA football champions with Oklahoma University. Coach of the Super Bowl football champions, Dallas Cowboys. Coach Switzer discussed forming the elite athletic team. In addition, Coach Switzer has established a state of the art training facility for canine search and rescue teams —the non-profit GROUND ZERO in Oklahoma.

The 11th IAVRPT meeting will be hosted in either London or Cape Town, South Africa in two years.

Lin McGonagle on left (Past ARSIG President) posing with a Physical Therapist from England at the Academy of Orthopaedic Physical Therapy booth.

Therapeutic Treatment for a Thromboembolism—"Riley"

Amy Rogato, PT, DPT, CCRT
Tampa Bay Animal Hospitals

Riley is a 4-year-old Italian Greyhound who was diagnosed through abdominal ultrasound with aortic thromboembolism approximately 2 cm in length just proximal to the trifurcation that resulted in acute non-ambulatory paraparesis. Previous medical history includes inflammatory bowel disease and immune mediated hemolytic anemia. At initial presentation to veterinary emergency services on 1/27/18, Riley had questionable motor activity in the hind limbs, no appreciable pain on spinal palpation, and his bilateral hind limbs were palpably cold with absent pulses. He was medically managed with blood thinners.

Riley presented for initial rehabilitation consult on 2/1/18 with the following findings:

Body Condition: anorexia with Body Condition Score of 3/9.

Gait: unable to ambulate, paraparesis of bilateral hind limbs.

Functional transitions: sternal to sit: required moderate assistance. Sit-to-stand: unable, required dependent assist. Sitting balance: poor, required moderate assist to maintain sitting position with dependent assist to position hind limbs in square sitting.

Passive Range of Motion: bilateral hind limbs flaccid, range of motion (ROM) normal for all joints, digits of right hind limb were hard and fixed in a neutral position due to metabolite build-up from poor perfusion.

Palpation: no appreciable tenderness or pain to palpation of spine, front or hind limbs.

Neuro: unable to elicit flexor withdrawal of bilateral hind limbs, conscious proprioception absent bilateral hind limbs, unable to elicit patellar tendon reflexes bilateral hind limbs. Demonstrated trace and inconsistent hip flexion left>right when attempting to reposition himself. Deep pain difficult to assess, however appeared present left>right hind limb.

Other: Right hind limb cool to the touch and swollen compared to left hind limb.

Treatment

After discussion with the rDVM and family of the benefits and potential risks of therapeutic laser use, the rDVM and family agreed to therapeutic laser treatments. The first treatment used 3.98J/cm2 directed at abdominal aorta bifurcation from both right and left sides, followed by 3.98J/cm2 to bilateral: lumbar spine, coxofemoral joint, and lateral and medial thigh (in attempt to decrease inflammation and improve blood flow into distal limbs). Effleurage was performed to the right hind limb to decrease edema. Petrissage was performed to the right hind limb toes and left hind limb. Bicycling was performed to bilateral pelvic limbs x15 repetitions. Hip extension passive ROM with 5-second hold, was performed for 10 repetitions. Grade 1-2 joint compressions were applied to the tarsus and stifle bilaterally for increasing proprioceptive input. Neurodevelopmental sequencing sidelying to sternal to sitting with moderate assist for balance and dependent assist for placement of hind limbs. Assisted standing with placement of hind limbs in standing position and "drag" of paw pads along the ground was used to simulate walking and for proprioceptive input for 5 repetitions each. Neuromuscular electrical nerve stimulation (NMES) was attempted to elicit muscle contraction of bicep femoris bilaterally, however a contraction was not elicited.

Assessment

Riley is a 4-year-old NM Italian Greyhound who presents approximately 1 week status post diagnosis of saddle thrombus with paraparesis and an inability to ambulate. He is on close medical watch and medication therapy at this time. Riley demonstrates inconsistent and weak active hip flexion when attempting to perform transitions, and is flaccid in the hind limbs. According to rDVM, due to rigidity of toes in the right hind limb, it is likely that he will require amputation in the future because of poor perfusion. Riley's prognosis is guarded at this time due to his medical condition. The plan is to see the patient 2 times per week and proceed with a neurologic based treatment to improve function of hind limbs.

Goals

1. Within 2 to 4 weeks, clients will demonstrate independence in Riley's home exercise program (HEP).
2. Riley will demonstrate an ability to independently attain and maintain a sitting position in order to eat and drink.

Home Care

Clients were instructed to provide Riley with clean, dry bedding at all times to limit urine/fecal scald and to change Riley's position every 2 to 4 hours to decrease risk of bed sores. They were also instructed on massage of hind limbs and low back for 5 to 10 minutes per day, bicycling of the hind limbs 15 repetitions 3 to 4 times per day, hip extension stretch with 5 to 10 second hold for a total of 1 minute 3 to 4 times per day.

Riley has been seen 2 times per week since initial rehabilitation evaluation. During the month of February, Riley began to ambulate by using front limbs and lifting his pelvic limbs off of the floor with abdominals, latissimus, hip flexors, and epaxials. Unfortunately, Riley's right hind leg began to show signs of tissue decay, requiring coxofemoral disarticulation on 2/13/18. This exacerbated the inflexibility in the left hind limb. Riley was measured for a Walkin' Wheels cart to improve functional independence. Through transitional interventions, Riley demonstrated an ability to perform sternal to sit independently and was able to support himself in sitting without assist. By the end of February, Riley was showing inconsistent signs of active hip extension, weak supination when cranial tibial muscle was struck with reflex hammer, and weak tarsus extension.

Treatment Interventions

Continued therapeutic laser as previously described to decrease inflammation and improve blood flow into bilateral hind limbs. After amputation surgery, therapeutic laser was used on right hind for wound healing and pain control purposes. Focus placed on improving hip extension passive ROM through hot pack, soft tissue mobilization, massage, and HEP. Neurodevelopmental sequencing sidelying to sternal to sitting, dynamic sitting balance on unstable surface (Dyna-Disc™) with and without external perturbations to the surface. The therapist trialed repeated stimulation of reflex loop of sciatic nerve, patellar tendon, and Achilles tendon of left hind limb with the reflex hammer 10 repetitions to provide neural input to assist with active muscle function recovery. Therapeutic laser changed to the following towards the end of February: chronic inflammation setting 3.99 J/cm2 along sciatic nerve distribution into left hind to help facilitate neural function. Neurologic stimulation/activation techniques applied when standing in cart including quick stretch of antigravity muscles, flexor withdrawal, axial compression of hind limb, and paw "drags" at appropriate phase of gait cycle (Figure 1).

During March, Riley demonstrated excellent progress in the ability to use his cart independently including advancing left hind, placing paw, and using active hip and tarsus extension to propel his cart. His conscious proprioceptive reflex in his thoracic limbs

Figure 1. Supported standing in cart with quick stretch to dorsiflexors to stimulate foot placement.

and left pelvic limb were delayed but intact. Flexibility limitation of the left hind negatively impacted his success in the cart due to decreased ability to reach the floor. By the end of March, Riley was able to ambulate for short distances of 4 to 6 feet without his cart; however, he would consistently knuckle on left hind. As his activity level and motivation for ambulation increased, he demonstrated signs of decreased excursion of superficial digital flexor and deep digital flexor which exacerbated knuckling.

Treatment Interventions for March

Continued therapeutic laser use was administered to address chronic inflammation. The modality setting was 3.99J/cm2 and applied along sciatic nerve distribution into the left hind to help facilitate neural function. Also used therapeutic laser on muscle contracture setting applied to hamstrings, superficial and deep digital flexors, and gastroc muscle bellies, 3.99J/cm2 to help improve muscle flexibility. A continued focus was on improving hip extension passive ROM and muscle flexibility through applying a hot pack, using soft tissue mobilization, massage, and administering a HEP. Neurodevelopmental sequencing for sitting to standing with muscular facilitation tapping of gluteals was also used. Continued repeated stimulation of reflex loop of sciatic nerve, patellar tendon, and Achilles tendon of left hind limb with reflex hammer was conducted to provide neural input to assist with active muscle function recovery. Neurologic stimulation/activation techniques applied when standing in cart including a quick stretch of antigravity muscles, flexor withdrawal, axial compression of hind limb, and paw "drags" at appropriate phase of gait cycle. Initiated walking in wheelchair for short distance (5-8ft) with manual placement of foot to avoid knuckling as necessary. Initiated NMES to left gluteals 1:3 on/off ratio x5min at 40Hz with good tetanic contraction. Initiated front paws on unstable surface to help elicit protective extension reaction of left hind and resulted in mild success. Quick dropping of supported rear end also was used to facilitate protective extension of left hind with mild success.

Riley was independent with ambulation without a cart for household distances for the month of April. He demonstrated consistent hip and tarsus extension in standing and walking to support himself. He also demonstrated improved left hind hip extension ROM without pain, improved sartorius/quadriceps flexibility without pain which improved ability to ambulate. Hamstring flexibility and SDF, DDF excursion remained limited, which continued to impact knuckling. A toe-up device from OrthoPets was recommended to improve independence during ambulation and protect dorsal foot. The toe up device greatly improved having success with ambulation for household distances and improved success with participation in exercises to increase left hind strength.

Treatment for April

Continued therapeutic laser, massage, heat therapy, and stretching to left hind muscles. Continued front paws on unstable surface with external perturbations and progressed to front feet up on unstable surface plus back foot on unstable surface with external perturbations. Elevated sit-to-stands progressed to floor sit-to-stand. Used NMES on left gluteals progressed to 1:2 on/off ratio 6 minutes at 40Hz with good tetanic contraction. Utilized transcutaneous electrical nerve stimulation x10 minutes on cranial tibial musculature for neurologic input. Side stepping was added and done in both directions that Riley was successful at for 4 steps in each direction progressing to 2 sets and did not knuckle for side stepping; however, will knuckle for forward ambulation. Added brief 1 to 3 second front paw lifts to improve standing balance and strength of left hind. Toe up device fitted, and clients educated on wear time of short potty walks only (2-4 mins) then progress by 3 to 5 minutes every other day, pending no skin irritation. Advanced exercises with toe up device to include side stepping for increased distance, backing up 3x5 steps, sit-to-stand from ground surface x5 repetitions, and low 1" cavaletti pole stepping x4 repetitions. See Figures 2 and 3.

Figure 2. Front feet up on unstable surface with cookie stretches to improve hind limb strength and balance.

Figure 3. Cavaletti pole stepping to improve proprioception foot clearance, foot placement, and coordination.

Riley continues to be seen for rehabilitation services 2 times per week. It is unclear if CPs of left hind will return, however we are cautiously optimistic due to his progress thus far. Riley is currently independent in all functional mobility including ambulation and is at a decreased risk for foot trauma with the use of the toe-up device.

IMAGING SIG

(Continued from page 565)

23, Scott Epsley, PT, Grad Cert. Sports Physio, SCS, RMSK, presented a webinar entitled, *Ultrasound-Guided Dry Needling*. This session remains available at: https://youtu.be/p9xMvosQRfU. Alternately, you can simply go to YouTube, search on AIUM and enter a key word or the presenter's name to locate the webinar. These sessions are extremely informative and free. You will not find better continuing education at zero cost than these sessions.

One more is scheduled in 2018 with Chuck Thigpen presenting on ultrasound assisted examination of the shoulder. Stay tuned for more details. Announcement of webinar details will occur through the SIG e-mail membership list and through the SIG's social media.

Elections

By the time this newsletter appears, the Academy of Orthopaedic Physical Therapy will be nearing its annual elections in the month of November. The Imaging SIG will have voting for two offices: President and Nominating Committee member. Ballots will be available in November.

Each position is for 3 years. Members of the Nominating Committee rotate to become the committee chairperson in the third year of the term.

RESIDENCY/FELLOWSHIP SIG

(Continued from page 566)

Aggregate Residency/Fellowship Program and Applicant Data

The APTA published the 2016 and 2017 Annual Reports related to aggregate residency/fellowship program and applicant data. All annual reports (2015 through 2017) can be found on the Residency/Fellowship Education HUB Community.

To evaluate these, the ORFSIG has established a work group led by Peter McMenamin, Tom Denninger, Kevin Farrell, and Joe Donnelly to evaluate low resident application volumes/ways for programs to know of potential openings in other programs to share with residents not accepted in the future.

Quality Standards

As many of you already know, programs that held accreditation, candidacy status, or were actively undergoing a candidacy review on or before December 31, 2017, must come into full compliance with the new standards by January 1, 2020.

In June, ABPTRFE published the new Accreditation Processes and Procedures Manual (www.abptrfe.org/uploadedFiles/ABPTRFEorg/For_Programs/Apply/ABPTRFEProcessesAndProceduresVersion10.0.pdf)and its related Crosswalk document. To assist our members in understanding some of the changes, Kevin Farrell, Tina Hertlein, Brian Eckenrode, Frank Hoefer, Molly Malloy, and Kirk Bentzen have elected to assist in the review and education regarding the new Quality Standards and Processes & Procedures. There will be more to come on this at upcoming meetings.

Standardized Application Date/Sharing Applicants Work Group

Stephan Kareha, Misha Bradford, Aaron Keil, and Eric Magrum are leading a group developing a survey to evaluate if there is a group of programs interested in a standardized offer date for residents.

OPTP Quarterly Submissions

ACCEPTING case reports, resident/fellowship research, etc. to be highlighted in future issues of *Orthopaedic Physical Therapy Practice*. Take this opportunity to highlight participants in your program!

Orthopaedic Physical Therapy Practice
2920 East Avenue South, Suite 200
La Crosse, WI 54601

ACADEMY OF
ORTHOPAEDIC
PHYSICAL THERAPY