Synthesis Project
Class of 2026
Research Abstracts

Department of Physical Therapy
& Human Movement Sciences
Feinberg School of Medicine
Northwestern University

Northwestern Medicine®
Feinberg School of Medicine

Schedule of Events

DPT Student Poster Presentations
1:00-2:30 p.m. | Simpson Querrey Atrium

Keynote Presentation with Dr. Stephen Hunter, PT, DPT, OCS, FAPTA
2:30-3:30 p.m. | Hughes Auditorium

Reception
3:30-4:30 p.m. | Simpson Querrey Atrium

Combining Outcomes with Evidence to Improve Patient Care in a Learning Health System

Stephen Hunter PT, DPT, OCS, FAPTA received his Bachelor of Arts in physical therapy from University of Utah in 1984, and his clinical doctorate in 2008. He is board certified in orthopedic physical therapy. Currently, Stephen continues to treat patients and is the director of Internal Process Control for Intermountain Health's rehabilitation services. He leads a team of 5 internal process control coordinators who work to establish a culture of quality and standardize evidence-based care across all rehabilitation disciplines and services. He is the past president of NARA (National Association of Rehabilitation Providers and Agencies). He supports research efforts including data collection and clinical implementation. Examples include investigations on Total Knee Arthroplasty (TKA) and low back pain (LBP) resulting in recent publications (Minick 2022, Caplin 2022) and three randomized LBP trials (Brennan 2006, Fritz 2014, Delitto 2020). He was the lead clinical author for a review publication developing a care guideline for TKA for physical therapists (Jette 2020).

About the Kaleckas Lecture

Ann Putnam Kaleckas was born in Chicago. She was awarded a Bachelor's of Science in physical therapy from Northwestern University in 1982 and a Masters in Health Science from the University of Indianapolis in 1990. Mrs. Kaleckas pursued her passion and worked as a physical therapist at Gottlieb Hospital, Baxter Healthcare, and a Naperville Clinic before co-founding DuPage Physical Therapy in 1996. Her practice in orthopedic and spine rehabilitation brought her much pride. Devoted to her family, friends, coworkers, patients, and community, Mrs. Kaleckas' generous and kind spirit enabled her to help improve the lives of countless individuals. Ann's dedication to her practice allowed her to freely open her heart to others and give of herself in significant ways. She is remembered as one that went the extra mile in all her endeavors.

After a challenging battle, Mrs. Kaleckas succumbed to multiple myeloma in 2004. Upon her passing, her husband Mr. Rich Kaleckas, along with many family and friends, chose to memorialize her life within the Department of Physical Therapy. In 2008, the inaugural Ann Putnam Kaleckas Lecture was held by the department. The Feinberg School of Medicine is grateful to Mr. Kaleckas as well as Ann's friends and family for their extraordinary commitment to honor Ann's legacy of giving.

SYNTHESIS PROJECTS - CLASS OF 2026

Synthesis Category: Research Report
Title: A Qualitative Study Exploring the Perspectives on Usability during a Telehealth Upper Extremity Assessment in Individuals Post-Stroke

Student Presenters: Muyao Teng, SPT; Emma Huettl, SPT; Hana Fakhoury, SPT
Faculty Preceptors: Carolina Carmona, PT, DPT, NCS; Justin Drogos, PT, DPT, NCSe; Roberto López-Rosado, PT, DPT, MS, MA; Jane Gyarmaty, PT, DPT, NCS; Ray Arceo, BA; Jun Yao, PhD
Institution(s): Northwestern University Department of Physical Therapy and Human Movement Sciences and McCormick School of Engineering

Abstract:
Background
Telehealth services have undergone substantial expansion in recent years, particularly in addressing the healthcare needs of individuals with limited access to in-person medical services. For patients experiencing post-stroke upper extremity impairments, telehealth provides an opportunity for remote evaluation and continuous monitoring of functional recovery, potentially enhancing accessibility and efficiency in their rehabilitation process. However, usability is key to successful implementation of telehealth services and research on the usability of remote outcome measure (OM) assessments for post-stroke upper extremity (UE) impairments is limited. This qualitative study is part of a larger project aiming to describe the experiences of individuals post-stroke that participated in two remote sessions to evaluate UE impairment and activity post-stroke. This study aims to understand what, if any, difficulties were experienced by participants with stroke during remote OM assessment.

Participants
N=27 (16 M, 11 F; median age=64) with moderate-severe UE impairment (UE Fugl-Meyer mean + SD=20.5/66 ±12) and chronic stroke (>6m post-stroke; mean + SD=9.7 years, ±8.6).

Methods
Participants with stroke attended 2 remote sessions over Zoom and were evaluated with a series of clinical assessments, concluding with the Tele-rehabilitation Usability Survey for Stroke (TRUS_S; developed by the team with Likert and open-ended questions). Each session was led by a different physical therapist (PT), with an average interval of 5 days between sessions. The TRUS_S includes an open-ended question asking participants about difficulties experienced during the session. Responses to the open-ended TRUS_S question were analyzed through 4 rounds of inductive descriptive coding and thematic analysis by the study team to generate a descriptive framework.

Results
Most participants (64.8%) reported no difficulties during the remote sessions. Data analysis of the remaining 35.2% resulted in three themes: (1) many of the difficulties encountered were external to stroke diagnosis and all were overcome; (2) communication, and (3) set-up

were primary difficulties encountered. Our findings were adapted into the Technology Acceptance Model to explain the relationship between these themes and their impact on telehealth acceptance.

Conclusion

Most participants with chronic stroke are able to participate in remote OM assessment for the UE without difficulty. Those who do have difficulty are able to problem-solve in the moment to successfully participate. Telehealth OM assessment for the UE may be feasible in individuals with chronic stroke, but more research is needed on implementation outside the research environment.

Clinical Relevance

Remote OM assessment for the UE is a viable approach for participants with chronic stroke, presenting an opportunity for increased participation and access to rehabilitation services. Having a plan to address communication (visual, verbal, and connection issues) and set-up (visual, audio, and platform-specific) will address most difficulties in usability.

References:

1. Klaassen B, Beijnum B, Hermens H. Usability in telemedicine systems - A literature survey. International journal of medical informatics. 2016-09-01 2016;93:57-69. doi:10.1016/j.ijmedinf.2016.06.004
2. Koohjani Z, Aslani A, Abasi S, Kyiani S. A Comprehensive Tool for Usability Evaluation of Telehealth. Studies in health technology and informatics.
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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: A Randomized Pilot Test of the Breast Cancer Pre-habilitation and Prospective Surveillance to Prevent, Detect, and Optimize Physical and Functional Recovery (BPREPeD)

Student Presenters: Haley Walker, SPT and Kate Lee, SPT
Faculty Preceptors: Ann Marie Flores, DPT, PhD
Institution(s): Northwestern University; Lynn Sage Breast Cancer Research Foundation

Abstract:
Background
Breast cancer (BC) and its treatment are associated with physical and functional impairments (PFIs, e.g. joint pain, fatigue, muscle weakness, loss of range of motion, altered skin sensation/neuropathy, postural abnormality, skin integrity, and lymphedema). BC-related PFIs negatively affect patient confidence and overall functional ability.[1,2] Over 80% of BC survivors report an average of 3 long-lasting (>11 years) PFIs.[3,4] Although physical therapy (PT) is the main discipline in cancer rehabilitation for treating PFIs, it is not considered a priority for standard oncology care due to limited knowledge of PT expertise, lack of surveillance, and underestimation of patient limitations.[5,6,7,8] The purpose of this study is to evaluate the feasibility and potential effects of a 6-month program that starts when BC treatment begins and a prehabilitation physical therapy evaluation, home exercise prescription (HEP), self-management education materials (booklet and website) and a PFI system that alerts the patient and her oncology team to the need for cancer rehabilitation/physical therapy.

Methods
Using a 2-arm randomized controlled clinical trial (intervention [INT] v. enhanced usual care [EUC]), we randomly assigned seventy-five participants to each arm. For both arms PFIs are monitored monthly with the Patient Reported Outcome Measurement Information System-Physical Function (PROMIS-PF) using a threshold score ≤45 to indicate moderate/severe impairment. Participants are also monitored at baseline and every 3 months for lymphedema. The oncology team is alerted about PFI or lymphedema via a letter recommending physical therapy referral. Intervention participants also receive: prehabilitation physical therapy evaluation, home exercise prescription, self-management education materials (booklet, study website, knowledge checks, text messages), and coaching phone calls. Our primary outcomes are feasibility (>80% retained and protocol completed) and PFI (PROMIS-PF). Our secondary outcome is the Self-Efficacy for Managing Chronic Disease 6-item Scale (SEMCD-6).

Results
We enrolled 75 participants with BC and retained 64; nINT= 35, nEUC= 34. The average age is 49.5yrs (s.d. 10.5) and 24% had Stage 0 BC, 48% Stage 1, 24% Stage 2, 4% Stage 3. Over half (53%) had mastectomy and 47% had lumpectomy. Mean baseline PROMIS-PF is 54.2 (s.d. 7.30) and mean baseline SEMCD-6 is 7.8 (s.d. 2.0), indicating normal physical function

and high self-efficacy, respectively. As a team, we participated in fidelity checking, in-person measurement visits, and established inter-rater reliability via dynamometer and goniometric measurements.

Conclusion

Our sample is young, reflecting the national trend of BC among younger women. At baseline, participants have high physical function and self-efficacy which can be leveraged to plan for and manage physical and functional recovery after BC.

Clinical Relevance

This trial is ongoing, and success of this project will highlight benefits of integrating PT-centered prehabilitation with patient education and monitoring for clinical decision-making support.

References:

1. National Academies of Sciences, Engineering, and Medicine. Diagnosing and Treating Adult Cancers and Associated Impairments. Washington, DC: The National Academies Press; 2021.
2. Cheville A, Rhudy L, Basford JR, Griffin J, Flores AM. How receptive are patients with late-stage cancer to rehabilitation services and what are the sources of their resistance? Archives of Physical Medicine and Rehabilitation. 2017 Feb;98(2):203-210. PMID: 27592401 PMCID: PMC5627763 DOI: 10.1016/j.apmr.2016.08.459
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Synthesis Category: Special Interest Report
Title: Anatomy and Kinesiology Palpation Videos

Student Presenters: June Chan, SPT; Julia Effinger, SPT; Charles Lu, SPT; Alex Martinez, SPT; Rebecca Turner, SPT
Faculty Preceptors: Kirsten Moisio, PT, PhD; Roberto López-Rosado, PT, DPT, MA
Institution(s): Northwestern University, Department of Physical Therapy & Human Movement Sciences

Abstract:
Palpation is a significant portion of the anatomical sciences, kinesiology, exam and evaluation, and musculoskeletal conditions curricula across Doctorate in Physical Therapy (DPT) programs. Instruction formats typically include written text or diagrams and real time demonstration, but there is a gap in virtual resources that are effective, reliable, and accurate among DPT programs. This combined with the growing use of e-learning tools in education indicates a strong demand for palpation video reference tools.

Following the COVID-19 Pandemic, e-learning tools have become a nationwide staple of education. E-learning tools have the potential to enhance student learning and target a variety of learning styles when implemented effectively. Optimally, they improve access to resources by being portable and facilitate engaging laboratory experiences.

The aim of this educational video project was to design an e-learning tool to supplement palpation teaching across the DPT curricula of the elbow and shoulder joint. The videos include content on palpation of muscular, ligamentous, and bony structures for the elbow and shoulder joints. Verbal and tactile demonstration of palpation techniques were performed on volunteers and filmed under the supervision of faculty preceptors. Multiple short videos with labeled screen shots were created to optimize learning. Video capture was conducted using iPhone products. Video editing was performed using BioDigital and FinalCutPro.

Focus groups and surveys were conducted to gather data and feedback about the efficacy of the video products. Revisions were made according to the data and feedback received. Further research is needed to assess the efficacy of utilizing this supplemental learning tool as an adjunct to traditional anatomy formats.

Acknowledgements
We would like to thank Brett Wilson for completing the video edits in FinalCutPro.

References:

1. Hung, S. T. A. (2016). Enhancing feedback provision through multimodal video technology. Computers & Education, 98, 90-101.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: Assessing the Impact of Shoulder Subluxation on Strength and Range of Motion in Individuals with Chronic Stroke: A Pilot Study

Student Presenters: Alan Duong, SPT, Elizabeth Zucker, SPT, Ethan Quan, SPT
Faculty Preceptors: Ana Maria Acosta, PhD and Christa Nelson, PT, DPT, PhD
Institution(s): Department of Physical Therapy and Human Movement Science, Feinberg School of Medicine

Abstract:
Purpose
Shoulder subluxation is defined as partial dislocation of the humeral head from the glenoid and it affects up to 81% of individuals post-stroke.[1] Ultrasonography (US) of the acromion-greater tuberosity distance (AGT) has been used to detect inferior subluxation in participants individuals post-stroke.[2,3,4] Acromiohumeral distance (AHD) has been used as a reliable measurement for other clinical diagnoses, however, its effectiveness in assessing subluxation in hemiplegic shoulders has yet to be seen.[5] The purpose of this pilot study is to determine the feasibility of utilizing a combination of US measurements to quantify shoulder subluxation, 3-D motion capture, handheld dynamometry, and goniometric measurements in a single session to assess shoulder function post-stroke.

Materials and Methods
Participants: 3 participants with chronic hemiparetic stroke were recruited from the Clinical Research Registry based in SRALab. Inclusion criteria included chronic stroke, (>6 months), absence of full rotator cuff tears.
Subluxation measurements: Participants were seated in a standard chair with their forearms resting on a pillow on their lap. A trained sonographer captured 3 US images containing the acromion and the greater tuberosity of the humerus in two different planes. Images were exported and analyzed offline with ImageJ software to measure both AHD and AGT.
Strength: Handheld dynamometry was used to measure shoulder strength in abduction, flexion/extension, horizontal abduction/adduction and internal/external rotation. Participants were instructed to push against the dynamometer at their maximum capacity for 3 trials of 5 seconds.
Range of Motion: Passive and active range of motion of the movements mentioned above were measured using a goniometer.
Kinematic Measurements: Motion capture markers were fixed to the scapula, trunk and humerus to track bone movement with a motion capture system. Bony landmarks were digitized with respect to each marker/bone and used offline to compute kinematics.
Analysis: Limb Symmetry Index (LSI) was used to quantify changes between the paretic and non-paretic sides. Measured as a percentage of paretic to non-paretic measurement.

Results
Participant characteristics: 2.5-21.5 years post stroke; 2 female, 1 male; 69 to 80 years old. Two of the participants had a cortical stroke while the third had a cerebellar stroke. LSI for passive range of motion ranged from 15-190%. LSI for strength between 23-120%. LSI of AHD measurements ranged from 78-130%, and AGT ranged from 100-140%. Each data collection session took approximately 2.5 hours to complete.

Conclusion
This pilot study shows that it is feasible to obtain quantitative measurements of shoulder subluxation, shoulder kinematics, range of motion and strength in participants with chronic stroke. All the measurements are sensitive to differences in passive and active range of motion and strength.

Clinical Relevance
By studying the relationship between subluxation and range of motion and strength deficits, clinicians can better understand how to address these deficits and create targeted interventions.

References:

1. Kumar P, Swinkels A. A critical review of shoulder subluxation and its association with other post-stroke complications. Physiother Theory Pract. 2009 (14)13-25. doi:10.1179/174328809X405883
2. Park GY, Kim JM, Sohn SI, Shin IH, Lee MY. Ultrasonographic measurement of shoulder subluxation in patients with post-stroke hemiplegia. J Rehabil Med. 2007;39(7):526-530. doi:10.2340/16501977-0099
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Synthesis Category: Research Report
Title: Barriers and Facilitators to Physical Therapy Following an Emergency Department Referral for Low Back Pain

Student Presenters: Cameron Bobos, SPT, Jenna Vigneault, SPT
Faculty Preceptors: Amee L Seitz, PT, DPT, PhD, Matthew Smith PT, DPT, DSc
Institution(s): Department of Physical Therapy and Human Movement Sciences, Northwestern University Feinberg School of Medicine

Abstract:
Purpose/Hypothesis
Low back pain (LBP) is one of the top ten reasons for a visit to the Emergency Department (ED). Of the patients seen in the ED for non-urgent LBP, 42% have moderate-severe pain and nearly half have persistent functional loss 3 months later. Studies show the benefits of early physical therapy following an ED visit for low back pain with reduced risk of subsequent lumbar surgery, need for advanced imaging, and reduction of long-term opioid use. Yet, less than 15% patients see a physical therapist after being referred from the ED. The purpose of this study is to identify barriers and facilitators of outpatient PT care after a referral from ED physician for acute LBP.

Subjects
Adults with LBP seen in the ED at Northwestern Memorial Hospital in the last 30 days (n=30) participated.

Materials and Methods
Using a question guide, patient perspectives on seeking PT management following the ED visit for LBP were captured over the phone. Interviews were audio recorded, transcribed, and reviewed for accuracy and de-identification. Then, written transcripts were used to identify major themes.

Results
The barriers identified to seeking PT following the ED referral were broad and include challenges with distance/travel to get to a PT clinic, limited or lack of insurance coverage for PT, scheduling conflicts, and lack of a primary care physician limited patients' use of PT after being referred by an ED physician. Facilitators to patients seeking PT identified by patients included recommendations and/or referrals for specific PT clinics, proximity of clinic near home/work, and prior positive experiences with a PT.

Conclusions
Modifiable barriers and facilitators identified in this study can be used by healthcare systems to enhance the patient experience, outcomes, and efficiency for health systems to deliver high value care.

Clinical Relevance

Strategies to overcome modifiable barriers could be as simple as an ED physician providing recommendations to a PT from a web-based list of PT clinics and having a first visit with a PT in the ED to provide a positive prior experience. The use of technology with personalized pathways of home exercise progression as stepped care or providing telehealth as an option to improve access requires further study. Ultimately, results seek to facilitate guideline concordant care reducing the economic and societal public health crisis of chronic low back pain.

References:

1. Cairns C, Kang K. National Hospital Ambulatory Medical Care Survey: 2020 emergency department summary tables. DOI: https://dx.doi.org/10.15620/cdc:121911.
2. Edwards J, Hayden J, Asbridge M, Gregoire B, Magee K. Prevalence of low back pain in emergency settings: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2017;18(1):143. Published 2017 Apr 4. doi:10.1186/s12891-017-1511-7
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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: Checklist Development of a Gait Skills Assessment: A Delphi Review

Student Presenters: Allison Chin, SPT; Zach Irwin, SPT; Aaron Zurmely, SPT
Faculty Preceptors: Rachel Tappan, PT, DPT, NCS; Heidi R. Roth, PT, DHS, NCS
Institution(s): Department of Physical Therapy & Human Movement Sciences, Feinberg School of Medicine, Northwestern University; Department of Medicine (Pulmonary and Critical Care), Feinberg School of Medicine, Northwestern University

Abstract:
Purpose/Hypothesis
Assessment checklists allow faculty to assess students' clinical skills with a standardized patient accurately and efficiently. Systematic development of rubrics provides content validity evidence for their use. This project's aim was to develop an assessment of physical therapist students' gait training skills.

Number of Subjects
10 core and associated faculty with experience teaching physical therapy gait skills.

Materials/Methods
This clinical skills assessment covers first-year student physical therapists' ability to evaluate and train gait tasks with a standardized patient. The grading checklist used in this assessment was developed with a four-step process. Step 1 was the creation of a preliminary checklist. Step 2 was the modification of the checklist through three rounds of Delphi review. In the first round, reviewers were able to rate each item "Keep As Is" or submit suggested modifications. Consensus in this round was defined as 100% of participants rating an item "Keep As Is" and zero comments. In subsequent rounds, participants rated items on a 4-point Likert Scale consisting of Strongly Disagree, Disagree, Agree, and Strongly Agree, the per item consensus was defined as ≥67% agreement. If multiple iterations of an item met the consensus threshold, the item with the highest mean Likert rating was selected. Once an item achieved consensus, it was omitted from subsequent rounds. Step 3 was pilot testing of the modified checklist by the author team using three videos of simulated student assessments of varied proficiently. Items were edited for formatting, item order, and clarity. Step 4 was a final round of Delphi review to confirm consensus of all items in the final checklist.

Results
The preliminary checklist consisted of 58 items across 5 sections. In round 1, 8 items reached consensus, 2 new items and 32 modifications were suggested. In round 2, 25 additional items reached consensus, including 1 addition and 1 deletion. In round 3, 58 out of 59 items reached consensus. Pilot testing resulted in reordering of several sections, deletion of 2 items and splitting another into 2 separate items. The fourth round of Delphi review had the last item reach consensus. The final round of Delphi review resulted in consensus of all 59 items in

the final checklist.

Conclusions
The Delphi review and pilot testing methods used for development of this assessment provide content validity evidence for the assessment's use in assessing student physical therapists' gait skills. The process supported the creation of a checklist to improve the accuracy and efficiency of grading in a physical therapy program.

Clinical Relevance
Gait training is important for physical therapy students to prepare for clinical experiences. DPT programs need standardized, evidence-based criteria to assess student performance. This gait skills checklist assessment integrates faculty expertise and facilitates grading of organized items. The Delphi review process provides content validity evidence for the use of this trait skills assessment checklist in a physical therapy program.

References:

1. Dupree A, McAuley A, Wetherbee E. Objectives to assess student readiness for first, full-time clinical education experiences in physical therapist education. J Phys Ther Educ. 2020;34(3):242-251.
2. Klein MR, Schmitz ZP, Adler MD, Salzman DH. Development of a rigorously designed procedural checklist for assessment of emergency medicine pesident performance of temporary transvenous cardiac pacing. AEM Educ Train. 2020;5(3):1-7.
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Synthesis Category: Research Report
Title: Comparison of Hand Function and Corpus Callosum Microstructure in Children with Hemiplegic Cerebral Palsy

Student Presenters: Dylan Huber, SPT; Anusha Manjunath, SPT; Savanna Yu, SPT
Faculty Preceptors: Alexandra Hruby, PhD Candidate, SPT[1,2]; Carson Ingo, PhD[1,3]
Institution(s): Department of Physical Therapy and Human Movement Sciences, Northwestern University Feinberg School of Medicine, Chicago, IL; Department of Biomedical Engineering, Northwestern University, Evanston, IL; Department of Neurology, Northwestern University Feinberg School of Medicine, Chicago, IL

Abstract:
Purpose/Hypothesis
Hemiparetic Cerebral Palsy (HCP) is often caused by a prenatal or perinatal injury to the brain and results in motor deficits affecting strength and coordination due to abnormal corticospinal tract development.[1-3] These impairments may also be affected by a disruption to the interhemispheric communication that occurs via the corpus callosum.[4,5] In this study, we used diffusion weighted imaging (DWI) and tractography to investigate the relationships between interhemispheric white matter tracts and the severity of grasp weakness and mirror movements in children with HCP. We hypothesized significant relationships would present that indicate decreased interhemispheric connectivity organization contributes to increased hand impairment severity in participants with HCP.

Subjects
Study included participants with HCP (n=13, 14.1y, 7M) and typical development (TD) (n=14, 14.8y, 7M).

Materials & Methods
This study utilized previously collected DWI data and hand impairment severity measures.[6] Probabilistic tractography was performed to create a distribution of potential streamlines between the precentral gyri in each hemisphere. Tracts were then thresholded by probability and viewed to ensure gross anatomical accuracy. Diffusivity metrics (FA, MD, AD, and RD) in the isolated tract was recorded for statistical analysis. Non-parametric statistical tests included Mann-Whitney U test and Spearman partial correlation. Statistical significance was set at p=0.05. Age and sex assigned at birth were included as covariates. Rho coefficients between (0.7 and 0.9) are considered highly correlated.7

Results
For participants with HCP, there were significant partial correlations between maximum grip strength of the dominant hand and diffusivity metrics of the isolated tract through the corpus callosum: MD (ρ=0.73, p=0.011), AD (ρ=0.71, p=0.015), and RD (ρ= 0.66, p=0.028). There were also significant partial correlations between mirroring severity and diffusivity metrics in the isolated tract: MD (ρ=0.76, p=0.006), AD (ρ=0.75, p=0.008), and RD (ρ=0.68,

p=0.020).

Conclusions

This study revealed significant correlations between corpus callosum diffusivity and both maximum grip strength and mirroring severity in children with HCP. Higher maximum grip strength was associated with less organized interhemispheric pathway microstructure, while increased hand mirroring correlated with less organized interhemispheric pathway microstructure. The corpus callosum plays a significant role in motor function, especially bilateral coordination, through interhemispheric inhibition.[4,5] These findings suggest that the integrity of the corpus callosum is not only crucial for motor function in HCP but also may be adversely affected by the early injury and subsequent neural growth and development.

Clinical Relevance

This may inform future therapies aiming to improve upper extremity motor function, specifically increasing grip strength and decreasing mirroring movements, with individualized approaches based on neural connectivity patterns.

References:

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Synthesis Category: Research Report
Title: Creating and Evaluating a Prediction Equation for VO2peak in Individuals with Early Parkinson's Disease

Student Presenters: Zepei Xie, BS, SPT, Brandi Thomsen, BS, SPT, Aileen Zhang, BS, SPT, Zakary Davis, BA, SPT
Faculty Preceptors: Daniel M. Corcos, PhD, Garett J. Griffith, PhD, MPH
Institution(s): Northwestern University Department of Physical Therapy and Human Movement Sciences, Chicago, IL; Intermountain Health, Neurosciences Clinical Program, Salt Lake City, UT

Abstract:
Purpose/Hypothesis
Parkinson's disease (PD) is a degenerative brain condition causing motor and non-motor symptoms. Endurance exercise training is commonly prescribed in PD as data suggest it benefits motor function early in the disease[1,2]. Cardiopulmonary exercise testing (CPET) can measure cardiorespiratory fitness (CRF) at baseline and over time. Since those with PD exhibit lower CRF and increased risk for cardiovascular disease[3] compared to peers, and since aerobic capacity (VO2peak) is the gold standard of CRF, it is important to understand VO2peak in those with PD. VO2peak prediction equations may be used when CPET is unavailable. Although these equations exist for healthy adults, there is a need for PD equations due to an altered gait which influences energy expenditure[4,5]. The purposes of the study were 1) to develop a PD-specific VO2peak prediction equation, and 2) to compare this PD-specific VO2peak prediction equation to published VO2peak equations.

Number of Subjects
127 individuals with idiopathic de novo PD, aged 40-80yrs, classified as Hoehn & Yahr stage 1-2, within 5yrs of diagnosis, and who exercised ≤3days/week at moderate intensity.

Materials and Methods
CPET protocol included a constant treadmill (TM) speed, with TM grade increasing 2% every 2-min. Multiple linear regression analyses were performed to predict VO2peak in a validation sub-sample; the VO2peak prediction equation was then applied to a cross validation sub-sample. This PD-specific prediction equation was then compared to general VO2peak prediction equations (ACSM6 and Foster equations).

Results
Patients (57.5% male) were aged 63.6±9.3yrs. CPET results in the total sample included mean VO2peak of 23.8±6.0mL/kg/min, TM speed of 3.0±0.6mph and grade of 10.8±3.5%.

TM speed, TM grade, and age were used to develop the PD-specific VO2peak equation:

VO2peak = 9.318 + 4.504*(TM speed [mph]) + 0.832*(TM grade [%]) – 0.121*(age [yrs]).

This equation predicted VO2peak in our validation sub-sample (R2=0.638, SEE=3.78mL/kg/min, p<0.001). There was no difference between estimated and measured VO2peak in the cross validation sub-sample (23.6±4.3 and 23.1±5.8mL/kg/min, respectively, p=0.386). The cross validation sub-sample achieved 98.3%, 89.8%, and 108.0% of estimated VO2peak from the PD-specific, ACSM, and Foster equations, respectively.

Conclusions

The PD-specific VO2peak prediction equation successfully predicted VO2peak in early PD patients. In contrast, VO2peak was over- and under-estimated in PD patients by the ACSM and Foster equations, respectively. This underscores the importance of a PD-specific regression equation when assessing VO2peak in individuals with PD. Future research should include additional clinical characteristics to further refine a VO2peak prediction equation in PD.

Clinical Relevance

VO2peak is an important marker of health status and decreases in VO2peak are linked with loss of independence and poor prognostic outcomes over time. Clinicians can use estimates of VO2peak to identify individuals for whom improvement in CRF via endurance exercise training should be a priority.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: Does Oxygen Delivery Tube Length Influence Oxygen Delivery Flow Rate?

Student Presenters: Michaela Danyo, SPT, Brady Safenovitz, SPT, Gabriella Zydallis, SPT
Faculty Preceptors: Jennifer M. Ryan PT, DPT, MS, Board Certified Cardiovascular and Pulmonary Clinical Specialist
Institution(s): Northwestern University, Feinberg School of Medicine, Department of Physical Therapy and Human Movement Sciences

Abstract:
Background
Physical therapist practice often extends the length of oxygen tubing to allow patients on supplemental O2 to walk greater distance as they recover. While connecting them is simple, the clinical decision to determine if lengthening the tube will impact the delivery of the oxygen requires discrete measurement. Evidence demonstrates the importance of patients participating in prescribed exercise to recover from or manage diagnoses that require supplemental oxygen, yet minimal research exists on the impact of the change in tube length despite Poiseuille's Law. Per Poiseuille, increasing the length of tube increases the resistance thus reducing flow rate within the tube. Our initial project measured flow rates of 2, 4, 6, and 15 L/min at varying lengths of tubing. Although initial findings didn't appreciate a change in flow rate from expected the number of trials did not meet 80% power and therefore wasn't sufficient to account for type II error. We hypothesized a 2 L/min flow rate would be more impaired than a 6 L/min rate at both the 57 and a 107-foot-long cannula. We also hypothesized that the 107 length will have a greater reduction in flow rate compared to the 57-foot-long cannula.

Methods
32 measures preformed at: 6L/min at 57 and 107' of tubing to test clinically relevant lengths used in home care; and 15L/min at 14' of tubing to test clinically relevant lengths used in acute care. Standard H tanks were used with a capacity of 7079L of oxygen per tank. Medical grade oxygen tubing was used a standard 7' tube, with 1 or 2 50' extenders with medical grade connectors. Oxygen Flow meter: Medical O2 Flowmeter 0-15L/min with O2 OHMEDA quick connect inlet. Controlled the amount of flow. Oxygen regulators: Harris 25C-2T50P-540 oxygen single stage present 50 PSI pressure regulator was used track amount of oxygen in the tank and amount of PSI. Lastly, a bung to seal the bag.

Results
Measures of 6L/min at 57Ft yielded an error rate of 8.67; 5.480 L/min. Measures of 6L/min at 107ft yielded an error rate of 5.32%;5.681L/min Measures of 15L/min at 14ft yielded an error rate of 2.33%;15.35 L/min.

Conclusion

Through our research on the impact of tube length on oxygen delivery, we did not find a consistent or significant impact on oxygen delivery. The degree of error measured was likely attributable to multiple factors, including, research design-related system failures and learning effects of the data collectors. Inter-tester reliability between timers was near zero. The amount of volume in the bag was calculated with low power, potentially resulting in a smaller volume. Due to these limitations, further trials are needed to strengthen the research and prove that tube length does not affect flow rate.

Clinical Relevance

Clinicians are adapting oxygen tube length during exercise to allow greater activity and training to recover from hypoxemia. Patients may independently adjust the tubing length at home, based upon their individual needs. It is important for PT's to monitor oxygen during treatment. Due to physical therapists having a direct role in patient education and titration of oxygen. This study aims to investigate impact of tube length on O2 delivery

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Synthesis Category: Research Report
Title: Evaluating a Novel Precise Measure of Flexion Synergy Expression in the Hand in Individuals with Chronic Stroke

Student Presenters: Raina Foreman, SPT, Erin Hamilton, SPT, Zack Peacock, SPT
Faculty Preceptors: Jane E. Gyarmaty, DPT, Michael D. Ellis, DPT, Ana Maria Acosta, PhD, Ahalya Mandana, MS
Institution(s): Department of Physical Therapy and Human Movement Sciences, Feinberg School of Medicine, Northwestern University

Abstract:
Background
Loss of independent joint control is a common and debilitating functional limitation following hemiparetic stroke. In the upper extremity, this manifests in the expression of flexion synergy: the involuntary coupling of flexion at the elbow, wrist, and fingers with abduction of the shoulder[1,2]. Recent investigations have quantified flexion synergy expression between the shoulder and elbow via mechatronic devices with intent to use these devices to enhance recovery in the inpatient rehabilitation setting[3]. A precise measure of flexion synergy expression in the hand has yet to be developed and implemented in this setting. Here we use mechatronic devices to quantify paretic hand grasp force under seven shoulder abduction loading conditions. In seeking to maximize the efficiency of a mechatronic protocol, the minimum number of trials necessary to capture maximum shoulder abduction torque and grasp force was also investigated.

Participants
Seven participants with chronic stroke (4 females and 3 males, mean age 62.0 ± 16.2 years, mean duration post-stroke 19.27 ± 9.68 years) recruited via convenience selection from a Northwestern University research participant registry.

Methods
Grasp force was recorded during maximal isometric shoulder abduction (MISA), as well as under six different shoulder abduction loading conditions during a reaching task with a standardized start position. The conditions were: 0% of MISA in the start position, 0% of MISA during maximal reach, 50% of MISA in the start position, 50% of MISA during maximal reach, load of gravity in the start position, load of gravity during maximal reach. Maximal volitional grasp force was recorded to allow for data normalization.

Results
Overall mean normalized abnormal grasp forces were 0.700 ± 0.277 (MISA), 0.031 ± 0.124 (0%, start position), 0.172 ± 0.211 (0%, maximal reach), 0.116 ± 0.115 (50%, start position), 0.282 ± 0.181 (50%, maximal reach), 0.038 ± 0.081 (gravity, start position), and 0.222 ± 0.165 (gravity, maximal reach). The mean trial in which maximum output was achieved was 6.3 ± 2.3 and 4.1 ± 2.1 for shoulder abduction torque and grasp force, respectively.

Conclusion

In participants with chronic stroke, use of a mechatronic device to quantify hand grasp force is feasible and time efficient. In maximal effort attempts, maximum shoulder abduction torque and grasp force were achieved within the first six trials on average. Increased shoulder abduction load during reaching tasks may be associated with increased abnormal grasp force, though considerable variability in grasp force is apparent in these data.

Further Research

A larger sample size is necessary to statistically evaluate the effect of abduction load on abnormal grasp force and to identify the most efficient and valid condition of measurement. Evaluation of flexion synergy at the hand should be performed with participants experiencing acute stroke to provide a more comprehensive measure of early stroke recovery.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: Functional Neurological Disorder in the In-Patient Setting of a Children's Hospital

Student Presenters: Mateya Rettig, SPT; Yanhao Shao, SPT; Nicole Sweetland, SPT
Faculty Preceptors: Laurey Brown, PT, DPT, PCS; Meredith Norwood, OTD, OTR/L
Institution(s): Northwestern University Department of Physical Therapy and Human Movement Sciences; Ann & Robert H. Lurie Children's Hospital of Chicago

Abstract:
Purpose
This study aims to explore the care pathway for children diagnosed with Functional Neurological Disorder (FND), a condition at the intersection of neuroscience and psychiatry. FND can present with a variety of symptoms, including motor, cognitive, and sensory impairments, which are inconsistent with known neurological conditions. While historically FND has been a rule-out diagnosis, it is now a rule-in diagnosis with specific diagnostic criteria. Although much of the research on FND has focused on adults, pediatric FND remains under explored, despite its significant impact on school attendance, social development, and long-term well-being. Through a retrospective chart review, this study seeks to fill the gap in knowledge regarding the diagnosis and management of pediatric FND.

Number of Subjects:
57

Methods
A retrospective electronic medical record (EMR) review was conducted on 59 patients with FND discharged from a 312-bed pediatric hospital between March 2012 and February 2025. The review collected data on co-occurring medical and psychiatric diagnoses, symptom duration, FND symptom descriptors, consultations performed, length of hospital stay, discharge recommendations, and other relevant factors.

Results
Initially 59 patient charts were reviewed via EMR at Lurie Children's Hospital. 2 charts were excluded due to missing discharge summaries and both were conducted at hospitals not affiliated with Lurie Children's Hospital. Results showed a high number of females vs males (80.7% female). Varied length of stay amongst charts, co-occurring diagnoses, and varying types of consults. No care conferences were performed using an interdisciplinary approach.

Conclusions
Medical provider awareness of FND is becoming more common, but there are still issues with delayed diagnosis and prolonged treatment, which can lead to increased healthcare costs, increased length of hospital stays, and negatively impact patient outcomes. Recommendations for optimal care pathways have been presented in recent literature, but

are not consistently followed or implemented by hospital systems. High numbers of co-occurring medical and psychiatric diagnoses, increased lengths of stay, and lack of care conferences lead to detrimental patient outcomes and can cause inefficient care pathways. This review provides evidence for opportunities to improve interdisciplinary care for pediatric patients with FND.

Clinical Relevance

This review offers insights about the efficiency of the care pathway for children diagnosed with FND. The results of the review support the need for a multidisciplinary care approach in the diagnosis and treatment of FND.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: Generative Artificial Intelligence Use in Doctor of Physical Therapy Programs

Student Presenters: Benjamin Price, SPT; Allison Dennemann, SPT; Benjamin Knoll, SPT; Maya Shanghavi, SPT; Brock Ambrose, SPT; Michael Hamor, SPT; Sean Toriyama, SPT; Brandon Tsai, SPT;Carolyn Oh, SPT
Faculty Preceptors: Craig P. Hensley, PT, DPT, MSCI; Christa Nelson, PT, DPT, PhD; Alison H. Chang, PT, DPT, PhD
Institution(s): Northwestern University, Department of Physical Therapy & Human Movement Sciences

Abstract:
Purpose/Hypothesis
The growing application of Artificial Intelligence (AI) in healthcare is poised to significantly impact the field of physical therapy (PT).1-2 Research on Generative AI (GAI) in Doctor of Physical Therapy (DPT) education remains limited.3-5 This study examines the use of GAI in DPT education among students and faculty.

Number of Subjects
1090

Materials and Methods
We distributed an online REDCap survey to faculty and students at US-accredited DPT programs. Survey invitations were emailed to PT program directors using information from the APTA Accredited PT Programs directory and shared via social media and direct outreach. Before distribution, we piloted the survey with a group of PT faculty and students, incorporating their feedback. The survey queried GAI use patterns and purposes; tools (e.g., ChatGPT, Copilot); training and comfort levels; views on GAI's role in PT practice, student preparedness, and academic integrity; adoption facilitators/barriers; and demographics. Descriptive statistics summarized the results.

Results
Our sample consisted of 1090 respondents: 895 (82.1%) students and 195 (17.9%) faculty. 706 students (78.9%) and 168 faculty (86.2%) used GAI in their DPT programs. Among users, both students (67.3%) and faculty (85.7%) identified ChatGPT as their primary tool, followed by Microsoft Copilot and Gemini/Google Bard. Primary reasons for use were to create study guides/sample questions (students: 67.3%, faculty: 43.5%) and patient cases (students: 51.3%, faculty: 57.7%). The top barrier to GAI adoption was concerns about reliability or scientific rigor for all students, regardless of GAI use (59.7%) and among faculty users (49.4%). The top barrier for faculty non-users (n=27) was lack of knowledge, understanding, or familiarity (66.7%). Of all respondents, most students (74.3%) and faculty (81%) agreed that GAI will be used in future PT practice; 66.6% students and 83.6% faculty

were unsure or believed that students will not have sound foundational knowledge of how to use GAI upon entering the workforce.

Conclusions

Approximately 80% of DPT students and faculty use GAI, primarily for developing study materials and patient cases, with ChatGPT as the most common tool. However, concerns regarding reliability, scientific rigor, and limited GAI literacy hinder broader adoption. While GAI is expected to play a role in future PT practice, uncertainty remains about whether students graduate with the necessary skills to use it effectively. These findings highlight the need for targeted GAI education in DPT programs to ensure competency in clinical applications.

Clinical Relevance

As GAI becomes increasingly integrated into healthcare, education regarding GAI in DPT programs is crucial for preparing students to use it competently and responsibly. Addressing knowledge gaps and reliability concerns through a structured curriculum can boost confidence and ensure effective and ethical application in patient care.

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Synthesis Category: Case Study Report
Title: High Intensity Gait Training Versus Behavioral Interventions: Impact on Retention of Walking Performance and Walking Capacity

Student Presenters: Kaitlin Murray, SPT; Halle Wanless,SPT; Gabriel Baggot,SPT; Desiree Smith,SPT; Kendall Bray Cox, SPT
Faculty Preceptors: Jennifer Kahn, PT, DPT; Keith Gordon, PhD, ATC, CSCS
Institution(s): Northwestern University Feinberg School of Medicine

Abstract:
Background and Purpose
A major goal of gait rehabilitation following incomplete spinal cord injury (iSCI) is to make lasting improvements in walking during everyday life, i.e. walking performance. However, our research in people with iSCI finds that while high intensity gait training (HIGT) improves walking capacity (speed, balance) it does not increase walking performance (steps/day)1. Evidence finds that behavioral interventions are effective for increasing non-walking physical activity in people with iSCI[2]. In people with stroke, behavioral interventions are more effective than HIGT alone for improving walking performance[3]. Additionally, retention of increases in walking performance following gait training has not been well established, but behavior interventions have shown qualitative improvements in physical activity[4, 5]. The purpose of this case series was to compare the effects of HIGT and a behavioral intervention on changes and retention of walking capacity and performance in two people with iSCI.

Case Description
Two individuals with cervical iSCI, completed a HIGT and behavioral intervention with goals of improving walking and balance. The HIGT consisted of twenty sessions at 75-85% HR max[6]. The behavior intervention was developed from the SCI ProActive Toolkit[7], consisting of 8-weeks of collaborative goal setting, weekly phone calls, completion of an activity log, and motivational interviewing strategies. Objective data was collected at pre, post-training, and at 3-months follow up to assess changes in capacity (Ten Meter Walk Test (10MWT), Timed Up and Go, Functional Gait Assessment, Berg Balance Scale) and performance (steps/day) and the retention of these changes.

Outcomes
Walking capacity:Pre to post training there were improvements with HIGT meeting the minimal detectable change (MDC); however, the behavioral intervention did not result in consistent changes.
Walking capacity retention: Following HIGT, improvements in the 10MWT meeting an MDC were retained from pre to follow up, but retention results for the other capacity measures were inconsistent. Behavioral intervention did not show consistent MDC improvements in capacity measures from pre to follow up.
Walking performance: HIGT did not result in improvements in steps per day pre to post

training; however, both participants improved steps per day by at least 94% after the behavioral intervention.
Walking performance retention: For HIGT, each participant decreased in steps/day from pre to follow up. Following the behavioral study, both participants decreased their steps/day from post to follow up, but demonstrated at least a 25% increase in steps/day from pre to follow up, indicating retention of improvements.

Discussion
This case series revealed improvements and retention of walking performance following a behavioral intervention. HIGT showed improvements and retention in walking capacity, but not performance. Clinicians should consider individualized behavioral interventions alongside evidence based physical interventions. Future studies should aim to combine HIGT with behavioral interventions to maximize both walking capacity and performance improvements

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Case Study Report
Title: Improving Diverse Visual Representation in Doctor of Physical Therapy (DPT) Education

Student Presenters: Jalen Carter, SPT; Madison Esposito, SPT; Aubrey Kiel, SPT; Maya Patel, SPT
Faculty Preceptors: Heather Henderson, PT, DPT
Institution(s): Northwestern University Department of Physical Therapy and Human Movement Sciences

Abstract:
Background and Purpose
Evidence suggests implicit racial bias exists in visual representation within medical education including course and lecture materials, case studies, and textbooks, leading to underrepresentation of individuals from minoritized backgrounds. This lack of representation may perpetuate existing health disparities in the US. Despite numerous studies in medical education, there is a gap in research for physical therapy. Our previous research aimed to address this gap by collecting data to highlight the lack of diversity in the curriculum. Our current project aimed to bridge this gap by collaborating with faculty to create photos and visual media that more accurately represents the physical therapy community and the individuals with which we work.

Previous Research Results: In our initial research study, we examined a total of 1,744 images and videos across four courses in the DPT curriculum at Northwestern University. Results showed that 71% of visual media included white individuals while only 29% of media was diverse.

Case Description
Drawing on previous research findings, our goal was to simplify the integration of diverse visual media in curriculum for faculty. We started by developing a new mitigation checklist to streamline the process of identifying bias in presentations. We then offered assistance in capturing new images that emphasize the representation of diverse individuals in the role of physical therapist. As a result, we successfully enhanced the diversity of visual media within the Northwestern University DPT curriculum.

Discussion
Limitations of our research may include, the inclusion of photos for courses that were not part of the initial data, the use of broader categories for new data collection, vs the detailed categories used in the past and the fact that non-diverse course directors selected some of the photos they were featured in, as they possess a deeper understanding of the skills being demonstrated. Despite the above limitations, proof of growth was still displayed after a full year. Through continued analysis, we hope to continue to refine our findings and contribute to a more inclusive educational environment. In our ongoing research, we aim to develop a comprehensive repository of diverse images to keep improving visual

representation in physical therapy didactic education.

Conclusion

Raising awareness and implementing strategies to enhance the diversity of visual materials increased diverse representation in the DPT curriculum to 38%. These findings highlight the critical need for continued efforts to integrate inclusive educational resources, ensuring a more comprehensive and holistic learning environment for all students, thus improving the health of our patients.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Special Interest Report
Title: Incorporating Scalable Movement Technology in the DPT Curriculum

Student Presenters: Oriana Altuve, SPT, Stephanie Chiu, SPT, Samuel Doong, SPT, John Rogers, SPT
Faculty Preceptors: Alison H. Chang, PT, DPT, PhD[1]; Vishesh Kumar, PhD[2,3]; Theresa Sukal-Moulton, PT, DPT, PhD[1]
Institution(s): [1]Department of Physical Therapy and Human Movement Sciences, Northwestern University Feinberg School of Medicine; [2]Department of Computer Science, McCormick School of Engineering, Northwestern University; [3]Department of Learning Sciences, School of Education and Social Policy, Northwestern University

Abstract:
Purpose
Recent advancements in remote therapeutic monitoring1 and scalable movement technologies (e.g., wearable sensors, computer vision2) are transforming physical therapy by enhancing patient engagement and treatment outcomes[3]. Digital therapy programs have shown improvements in pain, function, and mental health comparable to traditional in-person therapy, with greater patient engagement and lower dropout rates[4]. These technologies provide real-time data for personalized care, improve accessibility, and support in-home therapy. Therefore, technological literacy is increasingly important for DPT students. This project aimed to identify, design, and implement a low cost, accessible, and scalable application of movement technology (e.g. Micro:bit, computer vision) to measure body segment acceleration and joint angles during functional movements in the DPT curriculum. By introducing these tools, the project helps enhance DPT students' expertise as movement specialists, enabling them to use quantitative data to assess and track movement and promote motor learning.

Description
We incorporated motion capture technology in the Kinesiology II Task Analysis Lab. Using Micro:bit, students measured tibial acceleration during the landing phase of a vertical jump with different landing techniques. Students were asked to hypothesize how forefoot vs. rearfoot landing affects tibial acceleration. By collecting and analyzing real-time acceleration data, they gained hands-on experience in quantitative movement assessment, reinforcing key concepts in load distribution, impact forces, and injury risk. We demonstrated the application of computer vision to record and analyze sagittal hip and knee angles during 2 functional tasks: sit-to-stand from varying seat heights and initial conditions as well as vertical jump at various squat heights, with vs. without arm swing.

Summary of Use
The project integrates low-cost and accessible technologies, such as Micro:bit and computer vision, into the DPT curriculum. These tools are employed to capture real-time

movement data and analyze movement kinematics for functional tasks. By leveraging block-based programming, students can easily customize and adapt these technologies, fostering an interactive learning environment. This integration not only improves practical skills and engagement but also promotes inter-professional education by fostering collaboration between DPT and computer science students. Ultimately, this approach introduces students to the skills needed for a technology-driven future in healthcare. On a Likert Scale of 0 to 10, there were improvements in DPT students' self report of Excel skill (6.4 to 7.0) and attitude (5.7 to 6.6), as well as Micro:bit skill (0.5 to 4.8) and attitude (4.5 to 5.4).

Importance to Members

As technology advances in the field of physical therapy, it is our responsibility as DPTs to stay current. Technological literacy empowers students by enhancing their education and equipping them with the skills needed to improve patient care. This project demonstrates the feasibility of integrating low-cost and easily accessible technology into the DPT curriculum.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Theory Report
Title: Is Physical Therapy on a Path to Achieving Greatness as a Profession?

Student Presenters: Josh Eads, SPT; Jack McHale, SPT
Faculty Preceptors: Peter J. McMenamin, PT, DPT, MS
Institution(s): Northwestern University, Department of Physical Therapy and Human Movement Sciences

Abstract:
Background
50 years ago, Dr. Helen Hislop delivered the 10th Mary McMillan lecture, "The Not-So-Impossible-Dream." She highlighted the achievements of Physical Therapy (PT) in 1975, and recommended areas of growth to achieve greatness.(1) Since her lecture, other prominent PT leaders have added to the greatness discussion. Dr. Alan Jette's 43rd Mary McMillan lecture, "Face into the Storm"(2) and Dr. Jim Gordon's 45th, "If greatness is a goal…,"(3) highlighted greatness factors to be achieved by PT. Purpose: This theory report is a historical literature review to assess the profession's progress towards greatness. Methodology: We identified the greatness factors cited in these lectures and compared to current state of PT through the use of data from APTA, CAPTE, and ABPTRFE.

Findings
Greatness is defined as "The quality or state of being important, notable, or distinguished; the quality or state of being powerful or intense, and the quality of being large in size, stature, number, etc..."(4) Hislop stated: "My overriding dream is that PT shall achieve greatness as a profession. Our aims may be noble, our virtues admirable, our sins minimal, and our practice moral, but without the saving merit of a habitual vision of greatness, its attainment is impossible."(1) We identified six greatness factors in the McMillan lectures: establishing a required Doctorate degree for Physical Therapists, establishing a PT "clinical science" (evidence based practice), establishing ethical and practice standards, establishing areas of specialty, establishing PT as an autonomous career, and building upon the "three legged stool" of education, clinical experience, and research in DPT education.

Discussion
Achieved greatness factors include a doctorate degree, evidence-based practice, and ethical practice standards. Greatness factors in progress include areas of specialty, autonomy, and the three-legged stool. Research shows that these factors are essential to improved patient outcomes. Evidence includes: 1) improved patient outcomes after implementation of an orthopedic residency program(5) 2) Incorporating research into the DPT program improved student reports during clinical education, general PT knowledge, and understanding of health policy.(6) 3) Musculoskeletal related work absences improved with a shift towards primary care PT due to the US physician shortage.(7) 4) Patients reported improved ability to perform job after direct access telehealth PT.(8) Conclusion: PT is on a path towards achieving greatness as a profession with progress still to be made in

solidifying its place as a leading healthcare profession. However, recent reports predict that PT may fall short of demand by 2037.(9) For full greatness, we must push for more specialty training, establish full autonomy, and strengthen the integration of education, research, and practice. By striving for advancements in these areas, physical therapy can achieve greatness.

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Synthesis Category: Research Report
Title: Loss of 5-HT2C Function Decreases Hyperreflexia In Vivo and Ex Vivo Post-Spinal Cord Injury

Student Presenters: Erika Heinze, SPT, Jiin Park, SPT
Faculty Preceptors: Margaret I. Sim; Derin Birch; Amr A. Mahrous, PhD; C.J. Heckman, PhD; Vicki M. Tysseling, PT, PhD
Institution(s): Departments of Physical Therapy and Human Movement Sciences, Neuroscience, and Physical Medicine and Rehabilitation, Feinberg School of Medicine, Northwestern University

Abstract:
Purpose
The serotonin receptor, 5-HT2CR, is involved in the regulation of spinal motor function[1,2]. 5-HT2CR has a role in regulating motoneuron (MN) activity by adjusting the gain of MN excitability through persistent inward currents (PICs)[1,3–5]. After spinal cord injury (SCI), 5-HT2CR becomes constitutively active and contributes to hyperreflexia and involuntary motor behaviors like spasms which are common in individuals with SCI[6,7]. Utilizing ex vivo and in vivo hyperreflexia testing, this study investigates the contribution of 5-HT2CR to hyperreflexia and tests whether there are sex differences by comparing male and female 5-HT2CR knock-out (KO) mice and wildtype (WT) mice[8,9].

Material and Methods
At 10 weeks of age, mice were anesthetized, and transection spinal cord injury was administered at the T10 level. Ex vivo: Spinal reflexes were measured following extraction of the sacrocaudal segment of the mouse spinal cord. Dorsal and ventral roots were mounted on bipolar wire electrodes, stimulation was delivered at 2xT, and ENG responses were recorded[10]. Long polysynaptic reflexes (LPR; 40 to 500 ms) were recorded to measure synaptic input to the motoneuron. Long latency reflexes (LLR; > 500 ms) measure PIC contribution to the motor response. Total signal (TS) is the sum of LPR and LLR. In vivo: Percutaneous electrodes were placed in the tibialis anterior (TA) and lateral gastrocnemius (LG) muscles. Ball electrodes were used to deliver electrical stimulation to the plantar side of the hind paw to evoke a flexion withdrawal reflex and the EMG response was recorded[11].

Results
In the ex vivo data, the male KO mice showed significantly less ENG activity than male WT mice in LPR, LLR, and TS. In female KO mice, however, there was no difference compared to female WT mice. Male WT mice had greater ENG activity than female WT in LPR, LLR, and TS. Female KO mice showed greater ENG activity then male KO mice in LLR and in TS. In vivo, there were no significant differences between sex in either group, so their data was combined. The LG EMG activity in KO mice was not significantly different than WT. The KO

mice had significantly lower EMG activity in LLR and TS than in WT mice.

Conclusions
In the ex vivo experiments, KO mice had a sex-specific result as male KO mice had significantly less hyperreflexia compared to male WT, whereas the females did not. Overall, male WT mice had greater hyperreflexia than female WT mice. Notably, there were significant differences in both synaptic input and in PIC activation. In vivo, no sex-specific differences were observed. There was no significant difference in LG hyperreflexia between either group; however, in the TA, KO mice had significantly less hyperreflexia than WT mice. Clinical Relevance: Our data indicates that 5-HT2CR signaling does contribute to overall hyperreflexia post-SCI but may contribute more in male mice than in female mice. This indicates that the underlying mechanism of hyperreflexia may be sex-specific and, therefore, may require different treatments.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: Matching Patients with the Right Cancer Rehabilitation Service – Pre-Implementation of a Novel Best Practice

Student Presenters: Maggie Roeske, SPT
Faculty Preceptors: Dr. Ann Marie Flores, PT, PhD, CLT
Institution(s): Departments of Physical Therapy and Human Movement and Medical Social Sciences, Northwestern University; Robert H. Lurie Comprehensive Cancer Center of Northwestern University

Abstract:
Purpose
The Northwestern University IMPACT (NU IMPACT) Research Supplement pilot tested the 4Rs Cancer Rehabilitation Triaging System that connects Patient Reported Outcome Measurement Information- Physical Function (PROMIS-PF) threshold scores (indicating moderate/severe impairment development) to the 4Rs triaging questions for timely and appropriate referrals in select medical oncology clinics in each region of the NMHC system. We report on our 4Rs pre-implementation evaluation using stakeholder focus groups to gain information about implementation, adaptation, and sustainability of 4Rs.

Methods
4Rs consists of 4 questions that match patients with moderate/severe PROMIS-PF scores with referrals to the appropriate cancer rehabilitation service. We used the Consolidated Framework for Implementation Research (CFIR 2.0) to evaluate the pre-implementation process of 4Rs and determine potential for future implementation, dissemination and adaptation. We conducted a series of stakeholder focus groups with clinicians, administrators, and patients from clinics in each NMHC region - North, West, Central, and South regions. Clinical workflows of 4Rs differed between each region. Focus groups for each region have been conducted with stakeholders representing medical assistants, administrators, medical oncologists, nurses and patients. We used CFIR to map the focus groups' feedback to domains about the innovation, outer setting, inner setting, characteristics of the individuals and implementation process. Strategies were tracked in REDCap with our Strategy Tracker using the Expert Recommendations for Implementing Change (ERIC).

Results
We recruited 18 participants representing each stakeholder type. Our participants agreed (100%) that 4Rs is easy to use, delivered a relative advantage over competitors, and fits well with the culture and workflows of each clinic. 4Rs triage questions were regarded as easy to understand, met an unmet need, and helped patients learn how to advocate for their cancer rehabilitation needs. All participants indicate that 4Rs has potential to be integrated into usual cancer care, appropriately matches patients to cancer rehabilitation specialties, adds appeal for NMHC services, and increases the number of cancer rehabilitation

referrals. All participants recommended that 4Rs be completed by the patient ahead of clinic visits via MyNM with automatic generation of cancer rehabilitation referrals (SmartSets in Epic).

Conclusions
The 4Rs system holds promise as an effective approach to address the unmet need for cancer rehabilitation referral and intervention. Clinicians, administrators and patients endorse the system with key adjustments (patient completion) to align with clinic workflows.

Clinical Implications
Implementation of 4Rs is a novel and effective triaging system that, with improvement, will deliver seamless cancer rehabilitation referral support that can be disseminated and adapted across different clinics to fill an important unmet need in cancer care.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Special Interest Report
Title: Monitoring Paretic Arm Use at Home: A Wearable Sensor-Based Data Collection Approach for AI Training

Student Presenters: Danielle Allen, SPT; Jared Catone, SPT; Ashleigh Gutknecht, SPT; Alyssa Schmuecker, SPT; John Wu, SPT
Faculty Preceptors: Hongchul Sohn, PhD
Institution(s): Northwestern University Department of Physical Therapy and Human Movement Sciences

Abstract:
Purpose
Following stroke, flexion synergies, spasticity, atrophy, and other impairments lead to decreased use of the paretic arm. This leads to significant limitations in the daily activity and participation of those living with stroke. Current methods to assess motor impairment after stroke include standardized outcome measures used in the clinical setting, such as the Arm Motor Ability Test, as well as laboratory-based measurements such as motion capture systems and EMG. While clinical methods lack resolution and precision, laboratory methods are both time consuming and costly. Additionally, these tests do not fully correspond to the normal daily activities of the individual patient. Therefore, there is a need for accurate tracking of paretic arm use in an individual's more natural, daily environment. A wearable at-home sensor combined with artificial intelligence (AI) provides an opportunity to meet this need. However, there is still a need for further development of such device. Specifically, the need to translate the measurements from the wearable sensor to joint kinematics, as well as validation of the accuracy of such device through comparison with a gold standard measurement (e.g. motion capture). Therefore, the goal is to develop and validate an experimental protocol to simultaneously collect motion capture and wearable sensor data from individuals with stroke, with the aim of eventually using this data to train an AI model for an at-home device that monitors arm use.

Description
The protocol is developed for stroke patients. It requires individuals to perform various motor tasks of daily living through standardized clinical tests, such as AMAT and TUG. Motion capture and force sensors were used to detect whole body kinematics. We ran into several obstacles during construction of the protocol. There were instances where not all markers were captured due to the task performed, clothing used, or the direction of motion in regards to the camera capture system. These issues were prominent and modifications were made to reduce marker obstruction. In clothing tasks, a mesh material shirt was used. The thin and porous material exposed the markers, providing reliable data. The TUG presented challenges in that an individual needs to be present near the patient in order to ensure proper guarding and safety of the patient. This required large volumes of trials of the TUG to be collected to ensure markers were not obstructed. In the instance where markers were obstructed, a process known as gap filling was required. This required manually

identifying and labeling missing markers within the Qualysis software to ensure all markers were accounted for 100% of the duration of a given trial. Other potential struggles that may arise from this experiment may be due to the difference between the controlled manner in which these tasks are performed in the lab compared to the more uncontrolled movements an individual may make in the comfort of their own home. With that being said, the set-up, protocol, and execution of tasks within the lab elicited appropriate data.

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Synthesis Category: Research Report
Title: Optimizing Stroke Rehabilitation: Using Therapy Metrics to Discriminate Responders in Functional Outcomes

Student Presenters: Daniel Chae, SPT; Lauren Guno, SPT; Jiachang Hao, SPT
Faculty Preceptors: Arun Jayaraman, PT, PhD; Megan O'Brien, BS, MS, PhD; Francesco Lanotte, PhD
Institution(s): Shirley Ryan AbilityLab; Northwestern University

Abstract:
Purpose
In stroke rehabilitation, increased therapy dosage and intensity correlate with better outcomes.[1,2] However, predicting individual responses is challenging due to complex dose-response relationships.[1,3] For clinician to deliver precision rehabilitation, wherein different interventions are targeted toward those most likely to benefit, factors related to a patient's expected or demonstrated responsiveness to therapy must be considered.[4] Clinical notes, written by therapists for each therapy session, document treatment details and patient performance outcomes offering insights into these individual responses.[5] We hypothesize that therapy metrics can differentiate responders (R) from non-responders (NR) during traditional rehabilitation care.

Subjects
42 individuals admitted to the Shirley Ryan AbilityLab with a primary stroke diagnosis.

Methods
In this longitudinal study, three raters extracted demographic, clinical, and therapy data from electronic health records and clinical notes. Therapy metrics included total, overground (OG), and treadmill (TM) walking distance (WD), and maximum TM speed. Functional outcomes included 10-Meter Walk Test (10MWT), 6-Minute Walk Test (6MWT), and Berg Balance Scale (BBS). Responders were identified by comparing their improvement in functional outcomes against the minimal clinically important difference (0.16m/s for 10MWT, 71m for 6MWT) or minimal detectable change (6.9 points for BBS). Statistical analysis compared therapy metrics between R and NR and assessed potential biases based on sex, age, and body mass index (BMI). Based on data normality, a t-test or Mann-Whitney U test was used, with significance at $p<.05$.

Results
Responders who achieved clinical improvements in the 10MWT ($p=.001$), 6MWT ($p=.007$), and BBS ($p=.001$) demonstrated greater total WD during therapy. Total OG-WD during therapy also distinguished responders to the 10MWT ($p=.002$), 6MWT ($p<.001$), and BBS ($p<.001$). Total TM-WD differentiated responders in 10MWT ($p=.007$) and BBS ($p=.036$), while maximum TM speed was higher in 10MWT ($p=.003$) and 6MWT ($p=.001$) responders. Younger patients achieved higher maximum TM speed ($p=.048$), while sex and BMI had no significant

effects.

Conclusions
Therapy metrics from clinical notes distinguished R from NR in functional outcomes during inpatient rehabilitation. Responders demonstrated significantly higher therapy metrics throughout their stay, indicating greater engagement and performance. Age-related differences may also contribute to these results.

Clinical Relevance
These findings highlight the importance of tracking key therapy metrics to monitor progress. Regular monitoring could help clinicians detect improvements and optimize recovery by tailoring therapy intensity and duration. Certain key therapy metrics could help identify potential responders early, enabling precise, targeted interventions to enhance functional outcomes.

Limitations
The small sample size, single-site design, and lack of long-term follow-up may limit generalizability. This study did not account for psychosocial or neurological factors.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: PDISCO: Parkinson's Disease, Inferring Symptom Characteristics Objectively

Student Presenters: Claire Evans, SPT; Karen Gomez, SPT
Faculty Preceptors: Grace Sutoris, MS[3], Richa Rai, PhD[2,3], Joseph Jankovic, M.D.[4], Arun Jayaraman, PT, PhD[1,2,3]
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Abstract:
Purpose
Parkinson's Disease (PD) is a progressive neurodegenerative disorder, impacting 1% of those over the age of 60(1). Medications such as carbidopa-levodopa may treat PD symptoms leading to motor impairments such as bradykinesia and tremor(2).The Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS) is the standard clinical tool for evaluating symptom severity; however, its reliance on subjective clinical assessment can introduce variability(3). Markerless pose estimation offers a non-invasive and objective method to assess movements matters in PD, potentially enhancing clinical evaluations and enabling remote monitoring. We aim to utilize markerless pose estimation to remotely assess and monitor symptoms of PD to improve early detection of PD and easily track symptom severity.

Materials and Methods
This study analyzed facial expressions and postural features in 48 individuals with PD during the MDS-UPDRS Part III Motor Exam, with assessments conducted both ON and OFF medication. We clipped videos of tasks 3.2 Facial Expression and 3.13 Posture. Facial movement data collected from video recordings and analyzed using OpenFace. Action Units (AUs) were calculated from each frame and were averaged across each video session to produce mean scores for each AU. Pearson correlations between UPDRS scores and AU intensities in the ON and OFF states separately to assess whether higher facial muscle activation was associated with greater motor impairment. Mann-Whitney U tests were used to test whether the mean AU intensity differed significantly between ON and OFF states.

Results
AU17 (Chin Raising) and AU15 (Lip Corner Depressor) exhibited significant ON vs. OFF differences ($p = 0.004$ and $p = 0.003$, respectively), though neither correlated with UPDRS. AU23 (Lip Tightener) showed both a significant ON vs. OFF difference ($p = 0.017$) and a moderate correlation with UPDRS in the OFF state ($r = -0.38$, $p = 0.049$). AU45 (Blinking)

correlated with UPDRS in the OFF state ($r = 0.38$, $p = 0.046$) but did not show a significant ON vs. OFF difference.

Conclusions

Our results show that some facial expressions are more sensitive to medication status, while others track disease severity. Markerless pose estimation reveals facial movement features that correlate with UPDRS scores, offering a potential non-invasive biomarker. Facial features may reflect medication state or disease severity and could capture subtle motor impairments that may be difficult to quantify clinically. In the future, gait analysis can be utilized to capture global motor function, larger, more diverse cohorts can be studied to improve generalizability, and longitudinal studies can be conducted to track disease progression over time.

Clinical Relevance

Non-invasive, video-based monitoring reduces the need for specialized equipment. This can improve accessibility for remote symptoms tracking, reducing the burden on patients and providers. There is potential for automated, scalable PD assessments in clinical and home settings.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: Recognizing and Interrupting Microaggressions: Enhancing Clinician Allyship and Competence

Student Presenters: Neil Singh, SPT; Takyya Grovner, SPT; Alisa Bitoy, SPT
Faculty Preceptors: Elizabeth E. Holland, PT, DPT; Cori Arquines PT, MHPE; Tobey DeMott Yeates, PT, DPT
Institution(s): Northwestern University, Department of Physical Therapy & Human Movement Sciences

Abstract:
Background/Purpose
Microaggressions are subtle, offensive comments or actions directed at a minority or other non-dominant group that are often unintentional or unconsciously reinforces a stereotype[1]. The prevalence of microaggressions within healthcare education results in negative mental health outcomes and stress on students[2,3] and hostile environment for healthcare professionals[4,5]. Preparation for clinicians and educators to identify and interrupt microaggressions is critical to creating inclusive learning environments[6].

Hypothesis
A professional development workshop can positively influence knowledge, behaviors, and attitudes about identifying and disrupting microaggressions in both academic and clinical physical therapy settings[7].

Subjects
30 physical therapy academic and clinical educators and clinicians self-selected to participate in this workshop.

Materials and Methods
Participants engaged in one of two workshops (90-120 min each) to learn about recognizing and interrupting microaggressions using the VITALS framework. Participants completed a pre-session survey to assess baseline knowledge, behaviors, and attitudes regarding microaggressions. The same survey was completed at the end of each session. Statistical analysis was performed through a Wilcoxon signed-rank test.

Results
T here was a significant increase in the participants' confidence regarding their ability to define and recognize microaggressions, respond to microaggressions as a recipient or bystander, use the VITALS framework to interrupt microaggressions, and identify strategies to mitigate microaggressions in their organization/learning environments. There was no statistical difference in participants' perception of the importance of microaggressions in clinical educators' professional development.

Conclusions

This workshop is an efficient way to train clinicians to appropriately identify and intervene/interrupt when they witness or experience a microaggression. It ensures that clinicians understand the importance of addressing microaggressions that may foster a safer and more inclusive clinical environment for students and clinicians. Further research or subsequent sessions should focus on the effectiveness of implementing the VITALS framework in the clinic with a larger diverse group of clinicians and healthcare professionals.

Clinical Relevance

Clinical and academic educators and clinicians who participated in this training report feeling more confident in their ability to identify and intervene when witnessing or experiencing a microaggression. Training clinicians and educators using the VITALS framework addresses a gap in their confidence when it comes to skillfully addressing microaggressions in clinical learning environments.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Special Interest Report
Title: Sustaining Circling Practices in a DPT Program

Student Presenters: Alexandra Adams, SPT; Kimari Lewis, SPT; Nicki Mileski, SPT; Miller Tennant, SPT
Faculty Preceptors: Bill Healey, PT, EdD; Molly Kanaley MEd, LPC; Krista Van Der Laan, PT, DPT
Institution(s): Northwestern University Department of Physical Therapy and Human Movement Sciences

Abstract:
Purpose
Circling as part of restorative practices (RP) can enhance community and build communication micro-skills in active-listening, empathy and collaboration in academic medicine and healthcare.[1,2] Positive peer support has been shown to enhance resiliency in students pursuing a Doctor of Physical Therapy (DPT) degree.[3] The purpose of this project was to examine student perceptions of Circling in Orientation in a DPT program to establish support for development of a Circling and Restorative Practices Handbook.

Description
Community-building circles led by students were introduced into a DPT program one year prior to this project. The Circles were feasible and seemed well received by the students, faculty members, and staff who attended. The Circles were scheduled at Orientation and then once each trimester. Each circle had a specific theme or topic. After participating in Orientation Circles, led by 2nd-year students, faculty, and staff, 96 first-year DPT students completed a survey with 6 Likert-scale items and one open-ended question about their experience. The same 2nd-year students hosted four circles throughout the academic year and have developed a Student Circling and Restorative Practices Handbook to guide student leaders in future classes.

Summary of Use
Responses from the post-Circling survey collected at Orientation demonstrated that 98% of students "strongly agreed" and "somewhat agreed" that they felt a sense of connection and community and felt a shared sense of values. 100% of students "strongly" and "somewhat agreed" that they felt respected in the circles. 91% of students indicated that they would participate in a circle again. Responses to the open-ended survey item revealed that 1st-year students felt as though they were able to learn more about their peers, felt comfortable and safe in the space, enjoyed Circling, and had shared experiences and feelings. After partaking in circles during their first year in the DPT program and speaking to medical students from another university, the project team considered sustainability to help future cohorts engage in the practice. A Circling and Restorative Practices Handbook was developed that includes guidelines for Circling practice, background information, acknowledgement of the cultural significance of Circling, and templates for future cohorts to use. The goal is to continue Circling within the DPT program

and provide example templates and guidelines.

Importance to Members
Student participants reported positive feedback about engagement in Circling during Orientation. Circling practice allows for the development of community in an academically stressful atmosphere and aids in breaking down the hierarchy that is invoked by the traditional educational setting. The Handbook is a guide for future circles to follow to maintain the structure and intentions of Circling while also acknowledging the cultures from which the practice evolved.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: The Impact of Medical Diagnosis on Access to Early Therapy through Part C IDEA – A Scoping Review

Student Presenters: Claire Kelly, SPT; Lacey Manuel, SPT; Dagan Reinks, SPT; Alysa Ross, SPT
Faculty Preceptors: Krystal Madkins, MPH, MSLIS; Jessica Trenkle, PT, DPT, PCS; Kristin Krosschell, PT, DPT, MA, PCS
Institution(s): Feinberg School of Medicine, Northwestern University

Abstract:
Purpose
Children with a known medical diagnosis or with established developmental delay are entitled to therapy services through IDEA Part C, however it is well documented that these services are underutilized across the US. Additionally, each state has varying criteria for automatic enrollment into Early Intervention (EI) using medical diagnoses. To determine the landscape of the current literature regarding impact of medical diagnosis on EI access for children under 12 months of age, we conducted a scoping review with the PICO question: For infants under 12 months, how does diagnosis impact access to EI services through a state's EI program? We hypothesized that medical diagnosis would positively impact access to early therapy services for children under one year of age.

Number of subjects
4 studies

Materials and methods
This scoping review is reported in accordance with PRISMA-ScR. A search string of keywords and database-specific controlled vocabulary related to early intervention, pediatrics, and disabilities was performed on MEDLINE, Embase, Cochrane Library, Scopus, CINAHL, and PEDro on May 1, 2024, and included studies published in English, performed in the US, from 1986-present. Results were exported to Endnote for deduplication and unique records were uploaded into Covidence for blinded independent screening by two reviewers using pre-determined inclusion and exclusion criteria. Disagreements were resolved by team discussion. Final studies included children referred to EI at 12 months of age or younger and identified their medical diagnosis. Customized tables were developed to extract data from articles that passed screening. Blinded extraction was done by two team members and reviewed by the full team. Qualitative data synthesis was performed using study characteristics, participant demographics, access to EI, services received, and outcomes.

Results
After establishing reliability (κ>0.90) 6581 abstracts were screened, 142 underwent full text review. The final review included 4 retrospective cohort studies. All final studies included data regarding impact of diagnosis on access to EI for those under 1 year of age. These studies focused on the impact of medical diagnosis on EI access for children under 12

months of age. There was varying evidence that medical diagnosis positively impacts access to early therapy services, however all studies were of low-level evidence.

Conclusions
Prior to 1 year of age there is limited evidence on the impact of diagnosis on access to EI. Further studies are warranted. Significant gaps remain in the literature regarding impact of medical diagnoses on access despite the fact that each state has auto-eligible diagnoses for these services.

Clinical relevance
Having a known medical diagnosis in the first year of life theoretically should expedite access to EI, however current research does not yet support that. Additional studies looking at timeliness of EI initiation and reason for referral should be explored. Qualifications for EI auto-eligibility by state is varied and research is needed to identify a robust list of medical diagnoses that qualify children for neuroprotective care.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Research Report
Title: Using Computer Vision to Compare Spontaneous Movement in Infants with Typical and Atypical Development

Student Presenters: Sarah Gould,SPT; Ashley Jung,SPT; Grace Savino,SPT; Ashley Thompson, SPT
Faculty Preceptors: Weiyang Deng,PT, PhD; Rachel Anderson, BS; Arun Jayaraman, PT, PhD
Institution(s): Department of Physical Therapy and Human Movement Science, Feinberg School of Medicine, Shirley Ryan Ability Lab

Abstract:
Purpose
To evaluate the feasibility of using computer vision to identify differences in spontaneous movements between infants with typical and atypical development at two weeks corrected age. We hypothesize there is significant difference in linear variability (standard deviation) and nonlinear variability (sample entropy) in shoulder abduction and hip abduction joint angles when comparing the two groups at two weeks corrected age.

Methods
Sixteen infants (8 male, 8 female) at two weeks corrected age who are at risk of neuromotor delay were recruited to participate in the study. We marked 20 selected keypoints on 100 randomized frames for each 1-minute-long video using DEEPLABCUT. Data was processed via interpolation (5 points) and smoothing (window = 3). The Shapiro-Wilk test was used to test data normality and the Wilcoxon/T-tests were used to compare standard deviation/sample entropy of shoulder abduction/ hip abduction joint angles between the two groups.

Results
Right shoulder abduction demonstrated significantly higher sample entropy in typically developing infants vs. atypically developing infants ($p=0.010$). There was a significant increase in linear variability in typically developing infants in left shoulder abduction ($p=0.007$) and right shoulder abduction (0.017). There was no significant difference between sample entropy of typically and atypically developing infants with left or right hip abduction angle or left shoulder abduction angle. There was no significant difference between linear variability of typically and atypically developing infants with left or right hip abduction angle.

Conclusions
Computer vision is a feasible tool in measuring infant spontaneous movements in supine position during early infancy. It has the potential to detect infants with or at risk of developmental disabilities at two weeks corrected age.

Clinical relevance
Early detection of atypical movement patterns in infants can facilitate early intervention which has been linked to improved developmental outcomes.

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Synthesis Category: Research Report
Title: Validity of the Observed Selective Control AppRaisal (OSCAR) for Children with Cerebral Palsy in the Upper Extremity (UE)

Student Presenters: Miranda Yount, SPT; Micayla Miller,SPT; Julia Nolde,SPT;Kyle Berg,SPT; Arianna Stadler,SPT; Michelle Liao, SPT
Faculty Preceptors: Colleen Peyton, DPT, MS; Theresa Sukal-Moulton, PT, DPT, PhD
Institution(s): Northwestern University Feinberg School of Medicine,Departments of Physical Therapy and Human Movement Sciences and Pediatrics

Abstract:
Introduction
Cerebral palsy (CP) is a group of non-progressive disorders affecting movement and posture. Selective motor control (SMC) is commonly impaired in CP due to disrupted neural connections between motor pathways and muscles. This impairment limits the ability to activate individual muscle groups for fine motor tasks. Most existing SMC outcome measures rely on verbal instructions, which exclude individuals who cannot follow directions. Therefore, our team is developing Observed Selective Control AppRaisal (OSCAR), a new measure designed to assess SMC in children with CP of all abilities.

Purpose
This study aims to refine the administration of the OSCAR tool, evaluate validity, and assess inter-rater reliability.

Methods
OSCAR is administered by video recording a participant listening to a 5-minute audio story with standardized common objects (light-up ball, Post-it note, pen) placed on a black fabric board in front of them to encourage movement through manual exploration. Selective arm joint movement is scored from the video as either "yes" or "no". Scoring parameters are outlined in the OSCAR manual. If scored "yes," both the specific joint observed and object used are noted. A total score was determined by summing the number of joint motions where SMC was present. We used a Spearman correlation to evaluate construct validity of OSCAR score with Manual Ability Classification Scale (MACS, which assesses object-handling in children with CP). We used a t-test to assess discriminate validity between participants with and without CP. Each participant's video was scored by two raters to evaluate inter-rater reliability using Intraclass Correlation Coefficient (ICC). A p-value <0.05 was considered significant.

Results
23 participants; 15 with CP (MACS I (6); II (3); III (1); IV (1); and V (4)) and 8 without CP were assessed for SMC in arms using the OSCAR. The ball elicited the most SMC movements in children with CP (20% of total selective movements), though fewer than in children without CP. About 14% and 17% of SMC movements in children with CP were elicited through

interacting with the post-it and pen, respectively. A t-test revealed significant differences between children with and without CP for total arm scores ($p=0.05$) and distal joint movements demonstrated stronger discriminative validity ($p=0.01$), but no correlation was found between MACS and OSCAR total arm scores ($p=0.16$). Inter-rater reliability showed moderate agreement for total arm scores (ICC=0.48, $p=0.07$) and excellent agreement for asymmetry scores (ICC=0.77, $p<0.01$).

Conclusion
The ball was the most effective for eliciting SMC movements with the greatest distinction between children with and without CP. Our study supports the validity of OSCAR for assessing distal joint movements. OSCAR shows promise in validity and reliability but needs refinement. Future considerations include strategies to streamline real-time grading for more practical clinical use.

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Northwestern University Department of Physical Therapy & Human Movement Sciences

Synthesis Day | March 24, 2025

Synthesis Category: Special Interest Report
Title: Value Proposition: Master of Business Administration Education for Physical Therapy Leaders

Student Presenters: Audrey Berner, BS, SPT; Alex Kelly, BS, SPT; Nada Alaraj, BS, SPT
Faculty Preceptors: Emily Becker PT, MS, EdD; Sally Taylor PT, DPT, MBA
Institution(s): Department of Physical Therapy and Human Movement Sciences, Northwestern University, Feinberg School of Medicine, Chicago, Illinois; Shirley Ryan Ability Lab, Chicago, Illinois

Abstract:
Purpose
Business training combines leadership and management skills. Positive patient outcomes and quality of care are impacted by the environment that an effective leader creates[1]. Management focuses on resolving problems in a timely manner and seeking stability[2]. A definition of leadership includes individuals and groups across all levels of an organization that focus collaborative activities on achieving a common goal[3]. Emerging healthcare leaders from a variety of backgrounds are focused on teamwork, improving patient outcomes, and balance autonomy and accountability[4]. Education and training in business and physical therapy clinical principles is essential to future healthcare leaders. This study aims to explore the current integration of business training within physical therapy education and its value from the perspectives of individuals, organizations, patients, and payors for future collaboration.

Description
Participants include licensed physical therapists who have either obtained or are currently enrolled in a Master of Business Administration (MBA), who were recruited through snowball sampling, flyers, and social media. Preliminary interest was assessed through RedCap surveys, and those meeting criteria were invited to participate in 60-minute, one-on-one Zoom interviews. The interviews explored motivations for pursuing an MBA after a DPT and how it enhanced business knowledge for current or future roles. Interview transcripts were then analyzed using thematic coding, revealing five key themes.

Summary of Use
Eight interviews with physical therapists holding both a DPT and MBA revealed five key themes. First, participants gained a transformed understanding of the healthcare business ecosystem, advocating for diverse perspectives and creative approaches in their work. Next, accelerated career advancement allowed transition into new roles and accumulation of responsibilities. Third, participants expanded their professional networks, leveraging their dual expertise to engage more effectively and broaden connections. The fourth theme focused on structured learning of business knowledge, where classroom concepts were applied to real-world projects, fostering an innovative and adaptive mindset. Lastly, participants developed a duality between clinical and business roles,

demonstrating proficiency in cross-functional communication and deeper understanding of both domains. These themes identify the enhanced perspective individuals gain upon completion of DPT and MBA degrees.

Importance to Members

To ensure the viability of healthcare, business acumen may be a beneficial tool for physical therapists. This will facilitate success in healthcare environments in which they work and the care that is provided to the patients they serve. These themes underscore the multifaceted impact of combining DPT and MBA education in professional practice to effectively bridge the gap between clinical and business domains.

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