## Brian W. Schulz, Ph.D.

Clinicians in physical medicine & rehabilitation typically work from very broad principals of biomechanics, motor control, and exercise science. They generally conduct prospective randomized clinical trials of exercise interventions intended to improve clinical outcomes across several time points. Occasionally these are powered to detect changes in the true outcomes of interest (e.g. falls, injurious falls, death) but due to the low relative frequency of these events, intermediate clinical assessments shown to associate with these primary outcomes (e.g. Timed-Up-and-Go (TUG) with falls) are often used to bring the required sample size down to a more manageable number. These clinical outcome measures are limited in the depth of the information they collect and can determine that the subject improved, but not what exactly improved.

Biomechanics researchers typically evaluate a narrow clinical population at a single time point to determine that the population of interest is worse than a control population in some way during a specific task. Extensive and detailed differences in these populations can be detected, but the effectiveness of altering these differences on the underlying pathology or adverse outcome is rarely addressed.

There is a need for both clinicians and biomechanics researchers to "bridge the gap" between clinical practice and biomechanical knowledge. The following Research Recommendations are potential mechanisms to increase and improve the translation of biomechanics knowledge to clinical practice:

1. **Improve and expand the translation of complex and expensive biomechanical tests into simpler and cheaper clinical tests to make them more accessible, understandable, and useful to clinicians.** Examples of this recommendation include:
    a. Correlating gait speed and/or other more easily measured spatiotemporal variables with difficult to quantify kinetics such as hip extensor power.
    b. When evaluating complex outcomes such as whole-body center of mass (COM) that require a full motion capture lab, evaluate simplified outcomes in parallel such as single-marker COM representations to determine if similar results can be detected with less instrumentation.
    c. Creating and validating portable and simplified instrumentation that clinicians can easily use and interpret without assistance from a researcher. If the single-marker COM position representation from the above example proved adequate to detect meaningful effects, a portable system using a single inertial sensor and handheld interface could be devised for clinical use.
2. **The converse of this is also needed: the underlying biomechanical and motor control constructs quantified by the best/most popular clinical assessments need to be better understood.**
    The knowledge of what abilities correlate with improved performance on specific components of these clinical assessments would lead both to improved versions of these assessments and improved interpretation of existing tests. A hypothetical example of this is here illustrated for the TUG:
        The duration of specific phases comprising the TUG (i.e. stand, walk, turn, sit) would first be examined to determine if the duration of one or more phases predict fall risk better than the overall time. If the time to sit or stand proves to be the most predictive phase, detailed analysis would then be completed on these phases to determine which biomechanical or motor control construct (e.g. peak leg strength, power, motor control/balance) are most responsible for these delays. These underlying constructs could then be more effectively targeted by subsequent training interventions.
3. **Prospectively evaluate the effects of interventions on specific biomechanical outcomes.** Detailed testing on even subgroups of larger-scale prospective studies could provide invaluable data on mechanisms of improvement. For example, an isometric leg press has recently been shown to be a strong predictor of the ability to successfully recover from a lab induced trip, but it has not been established that training to improve leg strength is effective at improving the ability of subjects to recover from these trips.

**In summary**, these three proposed Research Recommendations would help bridge the gap between biomechanics research and clinical practice by "bringing the lab to the clinic and the clinic to the lab" in terms of outcome measures (**1 & 2:** clinical vs. biomechanical outcomes) and research techniques (**3:** low-N but detailed retrospective laboratory analysis vs. high-N but cursory prospective clinical trial).