Response Shift and Functional Outcomes in Individuals with Chronic Ankle Instability

Eastern Athletic Trainer’s Conference 2017
Funded By: EATA, Inc.

Cameron J. Powden, PhD, ATC
Cameron.Powden@indstate.edu
Objectives

• Summarize the existing literature pertaining to chronic ankle instability.

• Discuss the concepts of response shift and its effect on the assessment of patient reported outcomes.

• Describe the methods of a study evaluating the effects of a 4-week comprehensive, evidence-based rehabilitation program.

• Summarize the findings of this multifaceted treatment approach to address the impairments associated with CAI.

• Translate the findings and measures to clinical practice.
Background – Ankle Sprains

• Most commonly injured joint in the physically active
  • 10 to 30% of all athletic injuries (Fong et al. 2007)

• Ankle sprains account for 86% of all ankle injuries
  (Dizon and Reyes 2010)

• Approximately 23,000 ankle sprains occur each day within the US. (Waterman et al. 2010)

• Results in nearly 2 million sprains each year (Waterman et al. 2010)

• May be highly underestimated
  • 55% of ankle sprain sufferers do not seek medical treatment (McKay et al. 2001)
• Results in pain, swelling and ecchymosis

• Reductions in mobility and function lead to performance deficits as well as absence from competition and work (Doherty et al. 2014)

• 25% of individuals miss work or school for greater than 7 days (Doherty et al. 2014)
• Account for approximately 600,000 emergency departments each year (Waterman et al. 2010)

• General Estimate: $495 to $4,667/sprain (Bielska 2015)

• Interscholastic Athlete: ~$9,000/sprain (Knowles 2007)

• Annual aggregate healthcare cost of $4.2 billion (Waterman et al. 2010)
Background – Chronic Ankle Instability

• Nearly 65% of sufferers modify physical activity for years following. (Hiller et al. 2012)

• One out of three will develop CAI (Konradsen et al. 2002)
  • Recurring ankle sprains (Hertel 2002)
  • Episodes of giving way (Hertel 2002)
  • Decreased HRQL (Houston et al. 2015)

• Long-Term Consequences
  • Decreased physical activity (Hubbard-Turner and Turner 2015)
  • Increased risk of ankle osteoarthritis (Valderrabano et al 2006)
  • Increased fall risk later in life (Hass et al. 2010)
Background – CAI Contributing Factors

Chronic Ankle Instability

- Laxity
- Arthrokinematics
- Degenerative Factors
- Synovial Factors
- Postural Control
- Neuromuscular Control
- Strength
- Postural Control/Altered Gait

Mechanical Insufficiencies

- Range of Motion
  - (Hoch et al. 2012)

Functional Insufficiencies

- Balance
  - (Arnold et al. 2009; Hiller et al. 2010; Munn et al. 2010; Wikstrom et al. 2010)
- Functional Activities
  - Donovan et al. 2016)
- Repetitive Ankle Sprains

(Hertel 2002)
Background – ICF Model’s Influence

Health Condition
(Disease, Disorder, or Injury)

Chronic Ankle Instability

Body Structure & Function

Activity

Participation

Environmental Factors

Personal Factors

Contextual Factors
Health Related Quality of Life Deficits

- CAI HRQL deficits identified
  - Region-specific
  - Global
  - Dimension-specific
Background – CAI Rehabilitation Paradigm

(Donovan al. 2016)
Background – Accuracy and Response Shift

Rehabilitation = Catalyst

Response Shift
- Internal Standards
- Values
- Conceptualization

Change in Perceived HRQL

Perception of Normal
Perception of Baseline

Baseline → End of Care

Observed Change
Observed Change
The literature has yet to determine:

• The overall effectiveness of CAI interventions to improve patient-oriented outcomes.

• The effects of a comprehensive rehabilitation program on clinician- and patient-oriented outcomes.

• The overall impact of response shift within orthopedic conditions.

• The potential for response shift in those with CAI following rehabilitation.
CAI Interventions and HRQL

• **Purpose**
  - Provide a synthesis of the published evidence investigating the effect of CAI interventions on HRQL.

• **Key Findings**
  - Efficacy to improve ankle-specific self-reported function.
  - Lack of analysis regarding other types of PROs.
Response Shift in Orthopedics

• **Purpose**
  • Synthesize the evidence regarding the presence of RS following orthopedic rehabilitation

• **Key Findings**
  • Evidence of small potential for RS
  • High amount of variability

![Graph showing underestimation and overestimation of pre-disability in PROs](image)
The Problem Revisited

The literature has yet to determine:

• The overall effectiveness of CAI interventions to improve patient-oriented outcomes.

• The effects of a comprehensive rehabilitation program on clinician- and patient-oriented outcomes.

• The overall impact of response shift within orthopedic conditions.

• The potential for response shift in those with CAI following rehabilitation.
Specific Aim I and Hypothesis

• **Specific Aim I:**
  • Examine the effects of a four-week comprehensive evidence-based intervention for individuals with CAI on:
    • Clinician-oriented measures of DFROM, dynamic postural control, and strength.
    • Laboratory-oriented measures of static postural control.

• **Hypothesis:**
  • Following a four-week comprehensive intervention clinician- and laboratory-oriented measures will improve in those with CAI.
Specific Aim II & Hypothesis

• **Specific Aim II:**
  - Examine the effect of a four-week comprehensive evidence-based intervention on patient-oriented outcomes in those with CAI.
  - Determine if individuals with CAI who undergo this treatment experience response shift.

• **Hypothesis:**
  - Individuals with CAI will experience improvements in patient-oriented outcomes.
  - Response shift will occur following a four-week comprehensive evidence-based intervention.
• **Study Design:**
  • Interrupted time-series design
Subjects

• **Inclusion Criteria:**
  • History of ≥1 ankle sprain
  • ≥2 episodes of “giving way” in past 3 months
  • “Yes” to ≥5 questions on the Ankle Instability Instrument
  • ≤25 on the Cumberland Ankle Instability Tool
  • ≥14 on the Godin Leisure-Time Exercise Questionnaire

• **20 individuals with self-reported CAI completed the investigation**

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td>Male = 5; Female = 15</td>
</tr>
<tr>
<td><strong>Ankle</strong></td>
<td>Right = 9, Left = 11</td>
</tr>
<tr>
<td><strong>Age (years)</strong></td>
<td>24.35 ± 6.95</td>
</tr>
<tr>
<td><strong>Height (cm)</strong></td>
<td>169.29 ± 10.10</td>
</tr>
<tr>
<td><strong>Weight (kg)</strong></td>
<td>70.58 ± 12.90</td>
</tr>
<tr>
<td><strong>Previous Ankle Sprains (#)</strong></td>
<td>2.95 ± 1.50</td>
</tr>
<tr>
<td><strong>Episodes of Giving Way (3 Months)</strong></td>
<td>5.6 ± 6.54</td>
</tr>
<tr>
<td><strong>Time Since Last Sprain (Months)</strong></td>
<td>18.5 ± 17.22</td>
</tr>
<tr>
<td><strong>Ankle Instability Instrument (“yes”)</strong></td>
<td>6.85 ± 1.31</td>
</tr>
<tr>
<td><strong>Cumberland Ankle Instability Tool</strong></td>
<td>16.05 ± 5.55</td>
</tr>
<tr>
<td><strong>Godin Leisure-Time Exercise Questionnaire</strong></td>
<td>63.65 ± 25.86</td>
</tr>
</tbody>
</table>
All subjects completed a 4-week rehabilitation program

**Home-Based Intervention**
- Completed daily
  - Gastrocnemius-Soleus Stretching
  - Progressive Ankle Strengthening
- Compliance tracked by subjects using a home intervention log.

**Laboratory-Based Intervention**
- Three times per week (12)
  - Anterior-to-Posterior Talocrural Joint Mobilizations
  - Progressive Balance Training Program
  - Slow-Reversal Proprioceptive Neuromuscular Facilitation (PNF)
- Compliance and progress tracked by investigator
Home-Based Intervention

• Gastrocnemius-Soleus Stretching
  • Two Stretches on a half foam roller
  • Held to the point of mild discomfort
  • 3 x 30s for each

• Progressive Ankle Strengthening
  • 4-way Thera-Band
  • Week 1 and 2
    • Blue band (heavy resistance)
  • Week 3 and 4
    • Black band (special heavy resistance)
  • Sets and repetitions:
    • Week 1 – 3 x 10
    • Week 2 – 4 x 10
    • Week 3 – 3 x 10
    • Week 4 – 4 x 10
• Anterior-to-posterior Talocrural Joint Mobilizations
  • Maitland Grade III
  • 4 sets of 2 minute oscillations

• Progressive Balance Training
  • 5 balance tasks
  • 7 levels per task

• Slow-Reversal PNF
  • Concentric D1 and D2 patterns of the ankle
  • Sets and repetitions progressed based on session
Disease-Oriented Measures

- Dorsiflexion Range of Motion
- Dynamic Balance
- Static Balance
- Isometric Strength
Patient-Oriented Measures

- Disablement in the Physically Active Scale (mDPA)
  - Physical Summary Component
  - Mental Summary Component

- Foot and Ankle Ability Measure (FAAM)
  - Activities of Daily Living (ADL)
  - Sport
  - Quick-FAAM

- Fear-Avoidance Belief Questionnaire (FABQ)
  - Physical Activity (PA)
  - Work (W)
Testing Procedures

Clinician-Oriented Measures

Disease-Oriented Measures
Specific Aim I – Variables

• **Independent Variables**
  • Time

• **Dependent Variables**
  • Dorsiflexion ROM
    • WBLT
  • Dynamic Balance
    • Y-Balance (ANT, PM, PL)
  • Static Balance
    • Time-to-Boundary
      • Mean Minimal (MM) and Standard Deviation (SD) of MM in the AP and ML directions.
  • Ankle Strength
    • Dorsiflexion, Plantarflexion, Inversion, Eversion
  • Hip Strength
    • Abduction, Adduction, Flexion, Extension
Specific Aim I – Statistical Analysis

• Separate One-Way ANOVAs
  • Time
  • WBLT, Y-Balance, Strength

• Separate 2 x 3 ANOVAs
  • Time
  • Vision
  • TTB MM and TTB SD

• Sidak Post Hoc Comparisons
Specific Aim I – Statistical Analysis

• Minimal Detectable Change
  • ICC (2,1)
  • SEM x $\sqrt{2}$

• Standardized Response Mean
  • Ratio of Change and SD of Change
  • Weak (≤0.39)
  • Moderate (0.40-0.69)
  • Strong (≥0.70)
Specific Aim I – Results

Time Main Effect, $p < 0.001$

![Graph showing time main effect with statistical significance](image)

- Pre: 8.59 ($p < 0.001$)
- Post: 9.75 ($p < 0.001$)
- 2-Week: 10.13 ($p < 0.348$)

**Effect Size (ES):**
- Pre-Post $Δ$: 1.17 (ES = 1.29, CI = 0.82–1.80)
- Pre-2-Week $Δ$: 1.54 (ES = 1.27, CI = 0.86–1.71)

**Minimal Detectable Change (MDC):** 0.54
Specific Aim I – Results

Time Main Effect
\( p < 0.001 \)

\( p = 0.603 \)
\( p = 0.013 \)
\( p = 0.001 \)

\( p < 0.001 \)
\( p < 0.001 \)
\( p = 1.00 \)

\( p < 0.001 \)
\( p < 0.001 \)
\( p = 0.857 \)

Indiana State University
Specific Aim I – Results

Time Main Effect

\[ p < 0.001 \]

- **ES = 0.72**
  - CI = 0.12–1.34
- **ES = 0.99**
  - CI = 0.43–1.49

Time Main Effect

\[ p < 0.001 \]

- **ES = 1.22**
  - CI = 0.80–1.70
- **ES = 1.35**
  - CI = 0.87–1.75

Time Main Effect

\[ p < 0.001 \]

- **ES = 1.13**
  - CI = 0.49–1.57
- **ES = 1.15**
  - CI = 0.56–1.80
Specific Aim I - Results

**TTB MM ML**
- Vision $p < 0.001$
- Time $p = 0.054$
- Vision x Time $p = 0.125$

**TTB SD ML**
- Vision $p < 0.001$
- Time $p = 0.325$
- Vision x Time $p = 0.236$

**TTB MM AP**
- Vision $p < 0.001$
- Time $p = 0.008$
- Vision x Time $p = 0.007$

**TTB SD AP**
- Vision $p < 0.001$
- Time $p = 0.012$
- Vision x Time $p = 0.037$
Specific Aim I – Results

**TTB MM AP**

**ES = 0.23**  
**CI = -0.52-0.37**

- **Pre-2 Week Δ**
  - 0.81

- **Pre-Post Δ**
  - 0.71

- **MDC**
  - 0.81

- **ES = 0.78**  
  **CI = 0.44-1.18**

- **Pre**
  - 5.02
- **Post**
  - 4.88
- **2-Week**
  - 5.83

- **p = 0.593**  
- **p = 0.002**

- **ES = 0.04**  
  **CI = -0.38-0.62**

- **Pre-2 Week Δ**
  - 0.81

- **Pre-Post Δ**
  - 0.71

- **MDC**
  - 0.81

- **p = 0.51**

- **ES = 0.07**  
  **CI = -0.48-0.47**

- **Pre-2 Week Δ**
  - 0.81

- **Pre-Post Δ**
  - 0.71

- **MDC**
  - 0.81

- **p = 0.743**  
- **p = 0.855**  
- **p = 0.51**
Specific Aim I – Results

TTB SD AP

Pre-Post ∆  Pre-2-Week ∆  MDC

ES = 0.23  CI = -0.67-0.22

p = 0.313  p = 0.013

Pre  Post  2-Week

3.22  3  3.73  p = 0.012

ES = 0.61  CI = 0.24-1.02

p = 0.392

Pre  Post  2-Week

1.51  1.53  1.61  p = 0.831

ES = 0.03  CI = -0.28-0.67

p = 0.391
Specific Aim I – Results

**Inversion**
Time Main Effect
\( p < 0.001 \)

**Eversion**
Time Main Effect
\( p < 0.001 \)

**Dorsiflexion**
Time Main Effect
\( p < 0.004 \)

**Plantarflexion**
Time Main Effect
\( p < 0.001 \)
Specific Aim I – Results

**Inversion**
Time Main Effect
*p < 0.001*

**Eversion**
Time Main Effect
*p < 0.001*

**Dorsiflexion**
Time Main Effect
*p < 0.004*

**Plantarflexion**
Time Main Effect
*p < 0.001*
Specific Aim I – Results

**Abduction**
Time Main Effect  
$p < 0.003$

**Adduction**
Time Main Effect  
$p < 0.001$

**Flexion**
Time Main Effect  
$p < 0.038$

**Extension**
Time Main Effect  
$p < 0.001$

![Graphs showing data for Abduction, Adduction, Flexion, and Extension with corresponding p-values.](image-url)
Specific Aim I – Results

Abduction Time Main Effect
\[ p < 0.003 \]

Adduction Time Main Effect
\[ p < 0.001 \]

Flexion Time Main Effect
\[ p < 0.038 \]

Extension Time Main Effect
\[ p < 0.001 \]

ES = 0.96
CI = 0.56-1.42

ES = 1.10
CI = 0.62-1.70

ES = 0.41
CI = -0.03-0.90

ES = 0.84
CI = 0.43-1.34

ES = 0.54
CI = -0.11-1.10

ES = 0.75
CI = 0.31-1.24

ES = 0.61
CI = 0.12-1.04

ES = 0.89
CI = 0.43-1.36
Specific Aim I – Conclusions
Specific Aim II – Variables

• Independent Variables
  • Time
  • Type of PRO Assessment
  • Type of Change

• Dependent Variables
  • Region-Specific PROs
    • FAAM-ADL, FAAM-Sport, Quick-FAAM
  • Global PROs
    • mDPA-PSC, mDPA-MSC
  • Dimension-Specific PROs
    • FABQ-PA, FABQ-W
Specific Aim II – Statistical Analysis

- Separate One-Way ANOVAs
  - Time

- Separate One-Way ANOVAs
  - Type of PRO Assessment

- Separate 2 x 2 ANOVAs
  - Time
  - Type of Change

- Sidak Post Hoc Comparisons
Specific Aim II – Statistical Analysis

• **Minimal Detectable Change**
  • ICC (2,1)
  • SEM x $\sqrt{2}$

• **Standardized Response Mean**
  • Ratio of Change and SD of Change
  • Weak ($\leq 0.39$)
  • Moderate (0.40-0.69)
  • Strong ($\geq 0.70$)
Specific Aim II – Results

Response Shift

- Pre
- Then Post
- Then 2-Weeks

- **FAAM-ADL**
  - $p = 0.124$

- **FAAM-Sport**
  - $p = 0.136$

- **Quick-FAAM**
  - $p = 0.184$

- **mDPA-PSC**
  - $p = 0.246$

- **mDPA-MSC**
  - $p = 0.976$

- **FABQ-PA**
  - $p = 0.125$

- **FABQ-W**
  - $p = 0.760$
Specific Aim II - Results

Response Shift
Adjusted Change vs
Traditional Change

**FAAM-ADL**
- Type: $p = 0.032$
- Time: $p = 0.081$
- Type x Time: $p = 0.740$

**FAAM-Sport**
- $p = 0.084$
- Time: $p = 0.1492$
- Type x Time: $p = 0.163$

**Quick-FAAM**
- $p = 0.192$
- Time: $p = 0.093$
- Type x Time: $p = 0.309$

**mDPA-PSC**
- Type: $p = 0.070$
- Time: $p = 0.032$
- Type x Time: $p = 0.089$

**mDPA-MSC**
- Type: $p = 0.945$
- Time: $p = 0.791$
- Type x Time: $p = 0.921$

**FABQ-PA**
- Type: $p = 0.168$
- Time: $p = 0.582$
- Type x Time: $p = 0.410$

**FABQ-W**
- Type: $p = 0.698$
- Time: $p = 0.252$
- Type x Time: $p = 0.176$
Specific Aim II - Results

**FAAM-ADL**
Type: $p = 0.032$

<table>
<thead>
<tr>
<th>Traditional Change</th>
<th>Response Shift</th>
<th>Difference</th>
<th>MDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.857</td>
<td>9.911</td>
<td>2.054</td>
<td>3.88</td>
</tr>
</tbody>
</table>

**mDPA-PSC**
Time: $p = 0.032$

<table>
<thead>
<tr>
<th>Post</th>
<th>2-Weeks</th>
<th>Difference</th>
<th>MDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.957</td>
<td>9.65</td>
<td>1.693</td>
<td>6.76</td>
</tr>
</tbody>
</table>

*Values are reversed to have positive values reflect improvement.*
Specific Aim II – Response Shift Conclusions

Assessment of Response Shift

Pre = Then Post = Then 2-Weeks

Response Shift Adjusted Change

MDC
Specific Aim II - Results

Traditional Change

- **Pre**
  - FAAM-ADL: $p < 0.001$
  - FAAM-Sport: $p = 0.071$
  - Quick-FAAM: $p = 0.043$

- **Post**
  - FAAM-ADL: $p < 0.001$
  - FAAM-Sport: $p = 0.071$
  - Quick-FAAM: $p = 0.087$

- **2-Week Follow Up**
  - mDPA-PSC: $p < 0.001$
  - mDPA-MSC: $p = 0.087$
  - FABQ-PA: $p < 0.001$
  - FABQ-W: $p = 0.160$
Specific Aim II - Results

**FAAM-ADL**

\[ p < 0.000 \]

- **Pre**: 88.63
- **Post**: 95.77
- **2-Week**: 97.2

\[ p = 0.049 \]

\[ p < 0.001 \]

\[ p < 0.001 \]

**ES = 1.38**

CI = 0.98-1.73

**Quick-FAAM**

\[ p = 0.043 \]

- **Pre**: 79.38
- **Post**: 91.88
- **2-Week**: 93.33

\[ p = 0.487 \]

\[ p < 0.001 \]

\[ p = 0.117 \]

**ES = 1.43**

CI = 1.01-2.52

**ES = 1.45**

CI = 1.05-2.23
Specific Aim II - Results

mDPA-PSC

\[ p < 0.000 \]

*Values are reversed to have positive values reflect improvement.*
Specific Aim II - Results

**FABQ-PA**

\[ p < 0.000 \]

![Graph showing FABQ-PA scores](#)

*Values are reversed to have positive values reflect improvement.*
Discussion

ADL – ES=1.38
Quick – ES=1.43

FAAM-ADL
Quick- FAAM

Balance – ES=1.22
Manual – ES=1.10

mDPA-PSC

FABQ-PA

FAAM-Sport
• Changes Surpassed the MDC
• Large Effect Sizes (1.58, 1.21)

Reductions in fear

Improvements in physical activity
Discussion

Response Shift

Catalyst
- Rehabilitation Vs Surgery

Mechanisms
- Coping
- Social Comparison
- Goal Reordering
- Reframing Expectations

Response Shift
- Internal Standards
- Values
- Conceptualization

Changes in perceived HRQL

Time Post-Intervention
- 2 Weeks Vs
- 6 Weeks to 2 Years
Discussion

Specific Aim I
• 1.17 to 1.54 cm
Hoch et al. 2012
• 1.4 cm
Mckeon & Wikstrom 2016
• 2.23 cm

Similar to findings of theraband interventions

Specific Aim I
• > ~0.40 kg/n
Donovan et al. 2016
• > ~0.30 kg/n

How do these changes relate to injury risk?
Discussion

(Hoch et al. 2012) (Mckeon et al. 2008)
Limitations

- Lack of blinding
- Lack of a control/sham group
- Relatively short follow up period
  - Long-term effects
  - More time needed for response shift?
- Did not base intervention off of individual impairments
Future Directions

• Evaluate the true long-term effects
  • Can maintained exercises prolong effects?

• Prospective evaluation of injury and giving way risk.
  • Did we reduce the incidence of future ankle trauma?

• Employ an individualized impairment based intervention
  • Can treating an individual’s impairments improve treatment efficacy?
Conclusions

• A response shift was not detected in those with CAI following a comprehensive intervention.

• A multidimensional profile of HRQL was enhanced.

• Common disease-oriented detriments were enhanced.
Acknowledgments

Dissertation Committee

Emily Hartley, Kathleen Hogan, Megan Pathoomvanh, Chase Feldbrugge
Thank You! Questions?

Cameron J. Powden: Cameron.Powden@indstate.edu