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## Innovative Treatments for Patients Post-Stroke Across the Continuum of Care – Evidence-Based Strategies to Improve Outcomes

Shannon Compton PT, DPT, NCS, CBIS

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## About me

- Shannon Compton is a physical therapist with extensive experience in rehabilitation across the continuum of care for individuals with stroke and traumatic brain injury. She received her Doctor of Physical Therapy degree from the University of Oklahoma Health Sciences Center. She is an ABPTS Board Certified Clinical Specialist in Neurologic Physical Therapy, and a Certified Brain Injury Specialist. She currently practices in outpatient at the Healthy Aging and Neurology clinic of Northwest Rehabilitation Associates in Salem, OR.



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## Learning Outcomes

After this course, participants will be able to:

- Describe at least five relevant concepts in motor learning and neuroplasticity to provide a framework for high quality, intense rehabilitation intervention.
- Identify at least three necessary factors to set your patients up for optimal success in their recovery - inside and outside the clinic/facility.
- Describe at least two strategies on how to help the patient identify goals that are meaningful, realistic, and adequately challenging.
- Identify at least three strategies outlined in provided patient case examples to own patient caseloads across the continuum of care for in-person and telehealth therapy applications.

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## Back to the Basics

- 795,000 people a year experience stroke
- About 87% are ischemic stroke
- Leading cause of disability in the US - 3% of males and 2% of females report being disabled by stroke
- 6.4-6.5 million stroke survivors in US
- By 2030, estimated that stroke will cost the US \$184 billion
- After stroke, females often have greater disability than males. For example, an analysis of community-living adults (>65 years of age) found that females were half as likely to be independent in activities of daily living after stroke, even after controlling for age, race, education, and marital status.
- Women have a higher mortality due to stroke and a higher incidence of disability due to stroke
  - Worse outcomes at 3-6 months
  - Less likely to receive tPA
- (AHA, 2013; Ovbiagele and Nguyen-Huynh, 2011)

## Hospitalization Trends

- Acute care hospital stays are getting shorter
- Typical IRF stay is about 14 days for Medicare patients
- IRF over SNF placement is associated with greater functional gains, but this relationship might be complicated by age, race, disability severity
- Patients discharged to SNF more likely to be older, female, more physically impaired
- Predictive model where older adults, those with pre-existing physical disabilities, and people unable to ambulate were most likely to be discharged from acute care hospital to SNF
  - Did not find that NIHSS scales were involved in predicting discharge destination
- (Hong et al, 2019; Rakesh et al, 2019)

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## Functional Outcomes

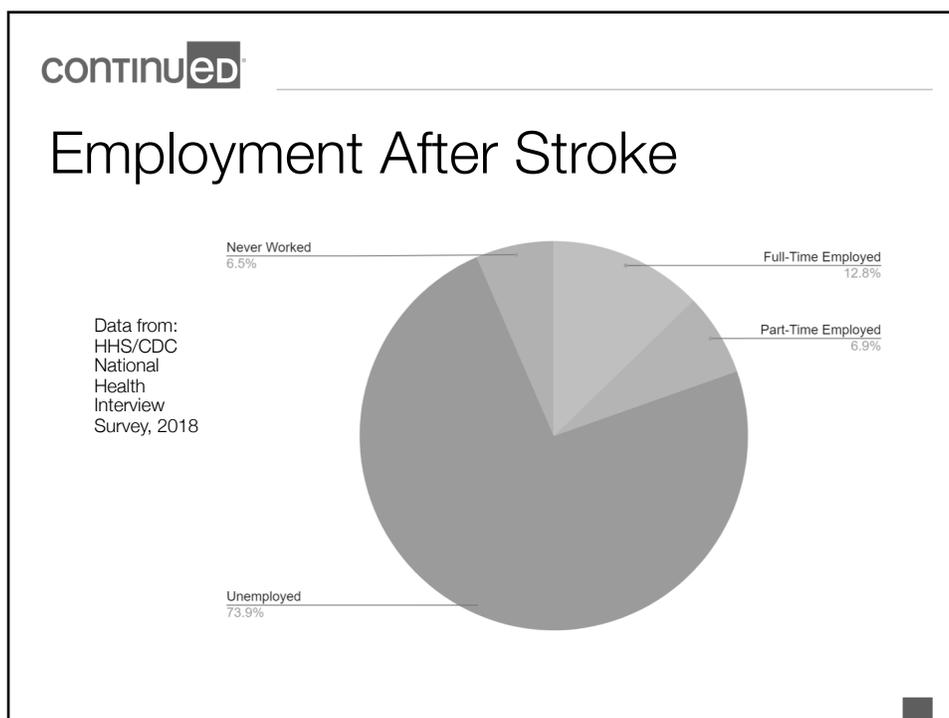
- People with higher levels of walking impairment are less physically active and at greater risk for further stroke
- People with higher levels of walking impairment are less likely to access the community → greater social isolation
- Rates of depression among stroke survivors (and caregivers) are high
- Many stroke survivors do not return to work

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## “Good Outcome” Isn’t Good Enough’

(Kapoor et al, 2017)

- Research tends to focus on physical outcome
- 2-3 years post-stroke, even those with a “good outcome” on modified Rankin Scale reported social isolation, cognitive impairment, and depression
  - 47% of those with mRS score of 0-1 had poor community re-integration as measured by RNLI



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## Feeling gloomy yet?

- Don't let these statistics get you down, let them motivate you.
- We have a couple tricks up our sleeves as therapists to help people achieve better outcomes!
  - Neuroplasticity
  - Motor learning
  - Focus on patient motivations

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## Case Study #1 - Mr. A.

- 62 year old male
- 5 years post-stroke
- Right-sided hemiparesis, very limited use of right upper extremity
- Expressive aphasia
- Ambulates independently without assistive device with right carbon-fiber AFO
- Current motivators: wants to be more independent at home to relieve wife of some caregiving stress due to other family health considerations; specifically targeting independence with fall recovery, and confidence walking on uneven surfaces so that he can perform a more intense home program without fear

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## Case Study #2 - Mr. J.

- 61 year old male
- 3 years post-stroke
- Ischemic R MCA with left-sided hemiparesis
- Ambulates with SBQC, left hinged AFO (recently graduated from KAFO), and SBA for household distances
- Current motivators: Wants to require less help from paid caregiver and return to some form of work to feel “useful” again; specifically targeting independence with in-home ambulation, and to no longer use wheelchair in community

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## Case Study #3 - Mr. K.

- 54 year old male
- 1 year post-stroke
- Thalamic hemorrhage with R-sided weakness
- Expressive aphasia
- Returning UE function
- Ambulates independently without assistive device or orthotic
- Current motivators: Go back to work to relieve financial strain on his wife and return to the company he built himself; specifically targeting higher level dual task + agility tasks, activities that involve cognitive DT + upper extremity task while moving

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## Neuroplasticity – Biological Basis for Change

- Neuroplasticity = brain's capacity to remodel (structurally and functionally) in response to stimuli/new experiences
- What do we know about stroke in regards to the brain?
  - Causes direct and indirect disruption of neural networks
  - Activation of immune response
    - Increase in inflammatory cytokines + microglia activity
  - Changes in dopamine metabolism

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## Neuroplasticity – Biological Basis for Change

### Neuroplasticity promoters:

- **BDNF** - Brain-Derived Neurotrophic Factor
- **IGF-1** - Insulin-like Growth Factor-1
- **VEGF** - Vascular Endothelial Growth Factor
- **OxA** - neuropeptide Orexin-A

### Neuroplasticity detractors:

- **Microglia**
- **IL-6** - interleukin-6
- **IL-8** - interleukin - 8
- **CRP** - C-reactive protein
- **TNF** - tumor necrosis factor

## Tipping the Scales

- We also know that there are specific ways to counteract the inflammatory immune response in the brain after stroke and shift the balance of scales back towards factors that promote neuroplasticity
  - Increase BDNF
  - Increase cerebral perfusion
  - Increase dopamine levels
  - Decrease inflammatory cytokines

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## Motor Priming (Stoykov & Madhavan, 2015)

- "...a type of implicit learning wherein a stimulus prompts a change in behavior."
- "...priming of the motor cortex is associated with changes in neuroplasticity that are associated with improvements in motor performance."
  - Stimulation-based priming
  - Motor imagery and action observation
  - Sensory priming
  - Movement-based priming
  - Pharmacological priming

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## Principles of Neurorehabilitation

(Maier et al, 2019)

- Structure of practice
  - Timing
    - Massed practice/repetitive practice
    - Spaced practice
    - Dosage/duration
  - Focus/target/etc
    - Task-specific practice
    - Variable practice
    - Increasing difficulty
- Modality
  - Multi sensory stimulation
  - Rhythmic cueing
  - Motor imagery/mental practice
  - Action observation/embodied practice
  - Social interaction
- Patient focus & feedback
  - Explicit feedback/knowledge of results
  - Implicit feedback/knowledge of performance
  - Modulate effector selection

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## 10 Principles of Experience-Dependent Plasticity Kleim and Jones (2008)

- Use it or lose it
- Use it and improve it
- Specificity
- Repetition matters
- Intensity matters
- Time matters
- Salience matters
- Age matters
- Transference
- Interference

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## OPTIMAL Theory of Motor Learning Wulf and Luthwaite (2016)

Motor learning is best promoted through:

1. Enhanced expectancies
2. Learner autonomy
3. External focus of attention

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## OPTIMAL Theory – Effects on the Brain

- Increased dopamine production
  - Improves long-term potentiation (greater neural connectivity)
  - Enlargement of spiny processes on medium spiny neurons
- Greater co-activation of neural networks
  - “Neurons that fire together, wire together.”
- Improved activation of neural networks involved in task-related functions and motor learning

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## Importance of Motivation

- We can set people up for success in every way for motor learning, but if they are not motivated to participate, their recovery will be limited
- What we do in therapy can sometimes be repetitive or abstract (reach for this cone, step on this box) so we need to make sure that we tie each activity back to the patient's motivation
- As Wulf & Luthwaite said, “Expectations are not motivationally neutral.” This means that we also need to ensure that we are adjusting our interventions so that patients feel they are attainable. If you think you will fail at something, what motivation do you have to attempt it?

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## Putting It All Together - Post-Stroke Motor Learning & Neuroplasticity

1. Motivation matters
2. Keep the focus external
3. Feedback (type, timing) is key
4. Volume matters
5. But so does quality
6. Intensity is not just about cardiovascular load
7. We can prime the brain for learning

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## Outline for the next section

1. Review a case study
2. Focus on activity related to patient's goals (video)
3. Relate activity to relevant motor learning principles
4. Discuss how to modify activity for different settings/telehealth

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## Case Study #1 - Mr. A.

Current motivators: wants to be more independent at home to relieve wife of some caregiving stress due to other family health considerations; specifically targeting independence with fall recovery, and confidence walking on uneven surfaces so that he can perform a more intense home program without fear

My plan: Train him to do something even harder than walk on uneven surfaces (jumping) so that walking seems more simple; work on walking under different conditions to improve right LE motor control.

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## Video - Mr. A.

Video 1 - Agility ladder hopping (first attempt)

Video 2 - Agility ladder training (external cueing)

Video 3 - Agility ladder hopping (post-training)

Video 4 - Backwards treadmill

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## Relevant Motor Learning Principles - Mr. A.

1. Motivation matters - In this case, he wants to attain a high level of independence with mobility. I explained how this task (hopping) relates to balance reactions, motor control, and confidence.
2. Keep the focus external - Rather than focusing on increasing the size of his hops, I gave him a target (the cup) to reach his foot toward.
3. Feedback (type, timing) is key - We did summary feedback after good trials, and let him watch video replays.
4. Volume matters - We practiced quite a bit over the course of one session!
5. But so does quality - I insisted that he take a break when the quality of his movement deteriorated.
6. Intensity is not just about cardiovascular load - In this case, hopping does get your heart rate up, but the intensity of the task also lies in the difficulty level and mental engagement necessary to complete it.
7. We can prime the brain for learning - Prior to this, we engaged in movement-based priming: aerobic exercise and hip abductor strengthening.

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## Modifying for Different Settings - Mr. A.

More acute settings: "My patients are not ready to hop - they need help to even stand."

What am I asking this gentleman to do by hopping down the agility ladder? I'm asking him to try a more challenging task that I believe is still attainable for him, but giving him an external focus of attention (the agility ladder and trying to get his shoes outside of the lines).

For the motor skill you are addressing, think of ways of increasing the demand *just a little* while keeping the patient's attention elsewhere.

When I worked in inpatient rehab with patients who required greater physical assistance, we did a lot of standing on different surfaces with another task - laundry folding, putting items away on a shelf, standing to brush teeth/comb hair, dancing in place

There is a lot of power to helping someone uncover a new skill they didn't know they had. Although we talked about the importance for someone's motivation that they feel a task is reasonable and attainable, our job, and part of our skill set, is to guide them to the point of discovery.

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## What About Telehealth? - Mr. A.

- Can you do something like hopping on telehealth?
  - Absolutely! It's all about environmental set up.
    - Countertops for support
    - My favorite at-home therapy tools are plastic cups, cans of food, etc. (sometimes patients have even better ideas based on what they know they have around!)
    - If a caregiver is present, enlist their help!
      - Show them where to stand to support the patient
      - Instruct them on how much help to give
    - Start with hopping in place to assess patient's safety near the stable surface
    - Progress to hopping along the support surface
  - At the end of the day, you know your patient best

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## Case Study #2 - Mr. J.

Current motivators: Wants to require less help from paid caregiver and return to some form of work to feel "useful" again; specifically targeting independence with in-home ambulation, and to no longer use wheelchair in community

My plan: Being able to get up from whatever chair you want, whenever you want, as safely as you want, is a large part of independence in the home, and Mr. J has trouble doing that consistently, so we are going to work on sit to stands to encourage more consistent left weight bearing.

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## Video - Mr. J.

Video 1: Sit to stand without intervention

Video 2: Sit to stand with a box under right foot

Video 3: Sit to stand with a balance disc under right foot

Video 4: Sit to stand with a box under right foot, and foot blocked so that it cannot slide backwards to help

Video 5: Sit to stand with right foot in non-weight bearing position and reach towards volunteer on left side

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## Relevant Motor Learning Principles - Mr. J.

1. Motivation matters - In this case, he wants to increase his independence in the home. I explained how this task (hopping) relates to balance reactions, motor control, and confidence.

2. Keep the focus external - His most successful trial, regardless of surface he was standing on, was when he reached to the left to high five a volunteer.

3. Feedback (type, timing) is key - I asked him to rate his own performance each time rather than giving him specific feedback.

4. Volume matters - We practiced quite a bit over the course of one session!

5. But so does quality - We did not continue to practice a movement pattern biased to the right just for the sake of getting a high number of reps of sit-to-stand.

6. Intensity is not just about cardiovascular load - Standing on a balance disc or just one foot is definitely a challenge for the mind as well as body!

7. We can prime the brain for learning - Prior to this, we engaged in movement-based priming: aerobic exercise and seated reaching for trunk activation.

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## Modifying for Different Settings - Mr. J.

“You are surrounded by people there and I don’t have that much support.”

I normally don’t have three volunteers! I rely quite a bit on environmental set up to achieve the same goal typically.

“I don’t always have access to balance discs/boxes/etc.”

If you are working in home health or happen to be at a clinic that just doesn’t have much equipment, you can make a lot happen with a stack of pillows, books, etc. (I never missed phone books until I started in neuro rehab!)

“My patients typically need more physical assist to stand up.”

You can still do a bias towards the affected side, but if you have a hi-lo mat or hospital bed, try to elevate it so that they only have to stand through a partial range of motion.

If they need some trunk support, see if there is a locking table or something else stable in the room they can use.

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## What About Telehealth? - Mr. J.

Sit to stands with different set ups are a perfect activity for telehealth

Can encourage patient to use chairs they typically sit in, or chairs they find it difficult to stand from

Great opportunity for caregiver training - best places to stand for safety, best ways to facilitate the patient doing as much as they can on their own

Help the patient set up the environment so they are successful when you are not around - like putting a small table near the chair they usually sit in to cue them to reach forward and towards the table (“like you are reaching for the remote/your glasses/your water when you go to stand”)

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## Case Study #3 - Mr. K.

Current motivators: Go back to work to relieve financial strain on his wife and return to the company he built himself; specifically targeting higher level dual task + agility tasks, activities that involve cognitive DT + upper extremity task while moving

My plan: This gentleman runs a company involved in manufacturing and is highly mobile throughout the day, navigating a busy industrial setting and managing many people, so he needs to be quick on his feet and able to use his UE automatically without it interfering with his cognitive function or balance

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## Video - Mr. K.

Video 1: Early stepping reaction training

Video 2: Stepping reactions in progress

Video 3: High level stepping reaction training

Video 4: Stepping reactions with UE and cognitive tasks

Video 5: Navigating a narrow space with UE and cognitive tasks

Video 6: Golf practice (because you have to relax after all that work)

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## Relevant Motor Learning Principles - Mr. K.

1. Motivation matters - He is very aware of how these seemingly ridiculous tasks relate to his work (and hobbies!)
2. Keep the focus external - Rather than have him focus on increasing step length or width, I try to have him focus on stepping towards certain targets (or not hitting other ones).
3. Feedback (type, timing) is key - We do summary feedback, I ask him to self-reflect, and we watch videos comparing past performance to current so he sees improvement.
4. Volume matters - We practice these high level tasks a lot.
5. But so does quality - I make him rest when his movement quality deteriorates.
6. Intensity is not just about cardiovascular load - By the time he gets to obstacle negotiation with the domino sorting task, he is clearly being very challenged by this task.
7. We can prime the brain for learning - Prior to this, we engaged in movement-based priming: aerobic exercise, LE strengthening, wobble board training for ankle activation.

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## Modifying for Different Settings - Mr. K.

- “Wow, my patients are so not ready for that.”
  - In more acute settings, patients might not be ready to train stepping reactions quite to this extent, but they can work on building confidence in their affected leg through stepping with non-affected leg towards targets, onto objects, over targets.
  - A good way to build confidence in stepping reactions is to work on tandem ambulation (or approximate it), depending on patient’s level.
- “I don’t have that equipment!”
  - Instead of a weight machine, you can attach a theraband to a stationary object (or the wall) and have the patient walk against that resistance.
  - You can also apply external perturbations to elicit stepping reactions while the person is walking using theraband or a gait belt. (I will sometimes enlist a family member for this!)
  - If you are in a home setting, using canned food or plastic cups to step over is a great solution. If you want to make it very challenging, use something larger like pots/pans or pillows!

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## What About Telehealth? - Mr. K.

- If you are asking someone to do something this intense, it is best to have a caregiver or family member present to spot them.
- Use household objects to create an obstacle course - this is a great opportunity for guidance about finding an appropriate level of challenge.
- Use theraband for resistance for walking or to give postural perturbations.
  - If theraband isn't available - use a belt, gait belt, just a hand, anything!
- If they have kids/grandkids, you can get the kids involved with games: balloon toss, ball toss, blowing bubbles for the patient to pop, etc.
  - (I have even been known to encourage Nerf gun battles!)

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## Summary

- Stroke continues to be a leading cause of disability in our communities, and unfortunately is not going to decline anytime soon
- As physical therapists, we are not just helping our patients move better - our job is to help people reimagine their futures after something traumatic has happened to them
- Neuroplasticity is a powerful tool we can use to our advantage - but we need to center our interventions around the person's motivation to maximize success
- Intensity does not just equate to cardiovascular load, but also to the complexity of the task we design

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## Parting Thoughts

“If we want to reach someone’s full capacity then we need to go beyond this limited choice that patients come up with on their own without a physical therapist - encourage potentially riskier, more difficult solutions. With what we know about brain plasticity, it is our job to help patients experience that they have more options.” -Beth Fisher, PT, PhD, FAPTA (John H. P. Maley Lecture at 2019 NEXT Conference)

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## References

- Doll, D., Barr, T., & Simpkins, J. (2014). Cytokines: their role in stroke and potential use as biomarkers and therapeutic targets. *Aging and Disease*, 5(5), 294-306. doi: 10.14336/AD.2014.0500294.
- Gower, A. & Tiberi, M. (2018). The intersection of central dopamine system and stroke: potential avenues aiming at enhancement of motor recovery. *Frontiers in Synaptic Neuroscience*, 10(18). doi: 10.3389/fnsyn.2018.00018.
- Hong, I., Karmarkar, A., Chan, W., Kuo, Y., Mallinson, T., Ottenbacher, K., Goodwin, J., Andersen, C., & Reistetter, T. (2018). Discharge patterns for ischemic and hemorrhagic stroke patients going from acute care hospitals to inpatient and skilled nursing rehabilitation. *American Journal of Physical Medicine and Rehabilitation*, 97(9), 636-45. doi:10.1097/PHM.0000000000000932.
- Kapoor, A., Lanctot, K., Bayley, M., Kiss, A., Herrmann, N., Murray, B., & Swartz, R. (2017). “Good outcome” isn’t good enough. *Stroke*, 48(6), 1688-90. doi: 10.1161/STROKEAHA.117.016728.
- Kleim, J., & Jones, T. (2008). Principles of experience-dependent neural plasticity: implications for rehabilitation after brain damage. *Journal of Speech, Language, and Hearing Research*, 51, S2225-S2239. doi: 1092-4388/08/5101-S225.
- Mang, C. S., Campbell, K. L., Ross, C. J., & Boyd, L. A. (2013). Promoting Neuroplasticity for Motor Rehabilitation After Stroke: Considering the Effects of Aerobic Exercise and Genetic Variation on Brain-Derived Neurotrophic Factor. *Physical Therapy*, 93(12), 1707-1716. doi:10.2522/ptj.20130053.
- Maier, M., Ballester, B.R., & Verschure, P. (2019). Principles of neurorehabilitation after stroke based on motor learning and brain plasticity mechanisms. *Frontiers in Systems Neuroscience*, 13(74). <https://doi.org/10.3389/fnsys.2019.00074>.

CONTINUED

## References (continued)

- Ovbiagele, B. & Nguyen-Huynh, M. (2011). Stroke epidemiology: advancing our understanding of disease mechanism and therapy. *Neurotherapeutics*, 8(3), 319-29. doi: 10.1007/s13311-011-0053-1
- Ovbiagele, B., et al. (2013). Forecasting the future of stroke in the United States: a policy statement from the American Heart Association and American Stroke Association. *Stroke*, 44, 2361-75. doi: 10.1161/STR.0b013e31829734f2.
- Rakesh, N., Boiarsky, D., Athar, A., Hinds, S. & Stein, J. (2019). Post-stroke rehabilitation: factors predicting discharge to acute versus subacute rehabilitation facilities. *Medicine*, 98(22). doi: 10.1097/MD.00000000000015934.
- Scrutinio, D., et al. (2017). Development and validation of a predictive model for functional outcome after stroke rehabilitation: the Maugeri model. *Stroke*, 48, 3308-15. doi: 10.1161/STROKEAHA.117.018058.
- Stoykov, M.E., & Madhavan, S. (2015). Motor priming in neurorehabilitation. *Journal of Neurologic Physical Therapy*, 39(1), 33-42. doi: 10.1097/NPT.0000000000000065.
- Vive, S., Geijerstam, J.L., Kuhn, G. & Bunketorp-Kall, L. (2020). Enriched, task-specific therapy in the chronic phase after stroke: an exploratory study. *Journal of Neurologic Physical Therapy*, 44, 145-55. doi: 10.1097/NPT.0000000000000309.
- Wulf, G., & Lewthwaite, R. (2016). Optimizing performance through intrinsic motivation and attention for learning: The OPTIMAL theory of motor learning. *Psychonomic Bulletin & Review*, 23(5):1382-1414. doi: 10.3758/s13423-015-0999-9.