Diagnostic Validity: Personality Assessment in the EMU

Dona E.C. Locke, PhD, ABPP
Arizona Neuropsychological Society
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Learning Objectives

• Review of diagnostic validity concepts.
• Brief review of literature on personality assessment measures in the EMU setting.
• Apply diagnostic validity concepts to personality assessment in the EMU.
Diagnostic Validity

• Asking the right question
  – Can we predict a person’s group membership based on their test score?
<table>
<thead>
<tr>
<th>Test Prediction</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>No</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

- **Criterion:** Best estimate of reality (i.e., person has condition)
- **Sensitivity** = \( \frac{A}{A+C} \)
- **Specificity** = \( \frac{D}{B+D} \)
- **Pos. Pred. Value** = \( \frac{A}{A+B} \)
- **Neg. Pred. Value** = \( \frac{D}{C+D} \)
- **Hit Rate** = \( \frac{A+D}{A+B+C+D} \)
- **Odds Ratio** = \( \frac{AD}{BC} \) (Complex Derivation)
- **Likelihood Ratio** = \( \frac{\text{Sensitivity}}{1 - \text{Specificity}} = \frac{A}{A+C} \frac{B}{B+D} \)

*Taken with permission from a previous presentation by Glenn Smith, PhD*
Sensitivity/Specificity

• Sens/Spec:
  – Proportion with the dx with a positive test
  – Proportion without the dx with a negative test
  – Are NOT base rate dependent

• Sp-in and Sn-out:
  – High specificity means a positive result rules in the dx
  – High sensitivity mean a negative result rules out the dx
Likelihood Ratios

• Likelihood Ratio
  – LR+: probability of an individual with the dx having a positive test / probability of an individual without the dx having a positive test
  Or: sensitivity / 1-specificity
  
  – LR-: probability of an individual with the dx having a negative test / probability of an individual without the dx having a negative test
  Or: 1-sensitivity / specificity
Likelihood Ratios

• Combines sensitivity/specificity information
  – Examples:
    • 80% sen; 50% spec: \( LR^+ = \frac{.80}{1-.50} = 1.6 \)
    \( LR^- = \frac{1-.80}{.50} = 0.4 \)
    • 80% sen; 90% spec: \( LR^+ = \frac{.80}{1-.90} = 8.0 \)
    \( LR^- = \frac{1-.80}{.90} = 0.22 \)

• Is not a function of base rate
  – 1 = no change in likelihood of COI
  – >1 = increase in likelihood of COI
  – <1 = decrease in likelihood of COI
Using LR to calculate post-test probability of COI

- Pre-test odds = BR / 1-BR
- Post-test odds = LR * pretest odds
- Post-test probability = Post-test odds / Post-test odds + 1
Using LR to calculate post-test probability of COI

• Example: BR = 30%
  – Pre-test odds = BR / 1-BR = .30 / .70 = .43

• 80% sen; 60% spec; LR+ = 1.6
  – Post-test odds = LR * pre odds = 1.6 * .43 = 0.68
  – Post-test probability = Post-test odds / Post-test odds + 1 = 0.68 / 1.68 = 41%
Example 2

- Example: BR = 30%
  - Pre-test odds = BR / 1-BR = .30 / .70 = .43

- 80% Sen; 90% Spec; LR+ = 8.0
  - Post-test odds = LR * pretest odds = 8 * .43 = 3.44
  - Post-test probability = Post-test odds / Post-test odds + 1 = 3.44 / 4.44 = 77%
Example 3

- Example: BR = 50%
  - Pre-test odds = BR / 1-BR = .50 / .50 = 1

- 80% Sen; 90 % Spec; LR+ = 8.0
  - Post-test odds = LR * pretest odds = 8 * 1 = 8.0
  - Post-test probability = Post-test odds / Post-test odds + 1 = 8 / 9 = 89%
Epilepsy Monitoring Unit

- Mayo Clinic Arizona EMU standard is routine neuropsychological evaluation during admission
- Role of Neuropsychology:
  - Cognitive + Personality Assessment
  - Most have cognitive complaints (regardless of eventual d/c dx)
  - Patients with epilepsy have mood and anxiety disorders at a rate higher than the general population
  - Neurology appreciates psychologist’s formulation for a patient with psychogenic spells
Personality Assessment

• Questions of Interest:
  1. Is there evidence of “somatization”
  2. Is there evidence of mood disorder
  3. Is there evidence of anxiety disorder
  4. Is there evidence of “axis II traits”
  ...

• Possible measures during 2008 decision making:
  MMPI-2, PAI, MMPI-2-RF
## MMPI-2 vs PAI

<table>
<thead>
<tr>
<th>MMPI-2</th>
<th>PAI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pros:</strong></td>
<td><strong>Pros</strong></td>
</tr>
<tr>
<td>- Some research literature in EMU</td>
<td>- Shorter, lower reading level</td>
</tr>
<tr>
<td>- Historical clinical use</td>
<td>- More straightforward scales</td>
</tr>
<tr>
<td><strong>Cons:</strong></td>
<td>- At Mayo Arizona used extensively outpatient</td>
</tr>
<tr>
<td>- Long</td>
<td>- Historically not as much EMU research (more now)</td>
</tr>
<tr>
<td>- More complex decision rules: “conversion V”</td>
<td></td>
</tr>
<tr>
<td>- Psychometric weaknesses</td>
<td></td>
</tr>
</tbody>
</table>
MMPI-2-RF

• Significant restructuring of MMPI-2
  – Pros
    • Much shorter (338)
    • Improved psychometrics
    • Can be rescored from existing MMPI-2 protocol (no new items, but also no new norms)
  – Cons
    • Zero EMU research
    • Considerably different from MMPI-2 especially Scale 3
MMPI-2 scales of interest

- **Scale 1: Hypochondriasis**
  - Dramatic and possibly bizarre somatic concerns
  - Vague, nonspecific physical complaints
  - Preoccupation with health problems
  - Tendency to develop physical symptoms in response to stress; consider psychological component to illness in medical patients
  - General pop (50T) < medical pts (60T) < somatoform (70-80T+)

- **Scale 3: Hysteria**
  - Perception of poor physical health
  - Often feel overwhelmed and react to stress with increased physical symptoms
  - General denial of (?lack of awareness of) emotional problems
  - Naïve optimism about others
  - General pop (50T) < medical pts (60T) < somatoform (70-80T+)
PAI scales of interest

• Somatic Complaints scale
  – Concerns about physical functioning and health
  – Probable impairment from somatic concerns
  – Marked elevations reflect multiple system complaints

• 3 subscales
  – Conversion: Impaired due to sensory/motor dysfunction
  – Somatization: High frequency and variety of complaints in addition to vague complaints
  – Health Concern: Preoccupation with health and physical problems. Social interactions focus on health.
MMPI-2-RF scales of interest

• RC1 (Restructured Clinical Scale 1)
  – Empirical Correlates (per manual)
    • Preoccupied with physical health concerns
    • Prone to developing physical symptoms in response to stress
    • Has a psychological component to somatic complaints
    • General population < Medical < Somatoform

• NUC (Neurologic Complaints)
  – Empirical Correlates (per manual)
    • Large # of various neuro complaints (dizzy, balance, numbness, weakness, loss of control over movement)
    • Multiple somatic complaints
    • Preoccupied with physical health concerns
    • General population < Neuro < Somatoform
MMPI-2 in the EMU

• 2 sets of decision rules:
  – Wilkus: 68% sen; 55% spec: LR = 1.5
  – Derry & McLachlan: 48% sen; 58% spec: LR = 1.14
PAI in the EMU

• Somatic Complaints scale
  – SOM ≥ 70
    • 56% sens; 73% spec: LR = 2.1
  – SOM-C ≥ 70
    • 59% sens; 84% spec: LR = 3.7
  – “NES Indicator”
    • SOM-C minus SOM-H (+ = NES; - = ES)
    • 84% sens; 73% spec: LR = 3.1

Wagner et al. (2005). Epilepsy Behav, 7, 301-4;
Prior Research Summary:

- **MMPI-2**
  - Decision rules with 1 and 3; “conversion v”
  - LR = 1.1 – 1.5

- **PAI**
  - SOM, SOM-C, NES Indicator
  - LR = 2.1-3.7

- **MMPI-2-RF**
  - nada
Mayo Arizona studies

- **MMPI-2/PAI randomized trial** (Locke et al. E&B, 2011, 21, 397-401)
- **MMPI-2/MMPI-2-RF rescoring trial** (Locke et al, E&B, 2010, 17, 252-258)
- **Incorporating validity profile**
  - **MMPI-2-RF** (Wershba & Locke, TCN, 2012, 26, 439)
Randomized Trial

- 2008-2010
- PAI/MMPI-2
- Randomly administered PAI or MMPI-2 during EMU eval
Randomized Trial

- A priori indicators of interest:
  - PAI
    - SOM $\geq 70$
    - SOM-C $\geq 70$
    - Stroup criteria (SOM-C $\geq 70$ or DEP-P $\geq 70$)
    - Wagner NES indicator (SOM-C minus SOM-H)

- MMPI-2
  - Derry & McLachlan
  - Wilkus et al.

- Secondary: MMPI-2-RF rescoring
  - RC1

Randomized Trial

- Validity Exclusions:
  - 5 PAIs
  - 3 MMPI-2
  - 2 MMPI-2-RF

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Sample distribution.</th>
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<tbody>
<tr>
<td></td>
<td>Epilepsy</td>
<td>PNES</td>
<td>Total</td>
</tr>
<tr>
<td>PAI</td>
<td>46</td>
<td>32</td>
<td>78</td>
</tr>
<tr>
<td>MMPI-2</td>
<td>33</td>
<td>32</td>
<td>65</td>
</tr>
<tr>
<td>Total</td>
<td>79</td>
<td>64</td>
<td>143</td>
</tr>
</tbody>
</table>

### Results

#### Table 3
Performance of PAI, MMPI-2, and MMPI-2-RF diagnostic indicators.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Sens</th>
<th>Spec</th>
<th>HR</th>
<th>LR+</th>
<th>Posttest probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAI indicators</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>SOM ≥ 70</td>
<td>83%</td>
<td>77%</td>
<td>79%</td>
<td>3.64</td>
<td>69%</td>
</tr>
<tr>
<td>SOM-C ≥ 70</td>
<td>72%</td>
<td>84%</td>
<td>79%</td>
<td>4.55</td>
<td>74%</td>
</tr>
<tr>
<td>Stroop criteria</td>
<td>86%</td>
<td>68%</td>
<td>75%</td>
<td>2.71</td>
<td>62%</td>
</tr>
<tr>
<td>Wagner NES indicator</td>
<td>62%</td>
<td>77%</td>
<td>71%</td>
<td>2.73</td>
<td>63%</td>
</tr>
<tr>
<td>MMPI-2 indicators</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Derry and McLachlan [4]</td>
<td>84%</td>
<td>52%</td>
<td>68%</td>
<td>1.73</td>
<td>52%</td>
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<tr>
<td>Wilkus et al. [6]</td>
<td>90%</td>
<td>32%</td>
<td>63%</td>
<td>1.33</td>
<td>45%</td>
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<tr>
<td>MMPI-2-RF indicators</td>
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<tr>
<td>RC1 ≥ 65</td>
<td>97%</td>
<td>50%</td>
<td>73%</td>
<td>1.94</td>
<td>54%</td>
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<tr>
<td>PNES scales both ≥ 3a</td>
<td>68%</td>
<td>69%</td>
<td>68%</td>
<td>2.17</td>
<td>57%</td>
</tr>
</tbody>
</table>

*Note.* Sens, sensitivity; Spec, specificity; HR, overall hit rate; LR+, likelihood ratio. LR+ calculated as sensitivity/1 – specificity. Posttest probability calculated as [(posttest odds/(posttest odds + 1))] × 100. Posttest odds calculated as LR×pretest odds. Pretest odds calculated as BR/1 – BR. The base rate used for this calculation was 38%, which was the percentage of patients with a confirmed diagnosis of PNES from the entire sample of those with a confirmed diagnosis of some sort at the time of discharge (e.g., epilepsy, PNES, physiological other).
<table>
<thead>
<tr>
<th>Indicator</th>
<th>Sens</th>
<th>Spec</th>
<th>HR</th>
<th>PPP</th>
<th>NPP</th>
<th>LR+</th>
<th>Posttest probability</th>
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<td>PAI indicator SOM</td>
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<td>≥70</td>
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<td>71%</td>
<td>87%</td>
<td>3.64</td>
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<td>81%</td>
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<td>80%</td>
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<td>72%</td>
<td>9.86</td>
<td>86%</td>
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<tr>
<td>≥85</td>
<td>24%</td>
<td>100%</td>
<td>70%</td>
<td>100%</td>
<td>67%</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>≥90</td>
<td>14%</td>
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<td>66%</td>
<td>100%</td>
<td>64%</td>
<td>—</td>
<td>—</td>
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<td>PAI indicator SOM-C</td>
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<td>9.61</td>
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<td>82%</td>
<td>73%</td>
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<td>82%</td>
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<tr>
<td>≥90</td>
<td>34%</td>
<td>95%</td>
<td>71%</td>
<td>83%</td>
<td>69%</td>
<td>7.58</td>
<td>83%</td>
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<td>MMPI-2-RF indicator RC1</td>
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<tr>
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<td>73%</td>
<td>65%</td>
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<td>63%</td>
<td>74%</td>
<td>1.72</td>
<td>51%</td>
</tr>
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<td>1.96</td>
<td>55%</td>
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<td>≥80</td>
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<td>84%</td>
<td>62%</td>
<td>71%</td>
<td>59%</td>
<td>2.48</td>
<td>61%</td>
</tr>
<tr>
<td>≥85</td>
<td>35%</td>
<td>88%</td>
<td>62%</td>
<td>73%</td>
<td>58%</td>
<td>2.84</td>
<td>64%</td>
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<tr>
<td>≥90</td>
<td>19%</td>
<td>94%</td>
<td>57%</td>
<td>75%</td>
<td>55%</td>
<td>3.10</td>
<td>65%</td>
</tr>
</tbody>
</table>
Considering Validity Profile: PAI

• 2010: Began full time administration of PAI on EMU
• Sample
  – 78 PAIs from randomized trial
  – 208 other PAIs (mostly since trial)
• Diagnoses
  – 113 Epilepsy (39.5%)
  – 86 PNES (30.1%)
  – 29 other medical
  – 3 both
  – 55 indeterminate

Sample

- Content independent validity exclusions
  - 12 protocols: INC > 73 and INF > 75
  - Final sample: 187 (106 ES; 81 PNES)

- Validity Categories
  - High PIM (≥ 57; n=62)
  - High NIM (≤ 73; n = 9)
  - Neither (n=116)

ROC analysis: SOM

Fig. 1. ROC curves calculated for SOM when PIM is present (PIM≥57, n=62) and when there was no PIM or NIM bias (n=116).

No difference in AUC for SOM with PIM (.76) or without bias (.77)
ROC analysis: SOM-C

No difference in AUC for SOM-C with PIM (.76) or without bias (.75)

Fig. 2. ROC curves calculated for SOM-C when PIM was present (PIM ≥ 57; n = 62) and when there was no PIM or NIM bias (n = 116).
## Best Classification Rates

<table>
<thead>
<tr>
<th>Scale</th>
<th>Score</th>
<th>SN</th>
<th>SP</th>
<th>HR</th>
<th>LR</th>
</tr>
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<tbody>
<tr>
<td>SOM + PIM</td>
<td>72T</td>
<td>56%</td>
<td>91%</td>
<td>76%</td>
<td>6.2</td>
</tr>
<tr>
<td>SOM no bias</td>
<td>70T</td>
<td>77%</td>
<td>69%</td>
<td>72%</td>
<td>2.5</td>
</tr>
<tr>
<td>SOM-C + PIM</td>
<td>59T</td>
<td>85%</td>
<td>57%</td>
<td>69%</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>68T</td>
<td>59%</td>
<td>83%</td>
<td>73%</td>
<td>3.5</td>
</tr>
<tr>
<td>SOM-C no bias</td>
<td>77T</td>
<td>56%</td>
<td>88%</td>
<td>75%</td>
<td>4.6</td>
</tr>
</tbody>
</table>
Comparison:
SOM 70T (clinical cutoff); 30% base rate

- No bias
  - 77% Sn
  - 69% Sp
  - 2.5 LR
  - Post test prob 52%

- + PIM
  - 59% Sn
  - 86% Sp
  - 4.2 LR
  - Post test prob 64%

- Sp-in and Sn-out
  - High specificity means a positive result rules in the dx
  - High sensitivity means a negative result rules out the dx
Comparison #2:
SOM 80T; 30% base rate

• No bias
  – 44% sn
  – 88% sp
  – 3.7 LR
  – Post test prob 61%

• + PIM
  – 19% sn
  – 97% sp
  – 6.5 LR
  – Post test prob 73%
Considering Validity Profile: PAI

- Overall classification rates similar with and without PIM bias.
- Few in our sample with high NIM.
- **BUT:** sen/spec different at specific cut scores with PIM and without bias.
- With PIM, spec higher so PPP higher, but sens lower so NPP lower.
- Without PIM or NIM, sens higher so NPP higher, but spec lower so PPP lower.
U of M MMPI-2-RF rescoring grant

- Retrospective rescoring
- 2001-2009
- 653 full length MMPI-2s on EMU
  - 214 epilepsy (33%)
  - 215 PNES (33%)
  - 24 both (3.5%)
  - 34 other physiological dx (5.5%)
  - 166 indeterminate (25%)

Locke et al. (2010). Epilepsy Behav. 17, 252-258.
MMPI-2-RF

• Pulled only confirmed ES or PNES
• Rescored to MMPI-2-F
  – 214 ES
  – 215 PNES
• Excluded invalid protocols
  – missing items or random protocols
• Final sample:
  – 196 ES
  – 203 PNES
# Diagnostic Utility RC1

Table 4

<table>
<thead>
<tr>
<th>Cut score</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Overall hit rate (%)</th>
<th>Likelihood ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥50</td>
<td>98</td>
<td>13</td>
<td>56</td>
<td>1.13</td>
</tr>
<tr>
<td>≥55</td>
<td>93</td>
<td>26</td>
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<td>1.26</td>
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<td>94</td>
<td>57</td>
<td>3.62</td>
</tr>
<tr>
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<td>95</td>
<td>55</td>
<td>3.09</td>
</tr>
<tr>
<td>≥90</td>
<td>14</td>
<td>97</td>
<td>55</td>
<td>4.51</td>
</tr>
<tr>
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<td>7</td>
<td>98</td>
<td>52</td>
<td>3.38</td>
</tr>
<tr>
<td>≥100</td>
<td>1</td>
<td>100</td>
<td>50</td>
<td>&gt;9.85</td>
</tr>
</tbody>
</table>
### Table 5
Sensitivities, specificities, and likelihood ratios for scores on NUC.

<table>
<thead>
<tr>
<th>Cut score</th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>Overall hit rate (%)</th>
<th>Likelihood ratio</th>
</tr>
</thead>
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<tr>
<td>≥50</td>
<td>100</td>
<td>2</td>
<td>52</td>
<td>1.02</td>
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<tr>
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<td>63</td>
<td>1.52</td>
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<tr>
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<td>98</td>
<td>53</td>
<td>6.44</td>
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</tbody>
</table>
Specific Example

RC 1 T score = 74

• Base Rate = **33%**
  - Pre-test odds = BR / 1-BR = .33 / .67 = .49

• 48% Sen; 81% Spec; LR+ = **2.5**
  - Post-test odds = LR+ * pretest odds = 2.5 * .49 = 1.23
  - Post-test probability = Post-test odds / Post-test odds + 1 = 1.23 / 2.23 = **55%**
Specific Example

RC 1 T score = 90

• Base Rate = 33%
  — Pre-test odds = BR / 1-BR = .33 / .67 = .49

• 14% Sens, 97% Spec; LR+ = 4.5
  — Post-test odds = LR * pretest odds = 4.5 * .49 = 2.2
  — Post-test probability = Post-test odds / Post-test odds + 1 = 2.2 / 3.2 = 69%
Considering Validity Profile: MMPI-2-RF

- MMPI-2-RF Validity Scales
  - NIM: F-r, Fs
  - PIM: L-r, K-r
  - Aspects of both: FBS-r

- Moderation and suppression
  - Moderation: Overall classification rate varies at different levels of bias
  - Suppression: Optimal cut score varies at different levels of bias

Results

• No moderation (similar classification rates)
• RC1 & NUC: suppression with F-r, Fs, K-r, L-r
• With NIM indicators, optimal cut score increased with higher levels of bias
• With PIM indicators, optimal cut score decreased with higher levels of bias
• With higher NIM, best classification rate at higher cut score

• With higher PIM, best classification rate at lower cut score

• Sensitivity/Specificity
Comparison:
RC1 70T (clinical cutoff); 30% Base Rate

• Rescoring trial
  – 64% sn
  – 71% sp
  – 2.2 LR
  – Post test prob: 49%

• Wershba analysis
  • High F-r (>79T)
    – 82% sn
    – 35% sp
    – 1.3 LR
    – Post test prob: 36%
  • Low F-r (<55)
    – 19% sn
    – 93% sp
    – 2.7 LR
    – Post test prob: 54%
Comparison:
NUC 85T (best hit rate); 30% Base Rate

- Rescoring trial
  - 53% sn
  - 81% sp
  - 2.8 LR
  - Post test prob: 54%

- Wershba analysis
  - High L-r (≥ 60)
    - 36% sn
    - 93% sp
    - 5.1 LR
    - Post test prob: 69%
  - Low L-r (<50)
    - 71% sn
    - 77% sp
    - 3.1 LR
    - Post test prob: 60%
Considering Validity Profile: MMPI-2-RF

- Again, classification accuracy similar with and without bias.
- But, sens/spec quite different
- As NIM increases, sens higher so NPP higher, but spec lower so PPP lower
- As PIM increases, spec higher so PPP higher, but sens lower so NPP lower (same as we found on PAI).
Considerations

• This only reviews somatoform risk indicators
• They get the gold standard anyway
• Multivariate analyses?
  – Scale combinations
  – Scales + medical history
• What about evaluation of mood disorders, anxiety disorders, etc?
• Impact of co-morbid functional somatic syndromes?
• Predictive of outcome?
Summary

• Diagnostic validity means moving beyond sensitivity and specificity.
• Sens/Spec should be given for the range of scores to be most clinically applicable.
• LR combined with your base rate gives you relevant post-test probability information.
• On PAI and MMPI-2-RF, validity profile impacts sens/spec
Summary

• Interesting that few pt. elevate NIM on the PAI
• On the PAI, SOM and SOM-C perform similarly (70-75% correct classification)
• On MMPI-2-RF, RC1 and NUC perform similarly (65-70% correct classification)
Thank you!

Questions?

Email: locke.dona@mayo.edu