Walking adaptability after neurologic injury: Assessment & intervention

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Summary:
Walking adaptability, the ability to modify walking to meet task goals and environmental demands, is an essential requirement for safe home and community ambulation. Walking adaptability is often severely compromised due to neurologic injury or disease, contributing to mobility disability and limited participation. Currently, there is a lack of comprehensive assessments and interventions targeting walking adaptability. The development of such assessments and interventions can be facilitated using a framework that considers the unique neural control demands of walking adaptability, such as increased executive and supraspinal control. In this presentation, the neural control of walking adaptability will be discussed and a framework for guiding clinical assessment and rehabilitation will be presented. Current and emerging strategies for adaptability assessment and interventions will be discussed, including findings from recent pilot investigations of individuals with spinal cord injuries and post-stroke. Highlights will include: a) evidence of differential neural control of walking adaptability compared to steady-state walking; b) development of a measurement hierarchy for adaptability assessment; and c) effects of retraining adaptability on walking, balance, and mobility-confidence. Video cases will be discussed and new approaches for the assessment and retraining of walking adaptability will be introduced.

Learning Objectives:
Upon completion of this course, participants will be able to:
1) Discuss the impact of impaired walking adaptability on participation
2) Differentiate the neural control of walking adaptability from steady-state walking
3) Apply a conceptual model of walking adaptability and discuss the current status of assessment
4) Discuss new approaches for clinical and laboratory assessments of walking adaptability
5) Describe and discuss current and emerging approaches for retraining walking adaptability
6) Describe recent pilot investigations of assessment and intervention of walking adaptability in individuals with neurologic conditions such as stroke and spinal cord injury and discuss how new technologies such as virtual reality can be applied
Session Outline:

I. Speaker and topic introductions, session objectives (~5 min)

II. Walking adaptability, effects of neurologic injury and disease and impact on community mobility and participation (~8 min)
   a. Community mobility requires walking adaptability
   b. Walking adaptability task performance is compromised and/or avoided after stroke and in other neurologic populations, resulting in reduced participation in life roles
   c. Rehabilitation should include walking adaptability.

III. Neural control of walking, model of walking control, features of steady state walking vs. walking adaptability, past and current research, challenges & opportunities, (30-35 min)
   a. Neural control of walking: automaticity and executive control (Clark et al. 2015)
   b. Evidence of differential control of steady state walking versus adaptability:
      i. electromyography (EMG) (Clark et al. 2013; Clark et al. in press)
      ii. functional near infrared spectroscopy (fNIRS) (Clark et al. 2014)
      iii. sympathetic nervous system arousal (Clark et al. 2014)
   c. Benefits and pitfalls of current neurophysiological assessments
   d. Neurophysiological insights inspire new strategies for rehabilitation

IV. Conceptual framework, current and new assessment approaches, past and current research, challenges & opportunities, video examples (30-35 min)
   a. Conceptual framework to assess walking adaptability
      i. Existing challenges for the measurement of walking adaptability (Balasubramanian et al. 2014)
      ii. Application of a conceptual framework: Domains of walking adaptability (Patla and Shumway-Cook 1999)
   b. Current assessments and measurement of walking adaptability (Balasubramanian et al. 2014)
   c. Need for a new assessment to measure walking adaptability (Velozo et al. 2012)

V. Current and new approaches for retraining walking adaptability, past and current research, challenges & opportunities, video examples (30-35 min)
   a. Current approaches and challenges for retraining walking adaptability
   b. New strategies for retraining walking adaptability—applying the evidence (Fox et al. in review; Foster et al. in press)
      i. Framework of walking adaptability (Balasubramanian et al. 2014)
      ii. Stimulate neuromuscular plasticity: repetition, intensity, task practice, saliency (Kleim and Jones 2008; Behrman and Harkema 2007)
      iii. Engage key neural control centers: spinal pattern generators for stepping, supra-spinal centers for postural responses, limb adjustments, visuo-motor control, executive functions (Yang et al. 2014; Fox et al. 2013)
   c. Adjuvant therapies, combinatorial approaches, new technologies

VI. Take-home messages (5 min)

VII. Questions (~10 min)
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Speaker Biographies:
Emily J. Fox, PT, DPT, PhD, NCS is a Research Assistant Professor in the Department of Physical Therapy at the University of Florida and a Clinical Research Scientist at Brooks Rehabilitation, Clinical Research Center. Dr. Fox is the Director of the Brooks Motion Analysis Center. Her research focuses on neuromuscular control and strategies to promote motor recovery following neurologic injury. A primary focus of her work is to develop innovative approaches to enhance locomotor control and recovery, including walking adaptability.

Chitra Balasubramanian, PT, PhD is an Associate Professor at the University of North Florida and the Director of the Clinical and Applied Movement Sciences Research Laboratory. Her primary research objectives are to quantify lower extremity impairment and investigate its association with walking and design targeted assessments and interventions for walking deficits in geriatric and neurologic populations. Her funding includes research grants from the University of North Florida and the Brooks Rehabilitation in Jacksonville, FL. The objective of her current project funded by Brooks Rehabilitation is to study walking adaptability in individuals post-stroke.

David Clark, ScD is a Research Health Scientist with the Veterans Affairs Brain Rehabilitation Research Center of Excellence at the Malcom Randall VA Medical Center. Dr. Clark is an Assistant Professor with the University of Florida’s College of Medicine. He is the Director of the Locomotor Neuroscience Laboratory. His primary research objective is to enhance mobility function in neurologically compromised populations. This is accomplished by identifying underlying mechanisms of impairment, establishing quantitative assessments, and designing novel evidence-based interventions.

References:
2. Balasubramanian CK. The Community Balance and Mobility Scale Alleviates the Ceiling Effects Observed in the Currently Used Gait and Balance Assessments for the Community-Dwelling Older Adults. J Geriatr Phys Ther. 2014;Jun 19. [Epub]


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