‘Performance Diagnosis Informs Athlete Management’

Professor Robert Newton

Performance Diagnosis Informs Athlete Management

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Introduction

• Discussion of the process of determining, assessing and monitoring performance qualities critical to the target sport

Assessment and Interpretation through Performance Diagnosis

• any sport – key cardiorespiratory and neuromuscular components characterize performance

• Discriminating and evaluating components - invaluable for athlete monitoring/program design

• Process termed “performance diagnosis”

• Certain measures represent specific or independent qualities of performance
Performance diagnosis is the process of determining an athlete’s level of development of distinct strength, power, speed, endurance and other qualities.

- Targeting specific performance qualities with prescribed training will result in enhanced athlete performance.

**Athlete and Coach Feedback**

- Critical for motivation and learning
- Creates team approach and trust
- Increases job security for the Strength and Conditioning Specialist!

**Window of Adaptation**

- Powerful movement has many components.
- Effective training should involve "Mixed Methods" approach.
- The more developed particular component - smaller the window of adaptation – principle of diminishing returns.
- Greatest efficiency of training derived from targeting components which the athlete is most weak.
Determination of key performance characteristics

- Essential for achieving goals
- Biomechanical evaluation
- Analysis of high level athletes in that sport
- Ongoing monitoring

Biomechanical Analysis

- Quantification of force, velocity and power profile of target movements
- Contact times
- Analysis of joint and muscle involvement:
  - Type and rate of contraction
  - Range of motion

Physiological Needs Analysis

- Game analysis, video, GPS
- Duration, intensity, work rest ratios
- Power performance under fatigue?
- Combative sports – impact of repeated physical contact
- Environmental issues – heat, cold, altitude
- Body composition
Analysis of high level athletes

- If successful can assume have appropriate performance qualities for sport
- Caution – success may be due to factors other than underlying neuromuscular and cardiorespiratory capacity

Ongoing monitoring

- Test athletes before and after phases involving certain training emphases
- Large improvements in targeted quality - deficient in that quality
- Maintain emphasis until some plateau occurs
- Careful
  - May not be important
  - Don’t sacrifice stimulus variation

Comparison Across Squad

- Individual ranked low on a particular quality
- Coach appraisal
- Rookies versus seniors
- Comparison to past squad profiles
- Individual ranking over time

Test – Retest Cycle

- Coach evaluates athlete
- Scientist – education & information
- Performance needs analysis
- Initial testing
- Training program design
- Implementation of program
Measurement Technology
Power
- Timing Systems
- Displacement (distance) measurement
- Force measurement
- Accelerometry
- High speed video

Timing Systems
- Light gates
- Contact mats
- Sprint speed
- Change of direction
- Reaction time
- Reactive Agility Tests
- Contact and flight times
- Counting and timing repetitions
- Real time feedback

Real time Performance Feedback
-4%
0.0

Displacement Measurement
- Distance
- Velocity
- Acceleration
- Mass – Force
- Force x velocity = power
Force Measurement

- Single axis force plate
- Vertical force
- Impulse
- Velocity
- Displacement
- Power
- Stiffness
- Rate of force and power development

Combined Systems

- Most valid and reliable
- Force plate
  - Force, impulse, RFD, MDS
- Displacement transducer
  - Distance, velocity
- Power = force x velocity

Example – Vertical Jump

![Graph showing vertical jump performance metrics]

Example – Vertical Jump

![Graph showing force-time relationship for vertical jump]
Example test protocol: vertical jump sports

- Basketball, volleyball, tae kwon do, gymnastics, diving, etc.

Maximal Strength

- Isometric maximum
- 1RM squat
- Sub maximal 6-10 RM for 1RM prediction

Variables

- Force maximum
- Force maximum / body weight
- Measures of mRFD

Loaded Jump Squats

- Measure force and bar kinematics
- Calculate height, velocity, force and power output
- Concentric spectrum e.g. 30%, 50%, and 80% 1RM and/or
- Determine optimal load for power production
Methods of calculating power output

Large errors in estimating optimal load if do not include body weight during jump squat

Dugan et al JSCR 2004

Determination of Optimal Load

- Adjust load in ballistic movements
- Results in changes in power output
- One load will produce highest power output

Optimal Load

- Load that elicits the highest mechanical power output
- Must consider total load moved i.e. include body weight if jumping
- Absolute load or
- % MVC or 1RM

Evaluating training by monitoring optimal load

- The load at which mechanical power is maximized shifts in response to training demands
- Provides a good tool for monitoring effects of periodization as well as detect overtraining, illness, staleness
Evaluating training program by monitoring optimal load…

Counter movement jump

- Record ground reaction force as well as displacement
- Calculate:
  - jump height
  - peak velocity
  - power output

Concentric only jump

- Record ground reaction force as well as displacement
- Calculate:
  - jump height
  - peak velocity
  - power output
  - MDS
  - mRFD
  - Total impulse

Drop jumps

- Record ground reaction force as well as displacement
- Jump for maximum height and height while minimizing contact time
- Test at 0.30, 0.45, 0.60, 0.75 m drop height
Drop Jumps…2

- Calculate:
  - jump height
  - flight time
  - contact time
  - flight/contact time – reactive strength (RS)
  - determine best drop height

Drop Jumps…3

- Best drop jump height
- Relationship to CMJ
- Changes with reactive strength training

Repeat jumps – power endurance

- Record ground reaction force as well as displacement
- Target time or number
- Calculate:
  - jump height
  - peak velocity
  - power output
  - changes in these variables over set
  - total work done
  - average power output

Contact Time

- Force plate or contact mat system to record contact times over multiple jumps or bounds
- Total contact time
- Average contact time
- Increase in contact time over set
Gait Analysis – step length and rate

Gait Analysis - COP

Gait Symmetry
• Vertical force difference
  104 N (p < .05)
• Horizontal force difference
  134 N (p < .05)
• Power output difference
  742 W (p < .05)

Reactive Agility Testing and Training
• Problem of validity of current agility tests
  • Must include anticipation and decision-making components (open skill)
  • Reactive Agility Test (RAT) Sheppard et al, 2005
Musculo-tendinous Stiffness

- Strength and flexibility training alters elastic characteristics
- Musculo-tendinous stiffness contributes to strength and power
- Tuning to movement frequency?
- Factor in injury
  Trainable!

Musculo-tendinous Stiffness

- Bench press (Wilson et al. 1994)
- Triceps Surae (Watsford et al. 2003)
- Leg Press (Walshe et al. 1997)
- Hamstrings (Dugan et al. 2005)
- Hopping (Dalleau et al. 2004)
- Sprinting (Morin et al. 2006)
- Diagnostic tool?

Musculo-tendinous stiffness CMJ

\[ k = \frac{(1441.313)(0.34572 - 0.0906)}{0.0004} = 4505 \text{ N.m}^{-1} \]

Musculo-tendinous Stiffness Sprinting
How to express the information

- One of the most important aspects
- Yet often done poorly or not at all
- Must be complete, valid and reliable
- Easily accessed – web based
- Secure and confidential
- Provides research, feedback, education
- Identify relative weaknesses and strengths
- Adjust training program

Profile of Strength Qualities

- Excellent

Profile of Strength Qualities

- Needs work

What to look for

- Deficiencies in a key quality
- Lack of progression of a target quality
- Sudden decline in a strength quality
- Excessive imbalances left to right
- Excessive Agonist – antagonist imbalance
The future?

- Online data collection - wireless
- Real-time reporting
- Web-based report and support
- Field monitoring – training and testing
- Education – on-line, extensive, pervasive, accurate, based in science, relevant

Total Athlete Management

- Demands on athletes in terms of training, travel, competition, sponsorship and social commitments
- Requires a holistic and coordinated approach
- Systems require more development

Total Athlete Management…2

- Ongoing assessment program including 4 or 8 weekly extensive testing sessions
- Integrated with weekly or more frequent minimized testing
- Crucial to accurately track negative and positive outcomes of these demands

Facilitate Planning

- Optimal preparation
- Long term monitoring
- Careful planning
- Individualised
- Based in science
- Travel management
- Competition
**Information Transfer**

- Key component for success - effectiveness of transfer of information
- Problems highlighted
- Training more effective
- Coach and athlete understanding increased
- Greater acceptance of testing and training demands

Human machine adapts rapidly and specifically
“Tuning” neural and muscular systems is essential
S&C Specialist is the “performance engineer”

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**Thank You**