RECOMMENDATIONS FOR AN EVIDENCE-BASED PARA DRESSAGE CLASSIFICATION SYSTEM: AN INTRODUCTION AND UPDATE ON RESEARCH

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CLASSIFICATION IN PARA SPORT

- Determines who is eligible to compete in para-sport and groups the eligible athletes in sport classes according to their activity limitation in a certain sport (IPC, 2015)

- Purpose: “to promote participation in sport by people with disabilities by minimising the impact of eligible impairment on the outcome of competition (Tweedy, 2002)”
  - Athletes are successful NOT because their impairment is less severe than competitors.

- Sport-specific Classification
  - An impairment of any given type, severity or location may cause relatively little disadvantage in one sport, but significant disadvantage in another
WHAT IS AN “IMPAIRMENT”? 
WHO – INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY AND HEALTH” (ICF).

**Body Functions** are physiological functions of body systems (including psychological functions).

**Body Structures** are anatomical parts of the body such as organs, limbs and their components.

**Impairments** are problems in body function or structure such as a significant deviation or loss.

**Activity** is the execution of a task or action by an individual.

**Participation** is involvement in a life situation.

**Activity Limitations** are difficulties an individual may have in executing activities.

**Participation Restrictions** are problems an individual may experience in involvement in life situations.

**Environmental Factors** make up the physical, social and attitudinal environment in which people live and conduct their lives.

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**Table 1. An overview of ICF**

<table>
<thead>
<tr>
<th>Components</th>
<th>Body Functions and Structures</th>
<th>Activities and Participation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domains</td>
<td>Body functions</td>
<td>Life areas (tasks, actions)</td>
</tr>
<tr>
<td></td>
<td>Body structures</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Change in body functions</td>
<td>Capacity</td>
</tr>
<tr>
<td></td>
<td>(physiological)</td>
<td>Executing tasks in a standard environment</td>
</tr>
<tr>
<td></td>
<td>Change in body structures</td>
<td>Performance</td>
</tr>
<tr>
<td></td>
<td>(anatomical)</td>
<td>Executing tasks in the current environment</td>
</tr>
<tr>
<td></td>
<td>Positive aspect</td>
<td>Activities</td>
</tr>
<tr>
<td></td>
<td>Functioning</td>
<td>Participation</td>
</tr>
<tr>
<td></td>
<td>Impairment</td>
<td>Activity limitation</td>
</tr>
<tr>
<td></td>
<td>Participation restriction</td>
<td>Disablity</td>
</tr>
</tbody>
</table>
IPC’S CLASSIFICATION CODE AND INTERNATIONAL STANDARDS (2007)

- General framework for Paralympic Classification across all sports.
- Committed to the development of:
  - Evidence-based systems of Classification.
  - Transparent and defensible systems of Classification
- “International Paralympic Committee Position Stand – Background and Scientific Principles of Classification in Paralympic Sport” (Tweedy and Vanlandewijck, 2011).
- No sport has fully achieved the requirement for a system of Classification to be evidence-based – Research Required
CLASSIFICATION SYSTEMS SHOULD:

- Describe eligibility criteria in terms of:
  - Type of impairment
  - Severity of impairment

- Describe methods for classifying eligible impairments according to the extent of activity limitation they cause

RESEARCH –

- Develop objective, reliable measures of impairment and activity limitation.
- Investigate the relative strength of association between impairment and activity limitation.
ELIGIBLE IMPAIRMENTS

1. Vision Impairment
2. Intellectual Impairment
3. Hypertonia
4. Ataxia
5. Athetosis
6. Impaired Muscle Power
7. Impaired ROM
8. Limb Deficiency
9. Leg Length Difference
10. Short Stature

“Minimum impairment Criterion – to be eligible the impairment must be severe enough that it impacts his/her sport performance (IPC, 2015).”
Figure 7.1  Schematic representation of research required for the development of evidence-based systems of classification. The boxes with the solid outlines (Steps 1–5) are essential. The boxes with dashed outlines (QA1–QA3) are not essential to every research program, but are generally important quality assurance (QA) measures.
EXAMPLE: CONNICK ET AL. (2015) HOW MUCH DO RANGE OF MOVEMENT AND COORDINATION AFFECT PARALYMPIC SPRINT PERFORMANCE?

• Focussed on:
  • Eligible impairments: ataxia, hypertonia, athetosis (i.e. CP, traumatic brain injury)
  • Sport classes: T35 – 38
  • Measures of impairment: Range of movement (ROM), Coordination
  • Measure of performance: acceleration, maximal velocity
  • Assess relative strength of association between measures of impairment and measures of performance to evaluate the validity of tests for purposes of classification.

31-38: Track and field athletes with cerebral palsy or other neurological conditions that affect muscle co-ordination and control. Athletes in classes 31-34 compete in a seated position (using a racing or throwing chair), while athletes in classes 35-38 compete standing.
Running speed
Time for \( n \) meters (s)

ROM (measured using digital inclinometer):
- Max thigh flexion and heel pull distance
- Max thigh extension
- Dorsiflexion lunge
- Backward stepping lunge

Coordination (lower limb reciprocal tapping task)
- Reciprocal unilateral tapping (RUT) 0.05 m target
- RUT 0.12 m target
- Reciprocal bilateral tapping (RBT)

60 m Maximal Sprint
- Time to 15 m (acceleration phase)
- Time between 30 – 60 m (maximal velocity phase)

Pearson correlation coefficients to evaluate relationship between outcome measures and sprint performance.

- Heel pull distance
- Maximum thigh extension (best leg)
- Maximum thigh flexion (best leg)
- Dorsiflexion lunge (best leg)
ROM and coordination tests were ratio-scaled = use of inferential statistics to quantify impact on running performance

Valid measures of impairment must also be:
- Specific to eligible impairment of interest
- Reliable
- Precise
- Quantitative
- Parsimonious (account for greatest possible variance in sports performance)
- Training resistant

FIGURE 4—A, B. Dorsiflexion lunge versus acceleration (0–15 m) and dorsiflexion lunge versus maximal velocity (30–60 m) respectively. In each panel, the coefficient of determination ($R^2$) is presented on the top right of the panel for RBI and for NDR. In each case, $R^2$ is significant for RBI but not for NDR ($P < 0.05$).

Connick et al., 2015
Project Title

The relationship between impairment, functional ability and performance in Para-Equestrian dressage riders: evidence-based recommendations for revising current Para-Equestrian Classification systems.

Project Aim:

To develop a comprehensive understanding of the effect of different physical impairment types on performance in dressage, which will inform recommendations for an evidence-based, sport-specific Classification system for Para-Equestrian dressage.
CLASSIFICATION IN PARA-DRESSAGE

1. **Grade I** – Athletes have severe Impairments affecting all limbs and trunk. The Athlete usually requires the use of a wheelchair. They may be able to walk with an unsteady gait. Trunk and balance are severely impaired.

2. **Grade II** – Athletes have either a severe Impairment of the trunk and minimal Impairment of the upper limbs or moderate Impairment of the trunk, upper and lower limbs. Most Athletes in use a wheelchair in daily life.

3. **Grade III** – Athletes have severe Impairments in both lower limbs with minimal or no Impairment of the trunk or moderate Impairment of the upper and lower limbs and trunk. Some Athletes may use a wheelchair in daily life.

4. **Grade IV** - Athletes have a severe Impairment or deficiency of both upper limbs or a moderate Impairment of all four limbs or short stature. Athletes are able to walk and generally do not require a wheelchair in daily life. Also includes Athletes having a visual Impairment equivalent to B1.

5. **Grade V** - Athletes have a mild Impairment of movement or muscle strength or a deficiency of one limb or mild deficiency of two limbs. Also includes Athletes with visual Impairment equivalent to B2.
Current athlete assessment examines:
- Balance
- Coordination
- Joint ROM
- Manual Muscle Testing
- Riding observation

Based on work conducted in 1990 (Meaden, 1990)

Up-to-date, scientific evidence required.

Can we determine valid:
- Measures of impairment?
- Measures of performance?
- The strength of association between measures of impairment and performance?
ARTICLE 432  MARKING

1. All movements, and certain transitions from one to another, which have to be marked by the Judges, are numbered on the Judge’s sheet.

2. They are marked from zero (0) to ten (10) by each Judge, zero (0) being the lowest and ten (10) the highest mark.

3. The scale of marks is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Excellent</th>
<th>7</th>
<th>Fairly good</th>
<th>4</th>
<th>Insufficient</th>
<th>1</th>
<th>Very bad</th>
<th>0</th>
<th>Not executed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>X</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enter in working trot</td>
<td></td>
<td>Halt. Immobility. Salute. Proceed in working trot. Track left</td>
<td></td>
<td>Quality of pace, high, and transitions. Straightness. Contact and poll. Bend through turn at C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CH</td>
<td>HKF</td>
<td>F</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Working trot</td>
<td>Medium trot</td>
<td>Working trot</td>
<td></td>
<td>Regularity and quality of trot, flexibility, engagement of hindquarters</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>FA</td>
<td></td>
<td>F</td>
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<tr>
<td></td>
<td>Transitions at H and F Working trot</td>
<td></td>
<td></td>
<td>Lengthening and shortening of steps and frame, maintenance of rhythm, quality of trot</td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>AD</td>
<td>D</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Down the centre line Volt(e) right (10m 0)</td>
<td></td>
<td></td>
<td>Regularity, balance and bend through turn and in volt, size and shape of volt(e)</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>DXG</td>
<td>G</td>
<td>GC</td>
<td>C</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>Down the centre line Volt(e) left (10m 0) Down the centre line Track right</td>
<td></td>
<td></td>
<td>Regularity, straightness and balance on centre line, bend and balance, size and shape of volt(e)</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

| 3. Submission (attention and confidence, harmony, lightness and ease of the movements, straightness, acceptance of the bridle and lightness of the forehead) | 10 | 2 |
| 4. Equestrian feel and skill of the athlete. Accuracy. | 10 | 2 |

**TOTAL** 340
Speed, Acceleration:

VS.

Distance:

Weight:
LINKING VALID MEASURES OF IMPAIRMENT TO MEASURES OF PERFORMANCE

1. Balance
2. Coordination
3. Range of motion
4. Strength
RESEARCH PROJECT OUTLINE

**Rapid review 1**
Identify sport-specific determinants of performance for dressage riding

**Rapid review 2**
Identify validated clinical impairment measures relevant to determinants of dressage performance

**Interviews**
Compare Para-athletes and stakeholders' opinions with determinants of performance and clinical impairment measures

**Potential quantitative performance outcome measures**

**Potential rider performance/impairment measures**

**Proposed clinical measures for assessment classification**

**Ridden tests**
Measurements of horse performance

**Simulator tests**
Standardised measurements of rider performance/impairment

**Clinical tests**
Results of clinical measures of impairment

**Test horse performance measures against rider performance measures**

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**Quantification of activity limitations that affect performance outcomes**

**Scientific evidence that assesses the relative strength of association between valid measures of impairment (clinical measures) and performance outcome measures**

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MEASUREMENTS OF RIDER PERFORMANCE
MEASUREMENTS OF RIDER PERFORMANCE

Trot = 25 deg flex-ex motion

Trunk-pelvis-horse interaction

COP effects

Alexander et al. (2015)
<table>
<thead>
<tr>
<th>Outcome Measure</th>
<th>Gait/Movement</th>
<th>Literature</th>
<th>Advanced/Elite Rider Values</th>
<th>Non-rider/beginner rider values</th>
<th>Performance Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trunk Segment</td>
<td>Walk</td>
<td>Bystrom et al. (2010)</td>
<td>5.95 ± 0.07</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lovett et al. (2005)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sitting Trot</td>
<td>Alexander et al. (2015)</td>
<td>10.12 ± 4.65</td>
<td>9.5 ± 2.3</td>
<td>No sig diffs in ROM between beginner and pro, but <strong>beginner riders</strong> max and mean values showed <strong>sig more forward trunk angle than pros</strong> (Eckardt and Witte, 2016)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bystrom et al. (2009)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Eckardt et al. (2014)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Eckardt and Witte (2016)</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Terada et al. (2006)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Posting Trot</td>
<td>Lovett et al. (2005)</td>
<td>4.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Canter</td>
<td>Eckardt and Witte (2016)</td>
<td>12.55 ± 11.10</td>
<td>20.5 ± 5.6</td>
<td>No sig diffs in rom between beg and pro (Eckardt and Witte, 2016)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lovett et al. (2005)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MEASUREMENT OF HORSE PERFORMANCE

- Qualitative scoring
  - Judge
- Paces
- Impulsion
- Submission

Quantitative measurements
- IMU sensors attached to the horse
- Stride frequency, Stride duration
- Velocity, Trunk elevation, Stride length
- Accuracy of transitions & Movements
<table>
<thead>
<tr>
<th>Gait/ Movement</th>
<th>Outcome Measure</th>
<th>Literature</th>
<th>Performance Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trot</td>
<td>Stride frequency</td>
<td>Biau and Barrey (2004)</td>
<td>Greater</td>
</tr>
<tr>
<td></td>
<td>Temporal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stride Regularity</td>
<td>Biau and Barrey (2004)</td>
<td>Greater</td>
</tr>
<tr>
<td></td>
<td>Stride Symmetry</td>
<td>Biau and Barrey (2004)</td>
<td>Greater</td>
</tr>
<tr>
<td></td>
<td>Impulsion</td>
<td>Biau and Barrey, 2004</td>
<td>Increased</td>
</tr>
<tr>
<td></td>
<td>Dorsoventral displacement (m)</td>
<td>Biau and Barrey, 2004</td>
<td>Increased</td>
</tr>
<tr>
<td></td>
<td>Dorsoventral activity (g^2/Hz)</td>
<td>Biau et al. (2002), Biau and Barrey (2004)</td>
<td>Increased</td>
</tr>
<tr>
<td>Gait/Movement</td>
<td>Outcome Measure</td>
<td>Literature</td>
<td>Performance Effect</td>
</tr>
<tr>
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</tr>
<tr>
<td>Trot</td>
<td>Stride frequency</td>
<td>Biau and Barrey (2004)</td>
<td>Greater</td>
</tr>
<tr>
<td></td>
<td>Stride Regularity</td>
<td>Biau and Barrey (2004)</td>
<td>Greater</td>
</tr>
<tr>
<td></td>
<td>Stride Symmetry</td>
<td>Biau and Barrey (2004)</td>
<td>Greater</td>
</tr>
<tr>
<td></td>
<td>FL Stance Duration</td>
<td>Deuel and Park (1990a, b)</td>
<td>Shorter FL stance duration</td>
</tr>
<tr>
<td></td>
<td>HL Stance Duration</td>
<td>Holmstrom et al. (1994), Clayton et al. (1997)</td>
<td>Longer HL stance duration</td>
</tr>
<tr>
<td></td>
<td>Swing Duration</td>
<td>Deuel and Park (1990a, b)</td>
<td>Shorter HL and longer FL swing duration</td>
</tr>
<tr>
<td></td>
<td>Tarsal Joint Motion</td>
<td>Holmstrom et al. 1994</td>
<td>Increased flexion at stance</td>
</tr>
<tr>
<td></td>
<td>Tarsal Joint Angular Velocity</td>
<td>Holmstrom et al. 1997</td>
<td>faster during stance</td>
</tr>
<tr>
<td></td>
<td>Stride Length</td>
<td>Deuel and Park (1990a, b)</td>
<td>Longer stride length</td>
</tr>
<tr>
<td></td>
<td>Stride Velocity</td>
<td>Deuel and Park (1990a, b)</td>
<td>Faster velocity</td>
</tr>
</tbody>
</table>
THE RELATIONSHIP BETWEEN IMPAIRMENT, FUNCTIONAL ABILITY AND PERFORMANCE IN PARA-EQUESTRIAN DRESSAGE RIDERS: EVIDENCE-BASED RECOMMENDATIONS FOR REVISING CURRENT PARA-EQUESTRIAN CLASSIFICATION SYSTEMS.
RAPID REVIEW 2 – IMPAIRMENT MEASURES

Fig 2. Flowchart illustrating the process of rapid review two
1. Does it measure impairment?
   *Refer to WHO terminology if unsure.*

   - **No** → Exclude
   - **Yes**

2. Is it a Patient Reported Outcome Measure (PROM)?

   - **Yes** → Exclude
   - **No**

3. What position is the impairment measure conducted in?

   - **Standing/Walking** → Exclude
   - **Sitting/Supine/Prone**

4. Does the impairment measure produce objective/quantitative data?

   - **No** → Exclude
   - **Yes**

**Include**
- Record conditions that measure is designed/validated for.
- Identify and record key words from listed papers mentioned in supporting material.
NEXT STAGES...
## Linking Rider Performance to Horse Performance

<table>
<thead>
<tr>
<th>Rider Performance</th>
<th>Horse Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pelvic Segment</strong></td>
<td><strong>Stride frequency</strong></td>
</tr>
<tr>
<td>A/P Tilt, Pitch</td>
<td><strong>Stride Regularity</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Stride Symmetry</strong></td>
</tr>
</tbody>
</table>

- ROM not sig different between pro and beginner riders, but the pro riders had sig greater min values (pelvis tilted more forward) (Munz et al, 2014)
- No significant differences between pro and beginner riders (Munz et al., 2014)
Step 3.5 Assess the association between horse and rider performance measures

Year 3 – Biomechanics Study

Recommendations TBD
NEXT STEPS

- **Ridden tests**
  - Measurements of horse performance

- **Simulator tests**
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  - Results of clinical measures of impairment

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- **Measurements of horse performance**

- **Standardised measurements of rider performance/impairment**

- **Results of clinical measures of impairment**

- **Scientific evidence**
  - Evaluates the relative strength of association between valid measures of impairment (clinical measures) and performance outcome measures.

- **Validation of clinical measures of impairment**

- **Scientific evidence**
  - Quantifies activity limitations affecting performance outcomes.

- **Measurements of horse performance**

- **Scientific evidence**
  - Validates clinical measures of impairment.

- **Scientific evidence**
  - Evaluates the relative strength of association between valid measures of impairment (clinical measures) and performance outcome measures.
Measurements of horse performance

Standardised measurements of rider performance/impairment

Results of clinical measures of impairment

measures
LINKING RIDER PERFORMANCE TO HORSE PERFORMANCE TO MEASURES OF IMPAIRMENT

- Increased Stride Length
- Hindlimb Stance Duration
- Increased Trunk Posterior Tilt
- Increased Trunk Strength

Performance Measure

Impairment Measure
THANK YOU

QUESTIONS?