The purpose of this course is to show the benefits of utilizing technology in the clinical setting and also demonstrate how this technology is readily available to all clinicians.

OBJECTIVES

After completing the course, each clinician should be able to meet the following objectives:

1. Each clinician will show a better understanding of how to incorporate the use of technology into their practice.

2. Each clinician will understand the benefits of utilizing technology during treatments for athletes and active adults to improve patient outcomes.

3. Each clinician will understand the benefits of utilizing technology to improve effectiveness of assessing athletes and active adults performing their sport or activity.

4. Each clinician will leave the course with a basic understanding of how to incorporate readily available technology into their daily clinical practice.
**SCHEDULE**

- Period 1: Thursday Oct 4th, 8am – 12pm
- Period 2: Thursday Oct 4th, 2pm – 5pm
- Period 3: Thursday Oct 5th, 8am – 12pm

**MY BACKGROUND**

- I have been working in a sports medicine setting since 2006.
- Over the past 5 years, we have assembled a team of physical therapists, athletic trainers, and strength and conditioning specialists that have developed assessment and treatment approaches/techniques that harness research grade technology in a clinical setting.
- My team started with iPads and have now incorporated force plates, wireless EMG and video analysis into their practice to improve patient outcomes.
- I currently practice at the newly constructed Bellin Health Titletown Sports Medicine and Orthopedics clinic across from Lambeau Field.

**WHY ASSESS MOVEMENT?**

ICF Model encourages assessment of patients within the context of their function.

Evaluation of patients, for example athletes and employees of different occupations, should be evaluated with consideration to their sport or occupational demands.

“Components of ROM, flexibility, muscular strength, endurance, coordination, balance, and motor control of multiple regions can be assessed simultaneously by observing the movement patterns in which the athlete normally functions.” (Kivlan & Martin (2012) Int J of Sports Phys Ther.)

**CATEGORIES OF INJURY**

1. Structural
2. Hormonal
3. Biomechanical
4. Neuromuscular
COMMON INJURIES IN ATHLETES

- Common running injuries
  - PFPS
  - IT band friction syndrome
  - Plantar fasciitis
  - Tibial stress fracture
  - Knee meniscal injuries


ADDITIONAL COMMON INJURIES

- Achilles tendonitis
- Calf strains
- Compartment syndrome
- Hamstring strains
- Low back pain
- Metatarsalgia
- Medial tibial stress syndrome/shin splints
- Piriformis syndrome
- Posterior tibial tendonitis
- Quad strain
- Other stress fractures

COMMON MISUNDERSTANDING

- Just because you are strong, does not mean you are moving properly
- Are you treating the symptom or the cause
- How many of your active patients seem to show a short term good response to focus simply on strengthening, flexibility and mobility…yet never fully got back to their goal of running/playing?

TRADITIONAL REHAB

- Heavy focus on quadriceps, specifically the VMO
STRENGTH RATIOS

- Study by Stearns, Keim and Powers in 2013 looked at knee to hip strength ratios and how it affected landing muscle firing patterns.
  - Women had higher knee to hip moment ratio than men during drop jump deceleration phase
  - Women also showed a high strength ratio of knee to hip
  - Use what is strongest?
  - Better when more uniform?

TRAIN FOR UNIFORM STRENGTH

- Stearns and Powers followed this study up with another study in 2014 looking at hip ext weakness during landing tasks
  - 3x/week for 30 min. focused on hip strength with plyometrics and balance perturbations
  - Saw increase in hip ext and abd strength, no change in knee ext strength
  - Drop jump showed improved knee and hip flexion and improved knee to hip moment ratio
- Powers gets labeled as the “hip guy”, when really what he focuses on is uniform strength to even out the work load for the joints

THE ROLE OF THE GLUTEUS MAXIMUS

- Tri-planar muscle
  - Extends hip
  - Abducts hip
  - Externally rotates hip

- The gluteals are the stable foundation to build up and down from

WHAT IS PERFECT POSITION FOR JOINTS?

- We might not all be able to agree on what is perfect…but we should be able to agree on what is not perfect
MECHANISM OF ACL TEAR

- Deceleration/Change in direction
- Knee flexion 0-30°
- Tibial rotation and varus/valgus forces
  - Kirkendall and Garrett, 2000
- Increased knee valgus and increased valgus moments were predictive of ACL tears
  - Hewett et al., AJSM, 2005

PATELLAR TRACKING

- Figure 2a and 2b. Diagram showing distribution of compressive forces on back of kneecap with normal patellar tracking (2a) and abnormal patellar tracking (2b).

HIP STABILITY AND PFPS

- Excessive Hip Internal Rotation and PFP
  - Souza et al., 2009
  - Boling et al., 2009
  - Wirtz et al., 2011
  - Noehren et al., 2011

- 10° change in the Q-angle increased peak pressures by 45%
  - Huberti & Hayes, JBJS, 1984
  - Powers, JOSPT, 2003

- Hip Adduction and PFP
  - Noehren et al., 2011
  - Noehren et al., 2013

TREATING PFPS

- Decrease laterally directed PFJ forces
  - Control and minimize dynamic Q-angle
  - Emphasis on gluteus maximus and medius strengthening (too many studies to list!)

- Decrease quadriceps dominance
  - Quadriceps strengthening?
  - It is a major decelerator but should it be our main focus?

- Maximize PFJ contact area
  - Minimize femur IR
COMMON MOVEMENT PATTERNS THAT CAUSE INJURY

- Knee valgus
- Hip internal rotation
- Hip adduction
- Poor shock absorption

RESEARCH

- There is limited evidence overall in the area of utilizing technology for clinic based activities.
- Historically, all research that utilized technology was not readily applicable to day to day clinic use due to cost and overall set up.

CATEGORIES OF MOVEMENT

- Hip stability
- Pelvic stability
- Trunk stability
- Shock absorption
- Hip strategy

HIP STABILITY
WHY WERE THESE CHOSEN?

- 70% ACL tears are non-contact
- **Categories:**
  1. Structural
  2. Hormonal
  3. Biomechanical
  4. Neuromuscular

RESEARCH

- Now you have background of the most common LE injuries, common movement patterns…
- What does the research say!

RESEARCH – MOVEMENT ANALYSIS

- Two-dimensional video analysis is comparable to 3D motion capture in lower extremity movement assessment
  - 2D and 3D video analysis of single leg squat
  - Measured displacement of trunk, hip, knee, ankle in frontal and sagittal planes

SCHURR ET AL
DEFRODA ET AL
- Two-dimensional video analysis of youth and adolescent pitching biomechanics: A tool for the common athlete
  - Guide of how to use 2D vs 3D to assess pitching.
  - Recognizing that 3D is gold standard, but not practical for most

MAYKUT ET AL
- Concurrent validity and reliability of 2D kinematic analysis of frontal plane motion during running
  - Found support for the use of 2D video analysis in the evaluation of frontal plane variables during running (specifically peak hip adduction)

OLBRANTZ ET AL
- Effect of post-trial visual feedback and fatigue during drop landings on patellofemoral joint stress in healthy female adults
  - Drop jumps during 3 conditions: baseline, feedback, post-fatigue feedback
  - Showed increased knee flexion, decreased PFJS and decreased ground reaction forces
    - Results did not carryover to post-fatigue condition

RESEARCH – PERFORMANCE TESTING
KIVLAN ET ALL

- Functional performance testing of the hip in athletes: A systemic review for reliability and validity
  - Found reliability in 2 movement, 3 balance, 11 hop/jump and 3 agility tests
  - In the functional assessment of hip dysfunction found 4 tests with evidence or validity and normative data for score interpretation

LEWIS ET AL

- Differences in lower extremity and trunk kinematics between single leg squat and step down tasks
  - Single leg squat and single leg step down tasks result in moderate to excellent correlation of knee and hip angles, less correlation at the pelvis and trunk

RESEARCH – FEEDBACK

POPOVIC ET AL

- Implicit video feedback produces positive changes in landing mechanics
  - box-jumps 3x/week for 6 weeks
    - Implicit and explicit groups received video feedback
    - Implicit cues were focused on entire jump
    - Explicit cues were focused on position of knees
    - Each session, overall amount of feedback was reduced
  - Implicit produced positive change, explicit degraded motor learning
DALLINGA ET AL

- Innovative video feedback on jump landing improves landing technique in males
  - Video feedback was done by mirroring landing with an “expert”
    - Subject is trying to create as much overlap with expert as possible
  - Results showed video feedback group had great hip flexion and lesser ground reaction forces

BENJAMINSE ET AL

- Video feedback and 2-dimensional landing mechanics in elite female handball players
  - Tested jump shots focused on landing
  - Test group received video feedback of an expert model with an overlay of their own jump shots from training sessions 1&2.
  - Results showed increased knee and hip flexion. (vertical jump did not improve, accuracy did not improve, but horizontal jump distance did improve)
    - Results showed video feedback had greatest improvement in hip flexion, and both the video and external focus group had greater hip flexion compared to internal focus group.

WOUTERS ET AL

- Effects of a movement training program on hip and knee joint frontal plane running mechanics
  - Significant improvement in hip IR/hip add moments with verbal and tactile cues of a 4 week training session
  - Video analysis not used in treatment, but was used in assessment

TSAI ET AL

- Increased hip and knee flexion during landing decreases tibiofemoral compression forces in women who have undergone anterior ligament reconstruction
  - Single leg drop jumps with video and verbal feedback
  - Results: increased hip/knee flexion, decreased compressive forces and decreased co-contraction
**TATE ET AL**

- The effects of a home-based instructional program aimed at improving frontal plane knee biomechanics during a jump-landing task
  - Cues given to improve hip/knee flexion and hip abduction during landing (basketball rebound)
  - Experimental group saw good retention in their improvements of knee/hip flexion and hip abduction with HEP

**TAYLOR ET AL**

- Real-time optimized biofeedback utilizing sport techniques (ROBUST): a study protocol for a randomized controlled trial
  - 3x/week neuromuscular preventive training and 1x/week biofeedback
    - Mode of feedback depending on their randomization to one of 3 biofeedback groups: hip-focused, knee-focused, sham
  - Primary focus was to assess impact of biofeedback on knee abduction moments.
  - Final analyses to be completed in April 2019

**MAJOR TAKE-AWAYS**

- Video analysis is a great tool for assessing movement, and assisting in treatment as well
- Getting people to change the way they move can be done in a variety of different ways

**TRAINING THE BRAIN**

- **Feedback**
  - External focus
  - Concurrent/Real time feedback is best for complex skills
  - Video and verbal
  - Frequency
    - 100% if external
    - 50% if multiple
- **Contextual Variety**
  - Start blocked and then random (AAABBBCCBCABBCACBCCABCBCA)
- **Motivation**
  - Positive support
  - Increase confidence (even if white lies!)
- **Build Variability (Scaling)**
  - Vary the height of the box jumps, create obstacle courses
- **Retention Tests**
  - Perform recheck tests to see if they are retaining what you are teaching. Has to become automatic
INTRO TO TECHNOLOGY

- Research grade technology:
  - high speed video capture and playback software (minimum 120 frames/sec)
  - Wireless EMG
  - Force plate
  - Isokinetic/isometric units for strength testing

- Most of these options are not realistic for most clinical settings.
- If you have someone in your market that has some of these items, do not hesitate to engage them and discuss how you can send patients for test, and then return patient to you

INTRO TO TECHNOLOGY

- Research grade technology is very costly, for most businesses it is hard to make the argument to get these dollars.

- There are many options readily available at your fingertips for video analysis:
  - Smartphone
  - Table

ATHLETIC MOVEMENT IS TOO QUICK FOR THE NAKED EYE

- https://www.youtube.com/watch?v=vJG698U2Mvo

PUT INTO PRACTICE

- Video analysis lab
  - Get out your smart phones and/or tablets
  - You can download a video capture app, or simply use your camera/video app already on your phone

  - Video:
    - Step down
    - Drop jump
    - Gait
LAB - FEEDBACK

- Now repeat those same tests and start practicing different forms of external and internal cues along with the video
  - How often to give feedback?
  - What type of feedback worked best?

LE STRENGTH AND MOVEMENT GUIDE

1. Non-weightbearing, isolation/activation
2. Weightbearing, double limb, static
3. Weightbearing, single limb, static
4. Weightbearing, double limb, dynamic
5. Weightbearing, single limb, dynamic
6. Weightbearing, double limb, ballistic
7. Weightbearing, single limb, ballistic
8. Change of direction

EXERCISE LAB

- Grab a band, and a partner
- We will start by doing each exercise without any feedback, then repeat with both external, internal and video feedback where appropriate
- What worked best?
- What exercises do you have to add to the list?
- What cues worked best for you?

WHERE TO GET MORE EXERCISE IDEAS?

- Social media is a great place to interact with other providers that are in practice settings similar to yours
  - Instagram – rehab science, prehab guys…
  - These are great places to interact, share ideas and get new ideas
    - Yes in a way we are competing with each other in our markets, but we are also all trying to elevate our profession overall