



**Synthesis Project**  
Class of 2025  
Research Abstracts

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

**M Northwestern Medicine**<sup>®</sup>  
Feinberg School of Medicine

## **Schedule of Events**

### **DPT Student Poster Presentations**

1:30-3 p.m. | Simpson Querrey Atrium

### **Keynote Presentation with Richard Souza, PT, PhD**

3-4 p.m. | Hughes Auditorium

### **Reception**

4-5 p.m. | Simpson Querrey Atrium

## **Advanced Imaging Approaches for Evaluating Patellofemoral Joint Biomechanics**



**Richard Souza, PhD, PT**, is the Vice Chair for Research in the Department of Physical Therapy and Rehabilitation Science at the University of California, San Francisco (UCSF). He is a physical therapist and biomechanics researcher with joint appointments in Radiology and Biomedical Imaging, and Orthopaedic Surgery at UCSF. He teaches courses on Radiology for the Physical Therapist, Gait Evaluation, and Observational Running Analysis in the UCSF/ SFSU Graduate Program in Physical Therapy. His research interests are focused on the relationships between mechanics of human movement and lower extremity injuries. Much of his research combines advanced quantitative MR imaging and the evaluation of physical activity and loading behaviors. The goal of these studies is to determine the influence of loading mechanics on hip, knee, and ankle health and to develop preventative and rehabilitative strategies for debilitating diseases such as osteoarthritis. These research projects are primarily funded by the National Institutes of Health. Dr. Souza is also the Program Director for the PhD program in Rehabilitation Science.

## **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.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Ultrasound Evaluation of Acromio-Humeral Distance: Reliability in Young, Healthy Participants

**Student Presenters:** Lance Grunert, SPT<sup>1</sup>, Eleni Papastratakos, SPT<sup>1</sup>, Nate Rusk, SPT<sup>1</sup>

**Faculty Preceptors:** Christa Nelson, PT, DPT, PhD<sup>1</sup>, Ana Maria Acosta, PhD<sup>1</sup>

**Institution(s):** <sup>1</sup>Department of Physical Therapy and Human Movement Science, Feinberg School of Medicine

**Abstract:**

Purpose:

Shoulder subluxation is a common presentation in chronic stroke, with incidence from 17%-84%.<sup>1</sup> Subluxation is correlated to pain, decreased ROM, decreased reaching ability, and motor recovery.<sup>1,2,3,4,7</sup> Clinically, shoulder subluxation is measured through finger breadth palpation or tape measurements,<sup>1,3,4,8</sup> but these assessments lack precision and reliability. Subluxation is also commonly assessed through radiographs, MRI, or CT scans.<sup>1,4</sup> Ultrasound (US) is readily available in the clinic and can evaluate the degree of shoulder subluxation without harmful radiation.<sup>3</sup> Two measures have been validated to evaluate subluxation<sup>2,4,5,6,7,8</sup>: the distance between the inferior aspect of the acromion and the superior aspect of the humerus (AHD), and the distance between the acromion and greater tuberosity of the humerus (AGT). Because US provides a 2D interpretation of 3D structures in the body, the orientation of the probe may impact measurements. The purpose of this study is: (1) to evaluate intra and inter-rater reliability of US to measure AHD and AGT distance, and (2) to recommend a best measure for future subluxation measurements in stroke.

Materials and Methods:

We recruited 13 individuals with no prior shoulder pathology (n=13; 7 female; age=24.5±2.30). US (Aixplorer Multiwave) was used to measure AHD and AGT distance while a motion capture system (Metria) was used simultaneously to measure probe and bone position and orientation. Participants were seated on a stool with their forearms resting on a pillow on their lap. Motion capture markers were secured to the scapula, trunk, humerus, and the probe. Bony landmarks in relation to these markers were digitized to register bone and probe movement. The measurements were repeated three times on each limb by two investigators assigned randomly for 24 total images. Images were imported to Fiji ImageJ software and measurements were conducted by two randomly assigned raters. Inter-rater reliability of US measurements for AHD and AGT were assessed using ICCs (ICC 1,2) with 95% confidence intervals.

Results:

Results for AHD measurements demonstrate excellent single rater reliability with an ICC(95% CI)=0.957(0.940-0.970) and excellent mean rater reliability with an ICC(95% CI)=0.978(0.969-0.985). Results for AGT measurement demonstrated excellent single rater reliability with ICC(95% CI)=0.975(0.964-0.982) and excellent mean rater reliability with an ICC(95%

CI)=0.987(0.981-0.991). Intra-rater reliability for AHD was excellent with test-retest reliability ICC(95% CI)=0.903(0.87-0.929), and good for AGT ICC(95% CI)=0.855(0.808-0.893).

#### Conclusion:

Overall, US proved to be a repeatable, reliable, and accurate method to evaluate acromio-humeral distance with excellent intra and inter-rater reliability. The results from this study show the potential of the method to evaluate shoulder subluxation in the stroke population.

#### Clinical Relevance:

Three novice ultrasonographers were able to assess these measurements accurately with excellent intra and inter-rater reliability, showing that ultrasound can be an effective clinical tool to evaluate subluxation and other shoulder pathologies.

#### **References:**

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Preliminary Results Quantifying Finger Dexterity in Individuals with Early-Onset Hemiparetic Cerebral Palsy

**Student Presenters:** Rachel Elder, BS, SPT

**Faculty Preceptors:** Julius Dewald, PT, PhD; Jun Yao, PhD

**Institution(s):** Department of Biomedical Engineering, Northwestern University, Evanston IL  
Department of Physical Therapy & Human Movement Sciences

**Abstract:**

Purpose:

The contralateral corticospinal tract (CST) has been studied as the main contributor to distal hand control. In early-onset hemiparetic cerebral palsy (HCP) normal brain development of the CST is interrupted causing motor deficits primarily in distal joints like the wrist and fingers and minimal expression of limb synergies<sup>1,2</sup>. Most clinical assessments impose a ceiling effect on individuals with mild functional impairment, however, research shows that even mildly impaired individuals with HCP experience weakness and reduced dexterity in the paretic hand<sup>3</sup>. Most studies of those with HCP do not include adults, yet many individuals experience deterioration in motor performance approaching adulthood<sup>4</sup>. Movement frequency has been shown to affect the mechanisms of fine finger control, but the independence of movement as a function of movement frequency has not been explored<sup>5</sup>. This study aims to develop a high-resolution method to quantify high-end hand and finger dexterity as a function of movement frequency. We hypothesize that individuals of all ages with early-onset HCP will have decreased maximum finger movement frequency and greater finger coupling in their paretic hand compared to the non-paretic hand correlating with motor impairment severity.

Methods:

Motor impairment was assessed with the Fugl-Meyer Motor Assessment (FMA). Participants were seated with the hand positioned to hold a cylindrical pressure mat to record grasp forces and fingers were instrumented with electromagnetic motion capture sensors attached to the fingernails and the dorsum of the hand to remove wrist motion. Surface EMG sensors were attached to muscles of the forearm to assess fatigue. Participants were cued to tap with all their fingers together and each finger individually along with a CHIRP signal of increasing frequency from 0.5 Hz to 8 Hz. For each tap, time since the last tap is calculated, and a coupling index (CI) is calculated using the formula  $CI = 1 - \frac{\text{displacement cued}}{\text{displacement total}}$  where a CI of 0.5 indicates that 50% of the total recorded finger movements are attributed to the non-cued fingers. A sigmoid function is fit to the curve of actual tapping frequency vs. cued frequency to find where individuals are no longer able to follow the cue.

Conclusions:

Data was collected from 4 individuals with HCP with ages ranging from 13-40 and FMA scores 59-66/66. As cued frequency increased, individuals were no longer able to synchronize with the

CHIRP signal and EMG analysis showed no clear signs of muscle fatigue. Individuals with HCP showed decreased change frequency and maximum tapping frequency in the paretic vs. the non-paretic hand that is correlated with FMA scores. Individuals with HCP showed reduced finger dexterity in the paretic hand vs. the non-paretic hand at lower frequencies via increased CI scores and increased CI variability. Preliminary results support this method to gather a high-end measure of dexterity that may not have a ceiling effect and is sensitive to current measures of hand impairment. More research is needed to understand how these results compare to metrics for functional use of the paretic hand in the real world.

#### References:

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** New insights into atypical corticospinal tract microstructure and hand impairments in children with early-onset hemiparetic cerebral palsy

**Student Presenters:** Alexandra Hruby (1,2)

**Faculty Preceptors:** Divya Joshi (1,2), Julius PA Dewald (1,2,3), Carson Ingo (2,4)

**Institution(s):** 1) Department of Biomedical Engineering, Northwestern University, Evanston, IL; 2) Department of Physical Therapy & Human Movement Sciences; 3) Department of Physical Medicine & Rehabilitation; 4) Department of Neurology, Northwestern University Feinberg School of Medicine, Chicago, IL

**Abstract:**

Unilateral brain injuries in early childhood can result in hemiplegic cerebral palsy (HCP), characterized by deficits such as weakness in the hand [1,2] and loss of independent motor control between hands, known as mirroring [3,4]. Since previous studies in HCP have not focused on quantitative measurement of these hand impairments, the objective of this diffusion MRI (dMRI) study is to investigate the relationships between atypical development in each hemisphere and quantitative measures of hand impairment severities of weakness and mirroring. Structural scans were acquired and used to identify anatomical regions of interest (ROIs) using a standardized atlas [5-7]. Five cortical areas with typical or potential corticospinal tract (CST) connectivity—precentral gyrus, postcentral gyrus, superior frontal gyrus, middle frontal gyrus, and superior parietal gyrus—were masked with the CST to determine the overlap volume, which was then normalized by the total volume of the CST. dMRI data were acquired and pre-processed as previously described to estimate diffusion metrics (FA, MD, RD, AD) [8,9]. Anatomical landmarks were used to guide probabilistic tractography of the CST to calculate the mean and standard deviation of diffusivity metrics. Hand grip strength and mirroring were measured using simultaneous recording of two handheld digital dynamometers in the unaffected and affected hands [10]. Spearman correlation analyses were performed between diffusivity metrics and hand impairment measures with age and sex as covariates. A Mann-Whitney U test was performed to determine if there was a significant difference in tract termination ratios between participants with HCP and controls. Statistical significance was set at  $p < 0.05$ . Results include 15 children with early-onset HCP (7M,  $13.8 \pm 6.0y$ ) and 13 controls (5M,  $14.4 \pm 6.3y$ ). For participants with early-onset HCP, there was a significant positive correlation between MD in the ipsilesional CST and grasp weakness severity ( $\rho = 0.63$ ,  $p = 0.021$ ) and a significant positive correlation between RD in the ipsilesional CST and grasp weakness severity ( $\rho = 0.68$ ,  $p = 0.0112$ ). There was also a significant negative correlation between FA in the contralesional CST and hand mirroring severity ( $\rho = -0.67$ ,  $p = 0.013$ ) that was primarily driven by a positive trend between RD in the contralesional CST and hand mirroring severity ( $\rho = 0.49$ ,  $p = 0.088$ ). In the non-lesioned hemisphere, there was a significant decreased density of tract termination in the precentral gyrus for HCP participants in comparison to controls ( $p = 0.044$ ). Conversely, there was an increased density of tract termination in the non-lesioned superior parietal gyrus for HCP participants in comparison to controls ( $p = 0.039$ ). Here, we show that in individuals with early-

onset HCP there is a significant relationship between supraspinal neural microstructure and impairments in normal hand function. HCP presents with unilateral motor deficits; however, these results show an injury early in development can have detrimental effects on the non-lesioned hemisphere, specifically the motor pathways and association areas, and involvement of the unaffected hand.

#### References:

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Is prior lower extremity injury associated with the presence or development of hip pain in adults? A systematic review

**Student Presenters:** Amanda Acosta, SPT; Urte Barauskas, SPT; Caroline Case, SPT; Grace Chaw, SPT; Chris Grecco, SPT; Whitney Pascoe, SPT; Joseph Sewall, SPT

**Faculty Preceptors:** Christa M. Nelson, PT, DPT, PhD ; Craig P. Hensley, PT, DPT, MSCI; Alison H. Chang, PT, DPT, MS

**Institution(s):** Northwestern University

**Abstract:**

Purpose:

Hip pain is a common musculoskeletal complaint that may be caused by a range of factors. Impairments in other lower extremity sites, including the knee, ankle/foot, or contralateral hip, may potentially contribute to hip symptoms, due to compensatory lower limb biomechanics or overuse during activity. This systematic review aims to summarize evidence on the association between prior history of lower extremity injury and subsequent hip pain.

Materials and methods:

Databases searched were MEDLINE, Cochrane Library, EMBASE, CINAHL, and PsycINFO. Study designs included randomized control trials and case control, cross-sectional, and cohort studies. Participants were required to be  $\geq 18$  years old and have non-traumatic hip pain. Ten reviewers applied inclusion/exclusion criteria for screening, full-text review, and study selection using Covidence software. Paired investigators independently screened each title and abstract for full-text review. Paired reviewers then independently assessed relevant full-text articles to determine eligibility for final data extraction. In articles where relevant data were lacking, the primary authors were contacted to obtain information for inclusion in the analysis.

Results:

Among 193 abstracts screened, 62 full-text articles were assessed. From these 62 articles, 3 were included in the final synthesis, while 6 were found to lack relevant data after data extraction. Cooper et al. found that previous hip injury was associated with an increased risk of bilateral hip osteoarthritis (OA). Tveit et al. found that adding the presence of a soft tissue knee injury in the regression model did not change the odds ratio for hip OA, suggesting that it did not play a significant role in hip OA development. Calculated odds ratios using the raw data provided by Dobscha et al. suggested a statistically significant association of 1) prior ankle/foot injury and knee injury (OR: 2.28, 95% CI [1.30-3.99]), and 2) isolated prior knee injury (OR: 1.84, 95% CI [1.15-2.96]) with current hip pain. While not reaching statistical significance, isolated ankle/foot injury was positively associated with current hip pain (OR: 1.45, 95% CI [0.93-2.27]).

### Conclusion:

The current body of literature offers limited insight into the relationship between hip pain and prior lower extremity injury. We noted significant variations in study designs, study samples, data collected, and findings. Among the three studies examined, two suggested a relationship. However, these studies did not examine the same type of injuries – one focused on foot/ankle and knee injuries, while the other investigated hip injuries. Further research is warranted, as none of the three studies directly investigated the research question posed by this review.

### Clinical Relevance:

Although current research is limited, our findings suggest that clinicians may consider lower extremity injury as a potential risk factor for hip pain. Clinicians should investigate prior lower extremity injuries in tandem with current best practices when evaluating patients with hip pathology.

### **References:**

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Investigation of Lower Extremity Sensor Data in Predicting Atypical Neuromotor Development in Infants

**Student Presenters:** Jack Crowley, SPT; Dina Flores, SPT; Helen Laboe, SPT; Sydney Morehouse, SPT; Eva Stees, SPT; Ruiming Wang, SPT

**Faculty Preceptors:** Imani Mann; Megan K. O'Brien; Arjun Jayaraman

**Institution(s):** Feinberg School of Medicine, Northwestern University  
Technology & Innovation Hub, Shirley Ryan AbilityLab

**Abstract:**

Purpose/hypothesis:

Neuromotor disorders in pediatric populations are often not identified until 1-2 years of age or older, such as after a child demonstrates delays in their developmental milestones.<sup>1</sup> This leads to delayed diagnosis and missed opportunities for early interventions and treatments. Early intervention has been shown to improve outcomes in these children, likely due to the higher levels of neuroplasticity at a young age.<sup>2</sup> Thus, it is critical to detect atypical movement patterns and neuromotor disorders as early as possible, ideally within the first year. The purpose of this study was to determine the efficacy of lower extremity sensor data to quantify atypical neuromotor development in infants. Our hypothesis was that infants with lower amounts of motion (AOM) at their ankles and hips would show more atypicality based on clinical scores.

Subjects:

107 infants across the risk spectrum for atypical neuromotor development at 3, 6, 9, and 12-months corrected age were included for analysis. Infants who exhibited atypical development had various clinical diagnoses, such as Cerebral Palsy. The dataset was a subset from a larger clinical study ("Project Corbett Ryan").

Materials/methods:

The infants wore movement sensors<sup>3</sup> on their lower extremities at the hip and ankle during ventral suspension. Movements were recorded for brief time periods ranging from 10 seconds to 2 minutes. Clinical scores and videos were also recorded, and infant behaviors were annotated from the videos to separate movements that occurred during different behaviors (e.g., content without stimulation, content with stimulation, fussy). AOM was computed from the sensor data<sup>4</sup> and evaluated for its relationship with clinical scores using Spearman's Rank Correlation Coefficient, after testing for normality.

Results:

There were no significant correlations between AOM and any clinical score at 3 and 12 months of corrected age. Significant correlations were found between both hip and ankle AOM and the Alberta Infant Motor Scale (AIMS) at both 6 months (hip:  $\rho = 0.326$ , ankle:  $\rho = 0.319$ ,  $p$ 's < 0.03)

and 9 months (hip:  $p = 0.624$ , ankle:  $p = 0.570$ ,  $p$ 's  $< 0.001$ ), where more leg motion was associated with higher scores.

#### Conclusions:

Motion of the lower extremities may be a partial indicator of atypical motor development, such as acquisition of gross motor skills. These results corroborate existing research that the AIMS is valid and reliable for quantifying atypical neuromotor development.<sup>5</sup> Other sensor metrics should be considered to further evaluate the efficacy of these data to measure neuromotor development.

#### Clinical relevance:

Sensor data may be helpful for early detection of neuromotor disorders, specifically in the pediatric populations. Earlier detection could allow earlier interventions and enhance further outcomes, since the higher neuroplasticity available for these children would help them to form new connections than at later ages.<sup>6</sup>

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** DPT Education for Interrupting Microaggressions Using the VITALS Framework

**Student Presenters:** Kaylee Becker, SPT; Hannah Gould, SPT; Gabriella Martinez, SPT; Ian Ridgeway, SPT

**Faculty Preceptors:** Elizabeth Holland, PT, DPT; Tobey DeMott Yeates, PT, DPT; Cori Arquines, PT, MHPE

**Institution(s):** Northwestern University, Department of Physical Therapy & Human Movement Sciences

**Abstract:**

Purpose:

Microaggressions (MA) are "...verbal, behavioral, or environmental indignities, whether intentional or unintentional, that communicate hostile, derogatory, or negative ... slights and insults..."<sup>1</sup> Health professions students experience MA, which have detrimental effects on their physical, emotional, and mental well-being, further influencing their ability to learn and provide quality patient care.<sup>2-4</sup> Medical educators use educational frameworks to train learners about MA<sup>2,5</sup>; however, no research to date investigates their use in Doctor of Physical Therapy (DPT) education. The purpose of this study was to examine DPT students' response to an educational intervention framework focused on identifying and disrupting MA in clinical settings.

Methods:

In this study, first-year DPT students in a Psychosocial Aspects of Human Behavior I course participated in a two-hour education session regarding MA using an adapted version of the VITALS framework.<sup>5</sup> The session included didactic content, role-play scenarios, and group discussions.

Study design:

Data was gathered using a pre/post survey that assessed participants' knowledge of MA and their beliefs and confidence in addressing MA using a 6-point Likert scale (strongly disagree to strongly agree).

Data Analysis:

Survey responses were summarized descriptively [mean (SD)]. A Wilcoxon signed-rank test was used to analyze participants' responses pre- and post-education sessions. SPSS (version 28.0) was used for statistical analyses.

Results:

Participants' (n=95) agreement with the following statements achieved statistically significant increases ( $p < 0.05$ ) after the education session: "I can define a microaggression," "I can recognize a microaggression in real-time," "I feel confident in addressing a microaggression as a recipient in an educational or health care setting," "I feel confident in addressing a

microaggression as a bystander in an educational or health care setting,” and “I would be open to feedback if someone approached me about a microaggression I committed.” There was a statistically significant increase in the overall rating following the intervention. The statement regarding participants’ feelings towards learning about MA as part of their physical therapy education did not achieve a statistically significant increase following the education session.

#### Limitations:

The variation in small group discussions and learner engagement may have impacted participant survey responses. The self-report survey and positive regard for peers as presenters may also introduce bias, affect data, and challenge external validity.

#### Conclusions and Clinical Relevance:

This adaptation of VITALS framework increased participants’ confidence in defining and addressing MA and improved their openness to feedback in a clinical setting. This education session equips DPT students with skills to identify and interrupt MA. Continued research is needed to determine how educational sessions on MA correlate with behavior in the clinical environment.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Matching Patients with the Right Cancer Rehabilitation Service – Implementation of Novel Best Practice

**Student Presenters:** Catherine Duffy

**Faculty Preceptors:** Dr. Ann Marie Flores

**Institution(s):** Department of Physical Therapy and Human Movement; Department of Otolaryngology Northwestern University; Robert H. Lurie Comprehensive Cancer Center at Northwestern University; Department of Medical Social Sciences

**Abstract:**

Purpose:

The purposes of the Northwestern University IMPACT (NU) Diversity Supplement are to (1) connect Patient Reported Outcome Measurement Information – Physical Function (PROMIS-PF) scores to the 4Rs Cancer Rehabilitation Triage System (4Rs) ; (2) evaluate the 4Rs pre-implementation process; (3) conduct stakeholder focus groups to gain information about implementation, adaptation and sustainability of 4Rs. Stakeholders include clinicians, administrators, and patients representing each NMHC clinic targeted.

Methods:

4Rs pilot testing in the North and West regions is complete. Implementation workflows of 4Rs differed between the North and West regions leading to different experiences with the 4Rs system. In the North, medical assistants asked the 4Rs triage questions for all patients during the rooming process. In the West, patients with PROMIS-PF alerts with scores < 40 (indicating moderate/severe impairment) were asked the 4Rs triage questions by nurses using a best practice alert that queues up a referral SmartSet for cancer rehabilitation specialty(ies). A focus group for each region has been conducted. Our stakeholders interviewed include medical assistants, administrators, medical oncologist, and nurses. We use the Consolidated Framework for Implementation Research (CFIR, ver. 1.0) to map the focus groups' feedback to domains about the outer setting, inner setting, and characteristics of the intervention and individuals

Results:

Both the North and West positively regarded the implementation of the 4Rs system and commented on the majority of CFIR domains. Both groups agreed that 4Rs is easy to use, fits well into the current culture and process of each clinic, should be used as standard care, appropriately matches patients to cancer rehabilitation specialists, contributes to better care, adds appeal for NMHC services, and increases the number of physical, occupational, and speech therapy referrals for patients with cancer.

Conclusions & Future Steps:

The 4Rs system appears to be an effective and desired method to fill the unmet need for care by appropriate rehabilitation services specialty. 4Rs is endorsed by clinicians for use in the clinic with important adaptations to accommodate clinic cultures and workflows. Next steps will include submission for R01-level funding from the NIH.

Clinical Implications:

4Rs provides effective triaging and seamless referral processes 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 25, 2024

**Synthesis Category:** Research Report

**Title:** Assessing the Validity of Shoulder Rotational Strength with Handheld Dynamometry

**Student Presenters:** Macy Bittner, SPT; Zachary Griffith, MS, SPT

**Faculty Preceptors:** Ameer Seitz, PT, DPT, PhD; Ahalya Mandana

**Institution(s):** Northwestern University Physical Therapy

**Abstract:**

Background:

The shoulder injury is highly prevalent in individuals who participate in high demand upper extremity activities. The rotator cuff provides dynamic control of the shoulder and is implicated in shoulder injury. Shoulder external (ER) and internal rotation (IR) strength assessment with a hand-held dynamometer (HHD) is used to assess rotator cuff strength to monitor progress in injury prevention programs, shoulder rehabilitation, and determine readiness for activity participation. Despite its growing utility, shoulder injury and reinjury rates persist. The validity of ER-IR strength assessment with a HHD relies on the clinician's ability to detect and limit compensations impacting the 1-dimensional (1D) measurement of force. Yet, how much compensation in force direction persists is currently unknown. Thus, the purpose of this pilot was to evaluate the extent of compensations in force direction and its' impact on strength results when using a HHD.

Methods:

Individuals without shoulder injury or pain were recruited. Shoulder strength was assessed as peak isometric joint torque (Nm) using 2 methods: a 1D HHD and a 3-dimensional (3D) load cell. Peak strength was assessed with a 6-second make test in IR, ER, and abduction at 90-degree abduction. The examiner instructed and cued each participant prior to testing in the desired force direction to minimize compensations using a submaximal trial with both assessment 1D and 3D methods. A 30-second rest was provided between trials to minimize fatigue. Peak force (n) was recorded and converted to joint torque (nm). Additionally, shoulder ER to IR (ER:IR) strength ratio was calculated as previously used in injury prediction. The peak torque magnitude produced with abduction, IR, ER, and ER:IR ratio using the 3D load cell was compared to values generated with HHD. Compensations in torque production in other planes was also assessed. During strength assessments, electromyography (EMG) was also collected from 12 shoulder muscles to assess rotator cuff activity relative to other primary and compensatory muscles.

Results:

The EMG activation of the rotator cuff and primary movers did not differ between strength testing methods (1D vs 3D). Thus the 2 strength assessment methods yielded similar muscle contributions. The torque data showed off axis torque generation consistent with compensation in both ER and IR. Torque using the HHD was greater than the 3D load cell in both ER (26.4 vs

23.1 Nm) and IR (29.7 vs 22.0 Nm). This higher value is influenced by compensations in abduction (30.1 Nm) and adduction (37.3 Nm) that are 30% and 70% greater than the intended direction, respectively.

#### Conclusions:

Adequate shoulder rotational strength is an essential component used in clinical decision making when evaluating individuals at risk for shoulder injury or determining safe return to high demand activities. Understanding the limitations to interpretation of rotational strength assessment with HHD due compensations in torque direction and muscles activated is essential. These pilot data justifies further study of the validity of HHD.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** The Impact of Oxygen Tubing Length and Connections on the Flow Rate Delivered

**Student Presenters:** Henna Di, SPT, Jack Scodius, ATC, SPT, Pete Theiler, 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:

Supplemental oxygen (O<sub>2</sub>) delivery is a common treatment method used for patients experiencing hypoxemia to assist with improved functional performance.<sup>1</sup> While PTs cannot prescribe O<sub>2</sub> delivery settings, they and other healthcare providers are often tasked with the administrative, regulating, and educating responsibilities. Currently, there are no national guidelines that consider the effect of airflow resistance on O<sub>2</sub> delivery with increasing lengths of supplemental O<sub>2</sub> tubing. Per Poiseuille's Law, it is known that volumetric laminar flow rate is influenced by the pressure difference between both ends of piping, length, dynamic viscosity, and cross-sectional area.<sup>2</sup> With multiple O<sub>2</sub> supplemental tubing lengths connected, it is anticipated the changes in tube length to create more resistance on the laminar flow of O<sub>2</sub>.

Aim:

Evaluate the effect of extending O<sub>2</sub> tubing on O<sub>2</sub> flow rate. Quantify oxygen flow rate of multiple clinically relevant oxygen delivery arrangements.

Methods:

A Douglas bag with a determined volume of 178L was connected to a 7-foot nasal cannula caulked to a rubber stopper – creating a closed delivery system. O<sub>2</sub> extension tubing was measured, and hand cut at 50 feet each to simulate a clinic environment where a provider may make this adjustment to increase the length of tubing for mobilizing the patient. The tubes were attached with standardized plastic connectors to increase the length of tubing to 57 feet (2 connections) and 107 feet (3 connections). Flow rates were set on the regulator at 2 L/min, 4 L/min, and 6 L/min to compare the difference of flow rate received by the Douglas bag to what was set on the regulator. The flow rate of 15 L/min was tested with standardized 7 ft extension tubing connections at 7 feet (0 connections), 14 feet (1 connection), and 21 feet (2 connections). Then standardized 25 feet tubing was compared to 25 feet tubing with 3 non-standardized connections (7 feet + 7 feet + 7 feet + 4 feet). A calculation of time expected to fill the 178L volume was compared to the actual time measured by researcher vision and judgement.

Results:

Using 1-2 standardized tubing connections at all lengths and flow rates resulted in a less than 5% error in average actual time to fill compared to expected. Using 1 to 3 non-standardized

tubing connections to increase tubing length from 7ft to 25ft at 15 L/min also resulted in a less than 4% error in average actual time to fill.

Conclusion:

Minimizing the use of extension tubing with both standardized and non-standardized O<sub>2</sub> tubing connectors may provide the most accurate flow rate compared to what is set on the O<sub>2</sub> tank regulator. If using one non-standardized extension tubing connector at lower flow rates used in home health, there is no significant difference in the average adjusted flow rate or actual time. At a higher flow rate in a hospital setting (15 L/min), increasing the tubing length beyond one extension with standardized connections produces a small, but potentially significant increase in average time. There was no increase with one tube directly attached to the Douglas bag.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Assessing Inter-Rater Reliability of Telehealth Versions of the Chedoke McMaster Stroke Assessment (Hand) and Upper Extremity Fugl-Meyer Assessment

**Student Presenters:** Amanda Reeder; Jenna Preslicka; Nicole Coughlin; Bing Zhu

**Faculty Preceptors:** Carolina Carmona; Justin Drogos; Jane Gyarmaty; Jun Yao

**Institution(s):** Department of Physical Therapy and Human Movement Sciences, Feinberg School of Medicine, Northwestern University

**Abstract:**

Background/Purpose:

Nearly 80% of individuals post-stroke have remaining upper extremity (UE) impairments.<sup>1</sup> Telerehabilitation services have increased in recent years,<sup>2</sup> yet there are few validated outcome measures (OMs) developed for UE assessment in telehealth.<sup>3</sup> These are important tools to assess arm function and recovery of individuals with stroke. Previous studies evaluated the validity of the telehealth versions of the Upper Extremity Fugl-Meyer Assessment (tUEFMA)<sup>3</sup> and Chedoke McMaster Stroke Assessment (Hand) (tCMSA\_H),<sup>4</sup> but other psychometric properties still need to be established. The aim of this study is to assess the inter-rater reliability of the tUEFMA and tCMSA\_H during remote assessment.

Methods:

Eleven individuals (8M, 3F; mean age 61y) with moderate severe arm/hand impairment (mean UEFMA =23/66) and chronic stroke (>6 months post) participated in three assessment sessions: one in person session using original versions of the UEFMA and CMSA\_H, and two remote sessions (via Zoom) led by two different clinicians using the tUEFMA and tCMSA\_H (mean time between remote assessments 4 days). Intraclass correlation (ICC) was used to evaluate inter-rater reliability (absolute agreement) between scores of the tUEFMA and tCMSA\_H obtained by 2 different clinicians during the remote sessions.

Results:

Good and significant agreements were found between total scores of the tUEFMA (ICC = 0.76,  $P < 0.05$ ) and of tCMSA\_H (ICC = 0.86,  $P < 0.05$ ).

Discussion and Conclusions:

This pilot study suggests the tUEFMA and tCMSA\_H are promising tools to remotely examine moderate-severe UE impairment in individuals with chronic stroke. Study findings support a good agreement between two evaluators using the tUEFMA and tCMSA\_H. Further research and validation are needed with a larger sample population, more diverse levels of impairment, and more evaluators.

Limitations:

Current limitations that may impact the accuracy of this study include a small sample size, variability in patient set-up of camera that may have obstructed view of the entire UE, variability of patient technology literacy, and no standardization of patient device used. Additionally, no participants with mild UE impairment were included, limiting the generalizability of our results.

**References:**

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Continuing education amongst Illinois Early Intervention providers: Facilitators, barriers and opportunities

**Student Presenters:** Elizabeth Bensussen, SPT; Emily Goudzwaard, SPT; Kiley Stephen, SPT

**Faculty Preceptors:** Jessica Trenkle, PT, DPT, PCS; Kristin J Krosschell, PT, DPT, PCS

**Institution(s):** This study was funded by the Northwestern Feinberg School of Medicine Department of PT and Human Movement Sciences.

**Abstract:**

Purpose:

The Illinois (IL) Early Intervention (EI) program provides critical early therapy services, including physical therapy (PT), to children with or at-risk of developmental disabilities from 0-3 years. EI has benefits in improved cognitive and motor performance plus long-term savings in social services.

EI physical therapists (PTs) target acquisition of gross-motor skills. As research into EI is continually updated, EI PTs need educational resources to maintain competency and best serve clients, who are frequently in a stage of critical neuroplastic potential.

To understand how EI PTs stay up to date with best practice models and how the EI Training Program (EITP) can support their ongoing learning this study sought to identify where and how IL EI PTs receive continuing education (CE), and what barriers and facilitators they identify to access high quality, evidence-based practice CE.

Number of Subjects:

42

Methods:

This survey study, approved by the Northwestern IRB, collected cross-sectional data from one-time respondents using REDCap. The survey was shared on multiple IL professional PT, EI, and pediatric PT websites. Additionally, emails were sent to individual providers, clinics, and individual Child and Family Connections offices (CFCs). SPSS was used to assess correlations between variables, groups and demographics using descriptive and non-parametric statistics.

Results:

Illinois EI PTs indicated less confidence that CE approved through EI reflects EBP and is up to date compared to CE approved for PT licensure alone. Ranks for EBP in CE required for licensure were significantly higher than ranks for CE required for EI ( $Z=-3.07$ ,  $p=.002$ ). Across all subjects, the top ways to access CE were through an EITP virtual course (69%), a non-EITP virtual course (52.4%), or a non-EITP in-person course (33.3%). Top barriers identified by respondents were affordability of courses (47.6%), time required to participate in CE (35.7%), and inability to find courses specific to evaluation and treatment of children in EI (28.6%). Facilitators to accessing high-quality EBP were not significantly different between CFCs in the

city versus suburbs, although city-based EI PTs reported increased support of coworkers/facility,  $X^2(2, N=42)=17.16, p<.001$ ). Conclusions: CE approved by EI is reportedly less reflective of EBP than CE approved by IL licensure. Clinicians report barriers to engaging with relevant and affordable CE and require more support and a wider variety of CE choices. EITP should re-evaluate offerings that reflect the evolving landscape of best practice for the evaluation and treatment of complex patient presentations.

#### Clinical Relevance:

IL PTs must have 40 hours of CE per 2-year licensure period. EI PTs must complete 30 hours of EI specific CE every 3 years. These hours are often not interchangeable, requiring additional coursework to maintain both. Gains made through EI can significantly optimize cognitive, social and behavioral outcomes, especially when interventions are appropriately targeted and complex. Therefore, IL EI PTs need access to up-to-date EBP CE for the best interventions and evaluation methods for infants and children.

#### **References:**

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Role of 5-HT<sub>2C</sub> receptors in hyperreflexia post-spinal cord injury in mice

**Student Presenters:** Lauren Carter, SPT; Carolyn Oh, SPT; Manasi Raghavan, SPT

**Faculty Preceptors:** Vicki Tysseling, PT, PhD

**Institution(s):** Department of Physical Therapy & Human Movement Sciences and Department of Neuroscience, Feinberg School of Medicine, Northwestern University, Chicago, IL

**Abstract:**

Purpose:

After spinal cord injury (SCI), people develop involuntary motor behaviors (IMBs) that can inhibit their functional recovery and decrease independence.<sup>1,2</sup> Hyperreflexia, a type of IMB, is initiated by a normally innocuous sensory input that, post-SCI, results in a large multi-joint motor output.<sup>1</sup> This is due to 5-HT<sub>2C</sub> receptors (5-HT<sub>2CR</sub>) on motoneurons undergoing a conformational change and becoming constitutively active.<sup>3</sup> 5-HT<sub>2CR</sub>s facilitate the reactivation of calcium and sodium voltage-gated channels resulting in persistent inward currents (PICs), which contribute to motoneuron hyperexcitability.<sup>4,5</sup> The subsequent physiological presentation is hyperreflexia in individuals post-SCI.<sup>1</sup> In this pilot study, we are investigating the mechanisms of hyperreflexia in transgenic mice post-chronic SCI, that lack 5-HT<sub>2CR</sub>s.

Hypothesis:

Following SCI, we hypothesize hyperreflexia responses will be diminished in 5-HT<sub>2CR</sub> knockout mice when compared to wild type mice.

Subjects:

Adult mice, 5 wild type (WT) and 6 5-HT<sub>2CR</sub> knockouts (KO), were used in this study.

Methods:

SCI: At 10 weeks old, WT and KO mice underwent complete transection injuries to spinal cord at vertebral level T10, corresponding to spinal segments T12 and T13.<sup>6</sup>

Hyperreflexia: Electrical stimulation (e-stim) was delivered through small electrical currents to the plantar side of the hind paw of mice.<sup>7</sup> Semmes-Weinstein monofilaments were applied to the plantar side of the hind paw.<sup>8</sup> For both sensory inputs, EMG responses from the withdrawal reflex were recorded from the lateral gastrocnemius (LG) and tibialis anterior (TA) muscles. Thresholds were determined as the lowest current and force inducing motor activity for e-stim and monofilaments, respectively.

Analysis: Threshold and EMG data were collected and processed in Spike2 software (CED), and data were normalized and analyzed in SPSS (IBM). Mann-Whitney U tests were run to determine significant differences between groups.

Results:

Total EMG signal for TA after electrical stimulation was significantly higher in WT as compared to KO ( $U=4$ ,  $p=0.045$ ). No significant differences were found in the LG EMG signals. The monofilament threshold was smaller for the KO group (0.03 g) than the WT group (0.14 g,  $U=0.5$ ,  $p=0.009$ ).

#### Conclusion/Limitations:

The significant increase in TA EMG signals in WT versus KO mice supports our hypothesis, highlighting the role 5-HT<sub>2</sub>CRs play in modulating the hyper reflexive response post-SCI. We expected lower EMG signal in the TA of KO mice to correlate with higher monofilament threshold due to decreased excitability in KO mice. However, the results indicate a contradiction. We hypothesize that differential circuitry in the electrical stimulation vs. monofilament stimulation may play a role in the opposing results seen.<sup>9</sup> Future studies would test motor neurons in vitro to better understand specific pathology and differential pathway signaling.

#### Clinical Relevance:

Understanding the mechanism of IMBs can lead to pharmacological advances in their treatment and improve functional recovery.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Development of Observed Selective Control Appraisal (OSCAR) for Children with Cerebral Palsy

**Student Presenters:** Amanda Lopez, Melanie Lancaster, Miranda Burkett, Isabella Ford

**Faculty Preceptors:** Theresa Sukal-Moulton, Colleen Peyton

**Institution(s):** Northwestern University Department of Physical Therapy and Human Movement Sciences

**Abstract:**

Purpose:

Selective motor control (SMC) is the ability to isolate joint movements and is crucial for both gross and fine motor tasks in children with cerebral palsy (CP). The loss of SMC indicates a disruption in corticospinal connections to the limbs. Existing outcome measures for SMC require responses to specific commands. However, these measures fall short when evaluating children who are less consistent with following directions. Recognizing this limitation, the purpose of our project is to create an observational outcome measure. The Observed Selective Control Appraisal (OSCAR) can be used with any child diagnosed with CP. Understanding selective motor control through observation not only bridges the accessibility gap but also provides valuable insights into corticospinal health in a non-invasive manner.

Methods:

Our design process started with a discussion with a caregiver to understand a caregiver's viewpoint, ensuring our outcome measure addressed real-world scenarios. Our outcome measure involved a 10-minute story session, comprising 5 minutes of unsupported sitting and 5 minutes at a table/desk. The 5 minutes at a table/desk included standardized toys suitable for children with/without cerebral visual impairments. We incorporated a caregiver-specific task, such as bed mobility, putting on shoes, and putting on a coat, chosen through collaboration with the caregiver. A manual was created to describe data collection directions, scoring, working definitions and independent joint control. The OSCAR scores can range from 0-32 scale with 1 point given for each joint able to be moved independently (9 points per arm, 7 points per leg). To enhance reliability, we utilized video recording from multiple angles for joint movement assessment and multiple team members performed scoring. Subsequently, we assessed four children without a CP diagnosis and one child with CP (GMFCS level V).

Results:

Three independent raters scored each of the participants. The four children without CP scored very high (range of 28-32) on the OSCAR and the one child with CP (GMFCS level V) scored low (range 3-4) on the OSCAR.

Conclusion:

Initial scores between a child with GMFCS level V and children without CP show promise for construct validity, however they need to be tested in a large cohort. It appears to be a feasible outcome measure to determine the best tasks for children to perform to capture independent joint movements. There needs to be additional research conducted to see if OSCAR is feasible for a larger sample and how the scores of the OSCAR are applicable to caregivers/future research. In the future, we hope the OSCAR can help identify the joints that a child with CP can selectively control to utilize this in their functional mobility. For example, putting a switch on the L side of the power wheelchair if the OSCAR arm score is higher on the L to achieve the most success.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** The Effect of Oxygen Tubing Length on Delivery of Supplemental Oxygen

**Student Presenters:** Henna Di, SPT, Jack Scodius, ATC, SPT, Pete Theiler, SPT

**Faculty Preceptors:** Jen 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:

Supplemental oxygen (O<sub>2</sub>) delivery is a common treatment method used for patients experiencing hypoxemia to assist with improved functional performance.<sup>1</sup> While PTs cannot prescribe O<sub>2</sub> delivery settings, they and other healthcare providers are often tasked with the administrative, regulating, and educating responsibilities. Currently, there are no national guidelines that consider the effect of airflow resistance on O<sub>2</sub> delivery with increasing lengths of supplemental O<sub>2</sub> tubing. Per Poiseuille's Law, it is known that volumetric laminar flow rate is influenced by the pressure difference between both ends of piping, length, dynamic viscosity, and cross-sectional area.<sup>2</sup> With multiple O<sub>2</sub> supplemental tubing lengths connected, it is anticipated the changes in tube length to create more resistance on the laminar flow of O<sub>2</sub>.

Aim:

Evaluate the effect of extending O<sub>2</sub> tubing on O<sub>2</sub> flow rate. Quantify oxygen flow rate of multiple clinically relevant oxygen delivery arrangements.

Methods:

A Douglas bag with a determined volume of 178L was connected to a 7-foot nasal cannula caulked to a rubber stopper – creating a closed delivery system. O<sub>2</sub> extension tubing was measured, and hand cut at 50 feet each to simulate a clinic environment where a provider may make this adjustment to increase the length of tubing for mobilizing the patient. The tubes were attached with standardized plastic connectors to increase the length of tubing to 57 feet (2 connections) and 107 feet (3 connections). Flow rates were set on the regulator at 2 L/min, 4 L/min, and 6 L/min to compare the difference of flow rate received by the Douglas bag to what was set on the regulator. The flow rate of 15 L/min was tested with standardized 7 ft extension tubing connections at 7 feet (0 connections), 14 feet (1 connection), and 21 feet (2 connections). Then standardized 25 feet tubing was compared to 25 feet tubing with 3 non-standardized connections (7 feet + 7 feet + 7 feet + 4 feet). A calculation of time expected to fill the 178L volume was compared to the actual time measured by researcher vision and judgement.

Results:

Using 1-2 standardized tubing connections at all lengths and flow rates resulted in a less than 5% error in average actual time to fill compared to expected. Using 1 to 3 non-standardized

tubing connections to increase tubing length from 7ft to 25ft at 15 L/min also resulted in a less than 4% error in average actual time to fill.

Conclusion:

Results show that connecting nasal canula tubing via standardized connections and non-standardized connections (cutting custom lengths, plastic tubes, and taping) does not appear to change flowrate regardless of the length. This serves as a proof of concept that patients are likely to receive the correct flowrate even if utilizing longer tubes. However, further research should be done to establish a statistically robust relationship between tubing length and flowrate, investigate the prevalence of this methodology in situ, and identify practical implications of the tube-length to flow-rate relationship.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Feasibility of a Bed Mobility Skills Assessment in a DPT Program

**Student Presenters:** Allison East, SPT; Alissa Korslin, SPT; Madison Ronzone, SPT; Victoria Sioli, SPT

**Faculty Preceptors:** Heidi R. Roth, PT, DHS, NCS; Rachel Tappan, PT, DPT, 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:

To evaluate student readiness for clinical care, physical therapist educators need clinical skill assessments that have evidence for validity and feasibility. A current student assessment for bed mobility skills has content and response process validity evidence, yet its feasibility has not been investigated. This project's aim was to measure the feasibility of this assessment, in terms of required faculty time relative to faculty reported feasible time.

Subjects:

Four faculty (1 core, 3 associated) with a mean of 17.8(11.8) years of clinical experience and a mean of 12.3(9.9) years of teaching experience in a DPT curriculum.

Materials/Methods:

The bed mobility skills assessment was composed of a simulated student encounter with a standardized patient of up to 15 minutes and documentation of the encounter, which participants rated with a 48-item checklist. Participants completed rater training to standardize checklist use when grading student performance. Participants used the checklist to grade videos of three simulated assessments with a range of student performance levels. Time was recorded at the following points: at the beginning of the patient encounter (T0), at the end of the patient encounter (T1), upon completion of the clinical skill performance portion of the checklist (T2), upon completion of documentation portion of the checklist (T3), and upon completion of the summary feedback (T4). All participants completed a survey of their experience and confidence using the checklist and their perception of the maximum feasible Post-Encounter Time. Primary outcomes were Post-Encounter Time (T4-T1) and maximum feasible Post-Encounter Time. Secondary outcome was Total Time (T4-T0).

Results:

Mean Post-Encounter Time was 4.8(2.2) minutes. Mean maximum feasible Post-Encounter Time was 13.8(2.5) minutes. The mean Post-Encounter Time was less than the mean maximum feasible post-encounter time. The mean Total Time was 14.5(2.6) minutes.

### Conclusions:

Post-Encounter Time was consistently less than the maximum feasible Post-Encounter Time, which supports the feasibility of this assessment; therefore, this checklist now has evidence for both validity and feasibility to support its use in DPT curriculum. Additionally, the study outcomes can be helpful in estimating resources required for this clinical skills assessment.

### Clinical Relevance:

Assessments of student skills must have evidence of validity and feasibility to evaluate whether students are ready for clinical care. In this study, we found that the time it takes educators to complete grading for this bed mobility skills assessment was less than what was perceived as feasible, demonstrating that physical therapist educators can efficiently implement this checklist with validity evidence in the classroom.

### **References:**

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Predicting End Tidal CO<sub>2</sub> from Respiration Volume Per Time for Breath-Hold Cerebrovascular Reactivity Mapping

**Student Presenters:** Chris Chin, BS, SPT; Katie Friedman, BS, SPT; Sara Hudson, BS, SPT; Robbie Ng, BS, SPT; Kelly Tichenor, BS, SPT

**Faculty Preceptors:** Rebecca Clements, BME; Molly Bright, D. Phil

**Institution(s):** Department of Physical Therapy and Human Movement Sciences, Feinberg School of Medicine, Northwestern University, Chicago, IL, United States of America.

Department of Biomedical Engineering, McCormick School of Engineering and Applied Sciences, Northwestern University, Evanston, IL, United States of America.

**Abstract:**

Purpose:

Cerebrovascular reactivity (CVR) is the ability of brain vasculature to dilate, increasing blood flow to the brain. CVR is used in analyzing brain health in various conditions such as stroke, TBI, arteriosclerosis, brain tumors, substance abuse, and aging [1]. Clinicians measure CVR by modulating blood gases: blood CO<sub>2</sub> is a strong vasodilator, and can be temporarily increased using breath-holding (BH). The vasodilatory response in the brain is measured using a functional MRI scan. Exhaled CO<sub>2</sub> is used to calculate end-tidal CO<sub>2</sub> (PETCO<sub>2</sub>), an estimate of arterial CO<sub>2</sub>, to calculate CVR. It may be difficult for some populations to BH or follow instructions, decreasing PETCO<sub>2</sub> measurement quality. A respiratory belt measures changes in thoracic expansion at the peaks of inspiration and expiration, which is used to calculate respiration volume per time (RVT) [2-3]. This metric of changes in ventilation rate should relate to changes in blood CO<sub>2</sub> levels. The purpose of this project is to develop machine learning methods to predict blood CO<sub>2</sub> changes using respiratory belt data. This will make CVR measurements more feasible in a wider range of patient populations, improving our ability to characterize, monitor, and improve the brain's vascular health.

Methods:

An existing dataset of 32 participants who completed 1-18 BH trials each was used. Each dataset contained CO<sub>2</sub> and respiratory belt data measured during BH tasks. These data had similar BH task timings, therefore we also acquired new data with a more variable BH task paradigm to improve the machine learning algorithm. We collected 1-3 datasets each from 17 healthy participants. Exclusion criteria were pregnancy, known neurological, vascular or respiratory conditions, and frequent smoking.

Each subject laid supine wearing a nasal cannula attached to a gas analyzer [4] and a respiratory belt [5] at the xiphoid process. An MRI head coil was placed around the head with a mirror secured above to observe a monitor displaying instructions. Participants performed 1 practice BH followed by 10 BH trials, with paced breathing, BH, and recovery time parameters randomized. BHs without sufficient increase in CO<sub>2</sub> were excluded, and each dataset was

randomly split into segments consisting of 2-7 consecutive “good” BHs, resulting in a final total of 293 datasets.

#### Conclusion:

In collaboration with BME students, the data were used to train a machine learning algorithm to predict PETCO<sub>2</sub> from RVT. The model was evaluated by assessing the correlation between the true and predicted PETCO<sub>2</sub> values in a held-out dataset. The best-performing model produced a correlation coefficient of  $r=0.846 \pm 0.077$ , suggesting the feasibility of machine learning to predict PETCO<sub>2</sub> from RVT. Maps of CVR and CVR delay generated using the true and predicted PETCO<sub>2</sub> data showed good agreement.

Future research should train the algorithm on a more diverse population, such as cohorts with varying lung volumes, CVP conditions, ages, and cognitive abilities. This will improve the generalizability of our machine learning algorithm to predict PETCO<sub>2</sub> in clinical research settings.

#### **References:**

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Rehabilitation After Stroke: Exploring Physical Therapy Characteristics to Predict Outcome Measure Improvements at Discharge

**Student Presenters:** John Rogers, SPT; Yiliu Cao, SPT

**Faculty Preceptors:** Francesco Lanotte, PhD; Matthew Giffhorn, PT, DPT, NCS; Shusuke Okita, PhD; Megan O'Brien, PhD; Arun Jayaraman, PT, PhD

**Institution(s):** Northwestern University Department of Physical Therapy and Human Movement Science; Northwestern University Department of Physical Medicine and Rehabilitation; Shirley Ryan AbilityLab

**Abstract:**

Background:

While previous studies have indicated that high-dosage and high-intensity therapy during stroke rehabilitation results in more favorable outcomes, the amount and structure of therapy vary widely between patients and institutions.<sup>1,2,3</sup>

Objective:

To assess the relationship between therapy characteristics and functional outcomes at discharge from Inpatient Rehabilitation Facilities (IRFs) in patients with acute or subacute stroke.

Methods:

A longitudinal study of 22 participants admitted to the Shirley Ryan AbilityLab (SRALab) with a primary diagnosis of stroke was conducted. Daily therapy documentations were reviewed from the patient medical record and annotated by three raters to quantify therapy characteristics (i.e., activity type, activity intensity, assistance level) and outcome measures. A subsequent cross-review process among the three raters ensured the consistency and accuracy of data entry. Functional outcomes included the 10-Meter Walk Test (10MWT), 6-Minute Walk Test (6MWT), and Berg Balance Scale (BBS) upon IRF admission (Adm) and discharge (Dis).

Analysis:

Simple linear regression was performed using R [version 4.3.1] to determine the association between therapy characteristics and changes in outcome measures across different time frames relative to Adm (i.e., Day 5/7/10/15 and the total duration of hospitalization), with the significant pairs retrieved against the criteria of  $R^2 > 0.4$  and  $p < 0.05$ . Comparative analysis was then conducted between 11 therapy characteristics (aggregated by computing total numbers and averages) and 8 representations of outcome measure improvement, over each time frame.

Results:

17 of 88 therapy-outcome measure combinations across all time frames satisfied our criteria. Analysis of therapy-outcome pairs revealed that the highest number of significant associations

was observed within the 15 days post-Adm (10 significant pairs). Furthermore, 7 days post-Adm may be the earliest time at which therapy dosage indicated improvements in functional outcomes at Dis. Maximum speed achieved during treadmill training was most predictive of improvements in 10MWT ( $R^2 = 0.542$ ) and BBS ( $R^2 = 0.613$ ) scores at Dis within 15 days post-Adm, and 6MWT ( $R^2 = 0.624$ ) at Dis within 7 days post-Adm.

#### Conclusion:

Maximum treadmill speed during therapy was strongly associated with improvements in walking speed, endurance, and balance. This variable may serve as a proxy for anticipatory dynamic balance, which is a critical component for improvements in gait post-stroke. Further investigation will involve larger sample sizes to assess the reliability and validity of our current results, while exploring whether specific cut-offs exist for IRF physical therapy treatment variables that correlate with improvements in outcome measures at discharge.

#### Limitation:

Our current findings are restricted by the type of therapy SRA lab provides. Different experiences among raters (two PT students and a practicing PT) could have biased the quality of the annotations. Finally, considerations for minimally detectable change or minimum clinically important difference were not included given the small sample size.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**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 (B-PREPeD)

**Student Presenters:** Sara Elderkin; Rebecca Young; Alexis Tran

**Faculty Preceptors:** Anne Marie Flores

**Institution(s):** Northwestern University; Lynn Sage Breast Cancer Research Foundation

**Abstract:**

Background:

Cancer-related physical and functional impairment (PFI) is high and a gap in care for self-management education exists. Patients with breast cancer face preventable PFI, are unprepared for what to expect and plan for recovery. The purpose of our study is to evaluate potential effects of an early (beginning prior to cancer treatment) physical therapy (PT)-centered intervention that regularly monitors for early detection of PFI and self-management of cancer-related impairment during the first 6 months after primary cancer diagnosis. We report on the building of the infrastructure required for this study.

Methods:

Seventy-five patients will be recruited to our randomized controlled trial with random assignment to either the enhanced usual care or intervention arm. Both groups will receive monthly monitoring using the Patient Reported Outcome Measurement Information System – Physical Function (PROMIS-PF). When the PROMIS-PF score is < 45 (moderate/severe impairment) a PT referral is warranted, and the oncologist is notified. Intervention participants are also notified and encouraged to contact their oncologist for a referral to PT. The intervention group is additionally supported for patient education on self-management via a study website with knowledge checks, regular texts, and phone call check-ins. Our primary outcome is acceptability measured by retention rate and protocol adherence. Our secondary outcomes are PROMIS-PF score, Self-Efficacy for Managing Chronic Disease 6-item Scale (SEMCD-6), Shoulder Pain and Disability Index, and study knowledge test. Our synthesis team contributed to building the infrastructure necessary to conduct this RCT.

Results:

We expect that at least 80% of intervention participants will report that B-PREPeD is acceptable prior to treatment and suitable to continue for 6-months after diagnosis. Compared to EUC, we expect B-PREPeD participants to have less PF decline and faster recovery as well as return to baseline PROMIS-PF scores by the end of 6-months. As a team, we supported the development of the B-PREPeD study website, participated in office testing of patient education text messages/REDCAP survey testing and fidelity checks, and established inter-rater reliability via dynamometer and goniometer measurements.

Conclusion:

We expect to see significant improvement in PFI prevention, self-efficacy, shoulder function, and self-management of PFI. Future research will modify and adapt the protocol to include new clinical practice guidelines for implementation as standard clinical care.

Clinical Relevance. Success of this project will inform standard of care and elements of the protocol will be implemented in clinical practice.

**References:**

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Safe Stress: Medical Improv as an Avenue to Teach Motivational Interviewing and Patient Activation

**Student Presenters:** Pablo De La Cruz, SPT; Jalen Jackson, SPT; Rachel Marrs, SPT; Mackenzie O'Hara, SPT; Ellyce Wong, SPT

**Faculty Preceptors:** Justin Drogos, PT, DPT, PhD(c); Jonathan Webb, MBA

**Institution(s):** Northwestern Doctor of Physical Therapy School

**Abstract:**

Purpose:

Medical improvisation (improv) is a training approach in healthcare education that uses improvisational theater techniques to teach skills such as communication and adaptability. Faculty instruction and its impact on student learning, participation, and experience has not been fully described in the literature. Our case study aimed to integrate medical improv techniques into 2 role-playing labs in the Psychosocial Aspects of Human Behavior 2 course of the Northwestern University DPT program and examine the outcome on students and faculty. We wanted to explore the interaction of novel exercises with previous medical improv experience, prior psychosocial coursework and clinical experiences, and its impact on the learning experience for students and faculty.

Participants:

97 second-year DPT students, 11 course faculty participated in labs. Student focus group: n=9, 1 randomly chosen from each lab group; Age: mean 25.7 yrs (range 23-31); 22/78% male/female; 'How outgoing are you?' (1-least, 5-most): mean 3.7 (range 2-5). All had prior experience with medical improv during DPT orientation and the Psychosocial 1 course. Faculty focus group: n=9; experience in course: mean 6.3 yrs (range 1-17). 5 faculty had prior experience with medical improv in the Psychosocial 1 course.

Methods:

All second-year DPT students participated in medical improv exercises ("1776" and "New Choice") as part of labs focused on motivational interviewing and patient activation. 9 of 11 course faculty were trained in the exercises before the course began. Following the labs, semi-structured focus group interviews were conducted separately with students and faculty. Transcripts were analyzed using segmentation and inductive analysis.

Results:

Inductive analysis revealed 3 shared themes among faculty and students and themes unique to their different roles. Shared themes include: the facilitator plays a key role in the learning experience; immediate linkage of exercises and application increases benefit; the exercises connected to skills of communication and adaptability. Students found previous exposure to medical improv aided their learning. Comments centered on purpose and application of the

activities rather than feelings of fear or apprehension, which were predominant in their first-year experience with medical improv. Faculty said medical improv provides a safe stress for learning by encouraging students and faculty to participate in experiences outside their comfort zone.

**Conclusion:**

Medical improv is a tool to promote engagement for learning motivational interviewing and patient activation as part of a psychosocial DPT curriculum. Prior experience with improv is beneficial for both students and faculty when implementing it into the classroom. A debrief is necessary to facilitate connection between improv and clinical applications.

**Clinical Relevance:**

Medical improv can be a useful tool for DPT students and clinicians to practice clinical skills in a safe stress environment. Implementing advanced improv exercises may benefit from more faculty training.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Improving diverse visual representation in Doctor of Physical Therapy (DPT) education

**Student Presenters:** Lula Berhe, Osayama Omoruyi, and Destiny Stovall

**Faculty Preceptors:** Heather Henderson

**Institution(s):** Northwestern University

**Abstract:**

Purpose:

Evidence suggests implicit racial bias exists in visual representation within medical education, including course materials, 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 analyzing medical education, there is a gap in research within Physical Therapy. The aim of this study is to recognize and address the disparity and underrepresentation of diversity within the curriculum of the Doctor of Physical Therapy (DPT) program at Northwestern University by evaluating embedded videos and photos in course content. Through data collection and highlighting the lack of diversity, we aim to raise awareness and set future goals to incorporate more inclusive images that better reflect the communities we serve.

Methods:

Four independent raters analyzed PowerPoint presentations and videos from three courses within Northwestern University's Doctor of Physical Therapy (DPT) program. They assessed physical characteristics including assumed gender, skin type, assumed race, body type, and body expression (e.g., facial hair, piercings, tattoos). Skin type was classified using the Fitzpatrick scale. In instances of disagreement, raters deliberated with a third party to achieve consensus. Images of human subjects with visible skin were included, while those of non-human subjects or images where analysis was impractical were excluded. To establish interrater reliability, each rater evaluated a set of 30 selected photos depicting individuals with diverse physical characteristics relevant to the study. Inter-rater reliability was assessed to measure agreement among the raters.

Conclusions:

In conclusion, our comprehensive analysis of images and videos within the DPT curriculum at Northwestern University has provided valuable insights into various aspects of representation. We have observed a lack of diverse range of gender identities, with notable percentages of female, male, and non-binary individuals represented, alongside a significant portion categorized as unidentified, primarily comprising infants. The utilization of the Fitzpatrick scale has allowed for the categorization of skin tones across a spectrum, with a majority falling within type 1. While the distribution of assumed race/ethnicity shows a predominant representation of White individuals, there is decreased notable presence from Asian, Black, Latino/a, and other ethnic backgrounds. Furthermore, the majority of individuals portrayed exhibit an average body weight, indicating a lack of body diversity. Finally, our examination of body expressions

highlights a small percentage displaying variations in expression. These findings underscore the importance of continued efforts towards inclusivity and representation within educational materials, ensuring a holistic and equitable learning environment for all students.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Research Report

**Title:** Muscle Volume Discrepancies in Hemiparetic Cerebral Palsy: A Comparative MRI Study Across Age Groups

**Student Presenters:** Nicholas Buto, SPT; Maya Harkavy, SPT; Jocelyn Kahn, SPT; Jeffrey Yu, SPT

**Faculty Preceptors:** Divya Joshi, PhD Candidate; Carson Ingo, PhD

**Institution(s):** Department of Physical Therapy & Human Movement Sciences, Northwestern University

**Abstract:**

Purpose:

This study's purpose was to measure the muscle volumes of wrist and finger flexors and extensors in individuals with hemiparetic cerebral palsy (CP) versus typically developing (TD) individuals, determine if muscle size differences between limbs vary between childhood and adulthood, and examine the correlation between muscle volumes and grip strength in individuals with and without CP.

Subjects:

The study cohort included 34 individuals (17.6 $\pm$ 9.0y, 19F), consisting of 11 children with CP (11.3 $\pm$ 2.5y, 4F), 9 TD children (11.0 $\pm$ 2.4, 7F), 7 adults with CP (28.0 $\pm$ 8.6, 4F), and 7 TD adults (25.3 $\pm$ 4.8y, 4F).

Methods:

MRIs of both forearms were acquired using a 1.5T Siemens Aera scanner and a 2x18 channel body matrix coil, with forearm and hand secured in an MR-compatible orthosis. T1-weighted images with fat suppression were acquired. Four muscles were segmented using the T1 images: Extensor Carpi Radialis (ECR), Flexor Carpi Radialis (FCR), Flexor Digitorum Profundus (FDP), and Flexor Digitorum Superficialis (FDS). The volume of each muscle was calculated using the FSL software library. Paired t-tests were performed to determine the differences in muscle volumes between arms. Pearson correlation coefficients were calculated for the relationship between the total flexor muscle volume and the maximum grip strength.

Results:

In both children and adults with CP, volumes were decreased in the paretic limb compared to the non-paretic limb for all four muscles ( $p < 0.05$ ). In TD children, FDP volume was decreased in the non-dominant limb ( $p < 0.05$ ) with no significant differences in the other muscle groups. In TD adults, ECR and FCR volumes were smaller in the non-dominant limb ( $p < 0.05$ ), but FDP and FDS volumes were not significantly different between limbs. Finally, the interlimb difference in total flexor muscle volume was significantly positively correlated to the interlimb difference in grip strength in children and adults with CP ( $p = 0.01, 0.043$  respectively) but was not correlated in TD individuals.

### Conclusions:

The main finding of this study is individuals with CP have reduced muscle volume in the paretic forearm (21-38%). Children with CP showed more interlimb differences in muscle volume than adults with CP, perhaps due to more time spent in PT intervention. Though TD children showed no interlimb differences in muscle volumes, TD adults had larger wrist flexors and extensors in the dominant limb, which may be indicative of greater use of the dominant side.

### Clinical Relevance:

Studies have shown that children with CP often have difficulties with ADLs due to decreased motor function and strength in their affected limb(s). This study suggests that decreased muscle volume may be a contributing factor. One method to mitigate this is to promote the use of the paretic side starting early in childhood with interventions such as CIMT to motivate the use of the affected hand and fingers and thus increase muscle volume. Given the strong correlation between flexor muscle volume and grip strength shown here, a clinically feasible method to quantify increases in muscle volume is to measure maximum grip strength.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Case Study Report

**Title:** High Intensity Gait Training (HIGT) versus a Behavioral Intervention: A Case Study Comparing Changes in Walking Capacity and Performance in iSCI

**Student Presenters:** Oliver D. Artiga SPT, Siena M. Robertson SPT, Karen M. Gallaway SPT, Raegan Yerington SPT, Michael Lin SPT, Andrew E. Hahn SPT

**Faculty Preceptors:** Keith E. Gordon, PhD, Jennifer H. Kahn, PT, DPT

**Institution(s):** Northwestern Medicine, Feinberg School of Medicine

**Abstract:**

Background/Purpose:

Ambulatory individuals with incomplete spinal cord injury (iSCI) engage in limited walking activity. While high intensity gait training (HIGT) is known to improve walking capacity (walking speed or balance measured in a clinical setting) these improvements do not consistently result in associated increases in walking performance (amount of walking in a person's usual environment). This suggests behavioral interventions may be needed to improve walking performance.

This case study assessed the feasibility of a behavioral intervention and compared walking capacity and performance outcomes to a HIGT intervention. The hypothesis was that a behavioral intervention will impact walking performance more than HIGT, with less impact on changes in capacity. The study outcomes will improve our understanding of how gait training and behavioral interventions independently affect walking capacity and performance in people with iSCI.

Case Description:

A 62-year-old male with a cervical iSCI completed a 20-session HIGT intervention and an 8-session behavioral intervention. A two-year period separated the two interventions. The gait training sessions consisted of up to 45 minutes of treadmill walking at a target of 70-85% heart rate max and focused equally on walking activities to increase speed and balance. The behavioral intervention included an initial assessment, eight weekly phone call check-ins, and a final assessment. The behavioral intervention was adapted from the ProACTIVE SCI Toolkit and included motivational interviewing, SMART goal setting, action planning, activity monitoring, problem-solving, prompts/cues, and graded tasks. Pre- and post-training outcome measures were collected to assess changes in capacity. The participant wore an activity monitor for 1-week pre-and post-training and tracked progress with collaborative goals to assess changes in performance.

Outcomes:

Walking capacity: Changes in capacity measures following the HIGT increased for the Ten Meter Walk Test (10MWT) preferred 0.16 m/s, fast 0.17 m/s, Berg Balance Scale (BBS) 4 points, and Timed Up and Go (TUG) 8.85sec. Following the behavioral intervention, changes in

capacity measures improved marginally: 10MWT preferred 0.02 m/s, fast 0.05 m/s, BBS 2 points, and TUG 4.63 sec.

Walking performance: Following the HIGT the participant decreased average steps/day by 1083 (52%). In contrast, following the behavioral intervention the participant increased steps/day by 3,425 (319%) and achieved collaborative goals.

#### Discussion:

The hypothesis was supported. The participant demonstrated improved walking capacity following HIGT but did not improve walking performance. In contrast, the participant improved walking performance but not capacity following behavioral intervention signifying a change from non-community ambulator to community ambulator. Our findings parallel recent studies that demonstrate the impact of behavioral interventions on walking performance in other neurologic populations. Future studies should investigate the impact of behavioral interventions in combination with HIGT on long-term walking capacity and performance for people with iSCI.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Special Interest Report

**Title:** Anatomy and Kinesiology eLearning Tool for the Talocrural and Subtalar Joints Using Cadaveric Donor Material

**Student Presenters:** Hannah Chang, Mary Elizabeth Evans, Sofia Iribarren, Jake Maloney, Nikole Martin

**Faculty Preceptors:** Kirsten Moasio, Roberto López-Rosado

**Institution(s):** Northwestern University, Department of Physical Therapy & Human Movement Sciences

**Abstract:**

Teaching resource for anatomy and kinesiology are variable for Doctorate in Physical Therapy (DPT) programs and cover the spectrum from traditional resources like textbooks, 2D images and cadaver labs to more recent teaching tools like anatomy visualization apps and, virtual reality experiences like HoloAnatomy and HoloHuman. E-learning tools have emerged as a promising avenue to enrich student learning experiences and broaden access to educational resources. These tools offer the advantage of portability and can engage students in interactive laboratory experiences when not in a classroom or lab. Importantly, they can cater to diverse learning styles. The goal of this educational video project was to create e-learning tools to supplement anatomy and kinesiology of the ankle joint, specifically for the talocrural and subtalar joints. Anatomical specimen from the right lower extremity were harvested and dissected from two donors, 1 male donor aged 86 years, and 1 female donor aged 88 years. Two videos were created, one for the talocrural joint and one for the subtalar joint and focused on the osteokinematics and arthrokinematics for the specified joints. Multiple short videos were created, accompanied by labeled still photographs and screenshots of dissected specimens, to optimize learning. Narration was created in tandem with each video to guide the viewer through the learning content. Video capture was performed using an iPhone 13 Pro Max, and editing was done with iMovie. By embracing e-learning tools, students' exposure to kinesiology and anatomical concepts can be augmented alongside classroom and lab activities. Providing an array of learning tools may accommodate various learning preferences including, but not limited to, visual learners who learn best through images and videos, auditory learners who better grasp information via explanation and discussion, and multimodal learner who benefit from a combination of learning styles such as visual aids accompanied by spoken explanation or interactive demonstrations. This approach promotes accessibility and engagement, ultimately contributing to a more enriching educational experience for all learners

**References:** N/a



Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Special Interest Report

**Title:** Implementing Systematic Approaches for Task Analysis and Balance Diagnosis in an OP Neuro Setting

**Student Presenters:** Marina Bradley SPT; Aboli Gandhi SPT; Nadia Gibson SPT; Kevin Ormsby SPT; Ronak Savsani SPT

**Faculty Preceptors:** Laura Doyle, PT; Lois Hedman, PT, DScPT, MS

**Institution(s):** Department of Physical Therapy and Human Movement Sciences, Northwestern University Medical School, Shirley Ryan AbilityLab

**Abstract:**

Purpose:

The Framework for Movement Analysis of Tasks (1) and Movement System Diagnoses for Balance Dysfunction (2) were developed by Academy of Neurologic Physical Therapy to decrease unwarranted variation in physical therapist practice. Translation of new knowledge to clinical practice requires deliberate strategies. We adopted the Knowledge to Action Framework (3) to foster the implementation of the frameworks in an outpatient neurological clinical setting. The goal of this project is sustained implementation of these frameworks by the participants in their clinical practice.

Method:

Thirty-one physical therapists working in outpatient and day rehab neurologic settings were invited via email to participate in the project. An online survey (n = 31), two focus groups (n= 6), and a chart audit (10 charts) were conducted to help identify and describe the problem. Key themes from the initial survey include clinicians not identifying balance diagnoses for their patients and a belief that having a systematic approach would help guide movement analysis. Focus group participants reported no standardized process for movement analysis, impairment examination before performing movement analysis, reliance on outcome measures to write goals, and non-specific balance interventions. The chart audit revealed that task analysis was limited to level of assist, outcome measures are prevalent in goals, and little to no movement analysis or balance diagnosis terminology was included in the documentation. The Feasibility, Acceptability, and Appropriateness (FAA) survey (4) was completed by participants to help identify barriers and facilitators to implementation. Reported high levels of feasibility, acceptability, and appropriateness of the frameworks were facilitators for implementation while the focus group identified electronic medical record (EMR) compatibility and time constraints as barriers. Six participants engaged in the interventions that included two online educational modules, documentation guide, terminology pocket guide, and balance diagnoses templates. Group mentoring sessions focused on the participants' discussing video cases, applying frameworks with live volunteers, and problem-solving documentation and time concerns.

Conclusion:

To date, participants' reflections include valuing the organization and consistency of the frameworks and the linkage between diagnoses and specific interventions. They also acknowledged that efficiency can be increased by performing movement analysis prior to impairment testing and incorporating movement analysis into outcome measure administration. Documentation in the existing EMR continues to be challenging. To complete the knowledge to action process, the project will continue with monitoring knowledge use and evaluating outcomes via chart audits, final study surveys, and a 6-month follow-up survey to determine if knowledge use was sustained by the participants. The participants will also engage in a discussion of next steps for broader implementation.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Special Interest Report

**Title:** Changes in Leadership Self-Efficacy Following Leader Development Training

**Student Presenters:** Jacob Lum, SPT; Jordan Mousley, SPT; Yixuan Che, SPT

**Faculty Preceptors:** Emily Becker, PT, MS, EdD; Sally Taylor, PT, DPT

**Institution(s):** Department of Physical Therapy and Human Movement Sciences, Northwestern University, Feinberg School of Medicine, Chicago, IL, Shirley Ryan Ability Lab Chicago, IL

**Abstract:**

Purpose: Leadership is an inherent quality and characteristic of the health care professional,<sup>1</sup> is viewed as a core element of quality of patient care,<sup>2</sup> and modern leadership styles enhance quality of care.<sup>3</sup> The development of leaders is critical to an organization's current and future success.<sup>4,5</sup> Leadership development (LD) consists of formal training programs to cultivate leaders. Through LD, organizations can stay competitive with changing industry norms by internally facilitating employee self-awareness and improving individual behavior.<sup>6</sup> In this way, current literature poses LD as the bridge that transfers individual professional development to organizational change.<sup>7</sup> To date, there is a lack of literature evaluating the proximal outcomes of LD in health care. This study aims to investigate the proximal effects of an intensive LD course within the health care profession by evaluating 1) individual leadership self-efficacy changes, 2) identifying when that change occurs proximally, and 3) determining if the change is sustained.

Description:

Proximal outcomes are understood to be immediate changes after an intervention takes place and can be considered indicators for continued long-term development. To assess proximal outcomes of LD training, a quantitative 36-item survey was distributed to health care professionals who attended a 2-day LD course titled LAMP Leadership 101 Personal Leadership Development: The Catalyst for Leading Within.<sup>8</sup> All participants in the study voluntarily chose to complete the survey and the survey was administered three times: pre-course, 2-weeks post-training, and 6 months post-training. The survey collected demographic data followed by the Leader Efficacy Questionnaire (LEQ), a 22-item assessment that prompted participants to consider themselves leaders in their organization and rate their level of confidence in their own capability to lead on a number scale of 0-100, with a score of 100 representing 100% confidence and 0 meaning no confidence at all.<sup>9</sup> The LEQ was developed from the Leader Self and Means Efficacy construct and is valid in predicting outcomes such as enhanced motivation to lead others, leader performance, and effective leadership style.<sup>10</sup> Research that has utilized the LEQ has shown that leader efficacy can be developed through mentoring and targeted LD programs.<sup>11</sup>

Summary of Use:

Organizations would benefit from a comprehensive understanding of the impact and value of supporting clinicians to attend LD trainings. It is critical that all health care professionals develop

leader efficacy and confidence to successfully navigate challenges within the ever-changing healthcare environment. Clinicians that attend LD trainings can implement key skills and competencies into the environments they continually impact.

#### Importance to Members:

Gaining an understanding of the transformation in individual healthcare providers can offer insights into how their personal leadership skills contribute to organizational success.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Special Interest Report

**Title:** Development of Video-based Training Modules for Operating Movement Analysis Equipment in In-Patient Stroke Rehabilitation Trials

**Student Presenters:** Eddie Eufracio, SPT, Dan Serban, SPT, Kristin Vavaroutsos, SPT, and Kayla Watson, SPT

**Faculty Preceptors:** Mike Ellis, PT, DPT

**Institution(s):** Northwestern University

**Abstract:**

The purpose of this project was to address the need for improved training materials for clinicians operating technical movement analysis equipment in ongoing clinical trials at Shirley Ryan AbilityLab and Northwestern Medicine Marianjoy Rehabilitation Hospital. The training modules integrate a multimedia approach including video demonstrations and audio explanations to prepare clinicians for hands-on training prior to application with patients following a stroke.

The movement analysis equipment is used to evaluate patient impairments, including strength and flexion synergy expression, and the activity limitation of reaching function. The development process for the training modules began with a comprehensive review of the foundational research underlying quantification of synergy expression and associated impairments in individuals with stroke (Ellis et al, 2016). This provided an understanding of the neural mechanisms (McPherson et al, 2018) underlying stroke related upper extremity impairments and the foundation for understanding the evaluation procedures.

The next step involved learning how to operate the movement analysis equipment and run the existing research protocols employed in ongoing clinical trials. This provided the necessary perspective for designing a plan for filming including how to partition the total evaluation protocol into digestible modules for learning. The approach to filming was focused on capturing professional videos specifically geared towards training practicing physical and occupational therapists. Several brainstorming sessions took place to plan each individual video module. Key aspects to include in each module were identified in advance of filming.

Filming sessions captured physical therapy students demonstrating proper techniques on video. Students talked through what they were doing throughout the filming stage to help with the timing of later-created voice-overs. In the video processing stage, each video was checked for visual clarity and confirmation was made for inclusion of key aspects. Freeze-frames were used to provide additional guidance and increase the time on a particular shot to ensure sufficient time for longer audio explanations. Finally, voice-overs were created by watching the completed, audio-less videos and writing out what was to be said throughout each portion of the video. The voiceover was then recorded by reading the written script while simultaneously watching the video. This was done to ensure audio and video timing aligned as perfectly as possible. Each module was then compiled into a cohesive finished product.

The video training modules will be provided to future physical and occupational therapists that will contribute to ongoing stroke rehabilitation trials at Northwestern Medicine and Shirley Ryan AbilityLab. It is hoped that these modules will expedite onboarding by enhancing the learning process involved prior to operating the technical movement analysis equipment. The modules will also serve as refreshers for clinical sites with slower patient enrollment where memory/technique of research protocol administration can drift.

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Northwestern University Department of Physical Therapy &  
Human Movement Sciences

Synthesis Day | March 25, 2024

**Synthesis Category:** Special Interest Report

**Title:** Creating Circles for Community Building: Feasibility of Use in a DPT Program

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**Institution(s):** Northwestern University

**Abstract:**

Purpose:

Research depicts high levels of depression and stress in students obtaining a Doctor of Physical Therapy (DPT) degree, increasing susceptibility of experiencing burnout. DPT programs must acknowledge and support students' mental health during their training. Restorative practices, including circling, can build community and may promote resilience and reduce stress. The purpose of this project was to determine the feasibility of incorporating circling practice into a DPT program.

Description:

Circling is a practice centered on community relationships and has a rich history in ancient and indigenous cultures. Modern use of this practice has occurred in K-12 and undergraduate education, community justice, and the criminal justice system. Medical education and professional associations have implemented restorative practices to address mistreatment, racial injustice, public health, malpractice, and safety. Published reports of restorative practice use in DPT education were not found. Circling builds community by breaking down hierarchical barriers and nurturing mutual support, shared experiences, and resilience against burnout.

Summary of use:

An interest in embedding circling practices within a DPT program began after circling was used to address a conflict that necessitated a non-punitive, community-centered approach. Based on a literature review and consultation with an expert in restorative justice in healthcare environments, the project team decided to implement circles with the incoming class of DPT students. Before matriculation of the new class, 2nd-year students, faculty, and staff (n = 14) participated in a 2-day workshop addressing the history, structure, and facilitation of circles. The project team planned circles considering the audience, circle topic and goal, assigning circle hosts and guardians, location for conducting the circle, materials needed, scheduling the circle, and length of time allotted. Three circles led by trained members were held: 1) during orientation with 96 1st-year students, in 6 groups, focused on establishing community; 2) at mid-point of the fall term focused on struggling, which was open to all students, faculty and staff based on feedback to broaden circle participants; and 3) at the start of the winter term focused on celebration and open to all students, faculty and staff. After each circle, the project team met and discussed the circle's strengths and weaknesses, resulting in changes made to subsequent circles. The final two circles gathered 11-15 students, faculty, and staff. The goal is to continue circles in subsequent terms.



### Importance to Members:

Circling practice holds significant value for all members of a DPT program - students, faculty, and staff. It is a dynamic tool to address challenges faced in DPT education, fostering a supportive atmosphere, promoting empathy, and transcending the traditional academic hierarchy. It is a practice used traditionally outside of health care yet is feasible to implement successfully in a DPT program. Circling during DPT students' training will translate into better patient and colleague relationships in future clinical practice.

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