Using Pediatric PROMIS (Patient Reported Outcomes Measurement Information System) to Evaluate Symptom Burden Experienced by Children with Brain Tumors

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What is PROMIS®?

Patient-Reported Outcomes Measurement Information System®

- Supported by the NIH Blueprint/Common Fund (2004-2018)
- Now supported by HealthMeasures, the official information & distribution center for 4 NIH-supported measurement systems (PROMIS®, Neuro-QoL, NIH Toolbox®, & ASCQ-Me®)

HealthMeasures.net/PROMIS
What is PROMIS®?

- Measures used to evaluate and monitor physical, mental, and social health (adult & pediatric)
- More than 50 research protocols aligned with evolving PROMIS standards
- More than 60,000 people contributed data
  - Adults: 1,402 questions populating >80 “item banks”
  - Children: 462 questions populating >20 item banks
- English, Spanish, Dutch, German, and other languages emerging
- Universal concepts; expandable to specific issues
- International PROMIS working group
- Began as a US NIH effort to standardize patient reported outcomes for clinical research
- Expanded to clinical practice, quality measurement, population health, and international adoption
Essential Components of PROMIS

**DOMAIN**

The feeling, function, or perception you wish to measure

Cuts across different diseases and settings. E.g., physical function, depressive symptoms

**ITEM BANK**

Collection of items that each measure the same domain

Used to create different measure types, all producing a score on the same metric

Cuts across different diseases and facilities – much needed for patients with rare diseases such as children with brain tumors

HealthMeasures.net/PROMIS
Children with Brain Tumors

- Children with a brain tumor are vulnerable to experiencing moderate or severe adverse events, which lead to poor health-related quality of life.

- It is challenging to evaluate comparative effectiveness with this population because:
  - Brain tumors are both uncommon and diverse.
  - The functional impact of brain tumors and the range of surgical and treatment effects can vary based on characteristics of tumors such as location, size, and type.

- By focusing on common HRQOL domains, PROMIS offers an opportunity to address this deficit.
  - Developed using item response theory models, which enables computerized adaptive tests (CATs)
  - Scores are reported using T-score metric centered on the norming sample.
Study 1: Assess HRQOL of children with brain tumor using the PROMIS measures of Anxiety, Depression, Fatigue, Mobility, Upper extremity function, Peer relationships and Cognition.

Sample

- N=230; mean age was 14.1 (SD=3.7; 7-22 years); 52% male; 76% white; 84% were newly diagnosed.
- 95% attending school
  - 49% mainstream classroom without receiving any form of individualized educational programs (e.g., special education classroom within a regular school or special education school)
- Average years since diagnosis was 4.1 (SD=4.5)
  - The most common histology was astrocytic tumors (grades 1-4; 28.3%), followed by medulloblastoma (20%) and glial tumors (12.7%);
  - 21.7% had one or more lesions in the posterior fossa, 10.9% in the thalamus and 10.4% in the brain stem.
- Average years since last treatment was 2.6 (SD=3.4);
  - 73.8% received surgery, 74.1% chemotherapy, 56.8% radiation (41.9% received proton therapy), and 34.1% received all three modes of therapy.
Measures

- **Child**
  - PROMIS (computerized adaptive testing, CAT): Anxiety, Depression, Fatigue, Mobility, Upper extremity function, Peer relationships
  - 10-item PROMIS Cognition short-form (a.k.a., pediatric perceived cognitive function item bank, pedsPCF).
  - Symptom Distress Scale
    - Getting around, tired, feeling miserable, sleep, appetite & cognition

- **Parent**
  - Proxy versions
### Results – versus SDS

<table>
<thead>
<tr>
<th></th>
<th>SDS - Physical</th>
<th>SDS - Fatigue</th>
<th>SDS - Emotion</th>
<th>SDS - Sleep</th>
<th>SDS - Appetite</th>
<th>SDS - Cognition</th>
</tr>
</thead>
<tbody>
<tr>
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<td>F-value</td>
<td>p</td>
<td>F-value</td>
<td>p</td>
<td>F-value</td>
<td>p</td>
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<td>Compared to the Child-rated Symptom Distress Scale (SDS)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>9.91</td>
<td>&lt;.0001</td>
<td>9.93</td>
<td>&lt;.0001</td>
<td>8.78</td>
<td>&lt;.0001</td>
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<tr>
<td>Depression</td>
<td>11.14</td>
<td>&lt;.0001</td>
<td>9.45</td>
<td>&lt;.0001</td>
<td>9.08</td>
<td>&lt;.0001</td>
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<td>Fatigue</td>
<td>20.38</td>
<td>&lt;.0001</td>
<td>25.00</td>
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<td>8.13</td>
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<tr>
<td>Mobility</td>
<td>23.89</td>
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<td>7.33</td>
<td>0.0001</td>
<td>4.53</td>
<td>0.0043</td>
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<tr>
<td>Upper Extremity</td>
<td>10.71</td>
<td>&lt;.0001</td>
<td>5.17</td>
<td>0.0019</td>
<td>1.88</td>
<td>0.1348</td>
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<tr>
<td>Peer Relationships</td>
<td>1.91</td>
<td>0.1295</td>
<td>5.13</td>
<td>0.0021</td>
<td>3.25</td>
<td>0.0235</td>
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<tr>
<td>Cognition</td>
<td>4.81</td>
<td>0.0030</td>
<td>12.73</td>
<td>&lt;.0001</td>
<td>4.65</td>
<td>0.0037</td>
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<tr>
<td>Compared to the Parent rated Symptom Distress Scale (SDS)</td>
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<tr>
<td>Anxiety</td>
<td>1.52</td>
<td>0.2121</td>
<td>5.71</td>
<td>0.0010</td>
<td>8.07</td>
<td>&lt;.0001</td>
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<td>Depression</td>
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<td>0.0110</td>
<td>10.25</td>
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<td>14.16</td>
<td>&lt;.0001</td>
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<td>Fatigue</td>
<td>8.27</td>
<td>&lt;.0001</td>
<td>16.29</td>
<td>&lt;.0001</td>
<td>11.04</td>
<td>&lt;.0001</td>
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<td>Mobility</td>
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<td>5.23</td>
<td>0.0018</td>
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<td>Peer Relationships</td>
<td>1.91</td>
<td>0.1310</td>
<td>2.43</td>
<td>0.0679</td>
<td>4.98</td>
<td>0.0026</td>
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<tr>
<td>Cognition</td>
<td>2.12</td>
<td>0.0994</td>
<td>6.38</td>
<td>0.0004</td>
<td>3.28</td>
<td>0.0225</td>
</tr>
</tbody>
</table>

**Planned analyses**
Specifically... versus SDS-Physical:

 SDS: 1=least distress, 5=worst distress
Specifically... versus SDS-Fatigue:

ANOVA ANX, DEP, and FTG: p < 0.001; MOB, REL, UE, and COG: p < 0.001

SDS: 1=least distress, 5=worst distress
Specifically . . . versus SDS-Emotion:

- ANX: <0.001
- DEP: <0.001
- FTG: <0.001
- MOB: 0.004
- REL: 0.13
- UE: 0.024
- COG: 0.004

SDS: 1=least distress, 5=worst distress
Specifically... versus SDS-Sleep:

SDS: 1=least distress, 5=worst distress
Specifically . . . versus SDS-Appetite:

<table>
<thead>
<tr>
<th>Variable</th>
<th>T-Score</th>
</tr>
</thead>
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<tr>
<td>ANX</td>
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</tr>
<tr>
<td>DEP</td>
<td>0.004</td>
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<tr>
<td>FTG</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>MOB</td>
<td>&lt;0.001</td>
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<tr>
<td>REL</td>
<td>0.002</td>
</tr>
<tr>
<td>UE</td>
<td>0.07</td>
</tr>
<tr>
<td>COG</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

SDS: 1=least distress, 5=worst distress
Specifically . . . versus SDS-Cognition:

SDS: 1=least distress, 5=worst distress
# PROMIS vs. clinical variables, educational programs and parent-rated child’s HRQOL

<table>
<thead>
<tr>
<th></th>
<th>Parent-rated QOL</th>
<th>Karnofsky Performance Rating</th>
<th>Educational Program a</th>
<th>Time since last radiation b</th>
<th>Time since last chemotherapy b</th>
<th>Treatment modalities &amp; time since last treatment b</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>p</td>
<td>F</td>
<td>p</td>
<td>F</td>
<td>p</td>
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<tr>
<td><strong>Anxiety</strong></td>
<td>4.83</td>
<td>0.001**</td>
<td>1.98</td>
<td>0.142</td>
<td>0.17</td>
<td>0.681</td>
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<tr>
<td><strong>Depression</strong></td>
<td>8.04</td>
<td>&lt;0.0001**</td>
<td>1.38</td>
<td>0.254</td>
<td>0.34</td>
<td>0.563</td>
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<tr>
<td><strong>Fatigue</strong></td>
<td>14.29</td>
<td>&lt;0.0001**</td>
<td>5.43</td>
<td>0.005**</td>
<td>4.6</td>
<td>&lt;0.034*</td>
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</table>

**Higher scores represents worse symptomatic**

<table>
<thead>
<tr>
<th></th>
<th>Mobility</th>
<th>Upper Extremity Function</th>
<th>Peer Relationships</th>
<th>Cognition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.15</td>
<td>4.11</td>
<td>4.17</td>
<td>6.35</td>
</tr>
<tr>
<td></td>
<td>&lt;0.0001**</td>
<td>&lt;0.001**</td>
<td>&lt;0.001**</td>
<td>&lt;0.0001**</td>
</tr>
<tr>
<td></td>
<td>18.99</td>
<td>14.4</td>
<td>0.87</td>
<td>2.61</td>
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<tr>
<td></td>
<td>&lt;.0001**</td>
<td>&lt;.001</td>
<td>0.422</td>
<td>0.077</td>
</tr>
<tr>
<td></td>
<td>3.12</td>
<td>3.38</td>
<td>1.44</td>
<td>25.29</td>
</tr>
<tr>
<td></td>
<td>0.079</td>
<td>0.068</td>
<td>0.233</td>
<td>&lt;.001**</td>
</tr>
<tr>
<td></td>
<td>4.44</td>
<td>4.89</td>
<td>1.92</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>0.013*</td>
<td>0.009**</td>
<td>0.150</td>
<td>0.957</td>
</tr>
<tr>
<td></td>
<td>3.38</td>
<td>6.45</td>
<td>2.53</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>0.036*</td>
<td>0.002**</td>
<td>0.083</td>
<td>0.505</td>
</tr>
<tr>
<td></td>
<td>3.26</td>
<td>3.4</td>
<td>1.78</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>0.013*</td>
<td>0.011*</td>
<td>0.136</td>
<td>0.838</td>
</tr>
</tbody>
</table>

**Higher scores represents better functioning**

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**Notes:**

- a. “Regular classroom w/o any forms of IEP” vs. “received any forms of IEP or special education”
- b. “never received tx” vs. within 1 year” vs. “> 1 year”
Conclusions

- All PROMIS measures were significantly associated with Symptom Distress Scale reported by patients and parents
- Treatment, time since treatment, parent-rated QOL, educational program and performance ratings were associated with HRQOL
  - Domain dependent
Study 2:

Using Pediatric PROMIS to Evaluate Changes of the Symptom Burden Over Time
Objectives

Monitoring symptom burden reported by patients and parents using pediatric PROMIS Anxiety, Depressive Symptoms, Fatigue, Mobility, Upper Extremity Function, and Peer Relationships CATs, and Cognition brief, fixed-form over 12 months.

- Patterns of PRO changes reported by patients and their parents as well as factors associated with these patterns.
- Correlation between patient- and parent-reported patient symptom burden.
- Whether symptom burden reported by patients and parents predicted patient survival rate.

Symptom burden and HRQOL are used interchangeably
Sample (N=289)

- **Patient**
  - age: 12.4 yrs (range: 5-22; SD=4.7); 54.5% male; 78.6% white
  - Years since recent tx: 0.39 (SD=1.2)

- **Parent**
  - age: 43.0 yrs (SD=7.0); 17.4% male

<table>
<thead>
<tr>
<th>Does your child go to school?</th>
<th>Yes</th>
<th>No</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All patients</strong> (N=289)</td>
<td>93.0</td>
<td>90.8</td>
<td>96.0</td>
</tr>
<tr>
<td><strong>Patients with vs. without 12-month Follow-up w/o (n=150)</strong></td>
<td>90.8</td>
<td>96.0</td>
<td>0.432</td>
</tr>
<tr>
<td><strong>Patients with vs. without 12-month Follow-up With (n=139)</strong></td>
<td>96.0</td>
<td>0.098</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of classroom attending</th>
<th>Mainstream classroom, no IEP</th>
<th>Mainstream classroom, with IEP</th>
<th>Special education classroom within a regular school</th>
<th>Special education school</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All patients</strong> (N=289)</td>
<td>49.6</td>
<td>35.3</td>
<td>7.1</td>
<td>1.3</td>
<td>6.7</td>
</tr>
<tr>
<td><strong>Patients with vs. without 12-month Follow-up w/o (n=150)</strong></td>
<td>50.0</td>
<td>35.6</td>
<td>5.9</td>
<td>2.5</td>
<td>5.9</td>
</tr>
<tr>
<td><strong>Patients with vs. without 12-month Follow-up With (n=139)</strong></td>
<td>48.3</td>
<td>35.6</td>
<td>8.5</td>
<td>0.0</td>
<td>7.6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Histology</th>
<th>Low grade glioma</th>
<th>Medulloblastoma &amp; other embryonal tumors</th>
<th>Glioneuronal tumor</th>
<th>Ependymoma</th>
<th>Germinoma</th>
<th>High grade glioma</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All patients</strong> (N=289)</td>
<td>23.5</td>
<td>22.8</td>
<td>11.1</td>
<td>7.3</td>
<td>6.9</td>
<td>5.5</td>
</tr>
<tr>
<td><strong>Patients with vs. without 12-month Follow-up w/o (n=150)</strong></td>
<td>25.7</td>
<td>18.9</td>
<td>5.4</td>
<td>6.8</td>
<td>6.1</td>
<td>7.4</td>
</tr>
<tr>
<td><strong>Patients with vs. without 12-month Follow-up With (n=139)</strong></td>
<td>21.7</td>
<td>26.8</td>
<td>16.7</td>
<td>8.0</td>
<td>7.3</td>
<td>3.6</td>
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</table>

<table>
<thead>
<tr>
<th>Current Status of Tumor</th>
<th>Initial diagnosis only</th>
<th>Recurrent</th>
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<tbody>
<tr>
<td><strong>All patients</strong> (N=289)</td>
<td>86.3</td>
<td>13.7</td>
</tr>
<tr>
<td><strong>Patients with vs. without 12-month Follow-up w/o (n=150)</strong></td>
<td>81.5</td>
<td>18.5</td>
</tr>
<tr>
<td><strong>Patients with vs. without 12-month Follow-up With (n=139)</strong></td>
<td>91.3</td>
<td>8.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatments received</th>
<th>Chemo+radiation+surgery</th>
<th>None</th>
<th>1 of 3 possible treatments</th>
<th>2 of 3 possible treatments</th>
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</thead>
<tbody>
<tr>
<td><strong>All patients</strong> (N=289)</td>
<td>38.1</td>
<td>4.5</td>
<td>24.2</td>
<td>33.2</td>
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<td><strong>Patients with vs. without 12-month Follow-up w/o (n=150)</strong></td>
<td>33.1</td>
<td>4.1</td>
<td>27.7</td>
<td>35.1</td>
</tr>
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<td><strong>Patients with vs. without 12-month Follow-up With (n=139)</strong></td>
<td>43.5</td>
<td>5.1</td>
<td>19.6</td>
<td>31.9</td>
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</table>

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Radiation</th>
<th>Chemotherapy (missing=6)</th>
<th>Surgery (missing n=5)</th>
<th>Type of radiation received</th>
<th>Years since last treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All patients</strong> (N=289)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Patients with vs. without 12-month Follow-up w/o (n=150)</strong></td>
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<tr>
<td><strong>Patients with vs. without 12-month Follow-up With (n=139)</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

- **Note:** p-values indicate statistical significance.
Results

- **Linear mixed-effects models** - symptom changes over time at the group level
  - Patient-reported Cognition (t=-2.11, p=0.037) & parent-reported Anxiety (t=2.18, p=0.0333) got significantly worse over time

- **Cox proportional hazards model** – survival analysis
  - 24 deaths
  - Patient-reported Mobility (hazard ratio=0.725, p=0.011) and Upper Extremity Function (HR =0.703, p=0.006) predicted better survival.
  - Longer time since diagnosis and higher performance rating were also predictive of survival.

- **Latent class growth analysis** (LCGA) to investigate patterns of symptoms change over time at the individual level. Numbers of classes within each domain
  - ranged 2 and 5 for patients;
  - ranged 2 and 3 for parents across domains.
Anxiety

Correlation between change scores of parents and patients: $r = 0.421, p=0.0819$
Depressive Symptoms

Correlation between change scores of parents and patients: $r = 0.708$, $p=0.0005$
Correlation between change scores of parents and patients: $r = 0.49$, $p=0.0150$
Mobility

Correlation between change scores of parents and patients: $r = 0.44, p=0.0355$
Upper Extremity Function

Correlation between change scores of parents and patients: $r = 0.46$, $p=0.036$
Peer Relationships

Correlation between change scores of parents and patients: $r = 0.183$, $p = 0.4685$
Correlation between change score of parents and patients: $r = 0.119$, $p=0.3557$
## Predictors of Pattern (Class) Membership

<table>
<thead>
<tr>
<th>Domain</th>
<th>number of classes</th>
<th>Sample n (by class)</th>
<th>Marital status</th>
<th>Gender (child)</th>
<th>IEP</th>
<th>Parent rated QOL</th>
<th>Initial dx or recurrent</th>
<th>Number of tx received</th>
<th>Length (chemo)</th>
<th>Length (radiation)</th>
<th>PSR</th>
<th>Age (parent)</th>
<th>Age (child)</th>
<th>Years since dx</th>
<th>Years since last tx</th>
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<tbody>
<tr>
<td>Anxiety</td>
<td>child</td>
<td>2</td>
<td>4; 68; 108</td>
<td>*</td>
<td>***</td>
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<td></td>
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</tr>
<tr>
<td>Depression</td>
<td>child</td>
<td>2</td>
<td>88; 95</td>
<td></td>
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<tr>
<td>Fatigue</td>
<td>child</td>
<td>4</td>
<td>73; 63; 54; 5</td>
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<td>***</td>
<td>**</td>
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<tr>
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<td>17; 96; 35; 26; 13</td>
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<td>95; 106</td>
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<td>2</td>
<td>96; 38</td>
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<td>**</td>
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<td>34; 97</td>
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<td>***</td>
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<td></td>
<td>**</td>
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<td>70; 59</td>
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</tr>
</tbody>
</table>

* p<0.05; ** p<0.01; *** p<0.001

UE=Upper Extremity Function; Peer= Peer Relationships; Dx=diagnosis; Tx=treatment

a. A class with a sample size less than 5 was considered trivial and not meaningful.
Conclusions

• Linear mixed effects models showed declined patient-reported Cognition and parent-reported Anxiety over time.

• Patient-reported Mobility and Upper Extremity Function predicted patients’ survival.
  • Small sample size (death n=24).

• At the individual level, patients and parents showed different patterns of changed PROMIS scores over time across all domains, except depressive symptoms.
  • Significant factors differentiating class membership were identified, which were domain specific.
  • Different predictors were found between parents and patients.
Study 3:

Association between the pediatric PROMIS Cognition and Leukoencephalopathy of Children with Brain Tumors

Leukoencephalopathy Grades

<table>
<thead>
<tr>
<th>Grade</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>normal, injury not perceived</td>
</tr>
</tbody>
</table>
| 1     | • mild generalized white matter signal abnormality;  
        • minimal or mild generalized volume loss; or  
        • signal abnormality/damage limited to 1 lobe of involvement. |
| 2     | • moderate generalized white matter signal abnormality;  
        • moderate generalized volume loss; or  
        • signal abnormality/damage limited to 2 lobes of involvement. |
| 3     | • severe generalized white matter signal abnormality;  
        • severe diffuse volume loss; or  
        • signal abnormality/damage involving at least 3 lobes |
| 4     | • near complete loss of the white matter volume; or  
        • complete infiltration of the white matter by signal abnormality within the entire hemisphere |

Leukoencephalopathy grade was based on white matter damage and degree of deep white matter volume loss shown on MRI
PedsPCF Scores (in T-score)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Sample Size</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>grade=0</td>
<td>n=36</td>
<td>52.17</td>
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<td>grade=1</td>
<td>n=27</td>
<td>48.03</td>
</tr>
<tr>
<td>grade=2</td>
<td>n=22</td>
<td>47.26</td>
</tr>
<tr>
<td>grade=3 or 4</td>
<td>n=14</td>
<td>44.12</td>
</tr>
</tbody>
</table>

F=4.14, p=0.0084

n = 99; a subsample from the study 1
Mean comparisons of individual pedsPCF items

PBT_Cogp8: It takes your child longer than other people to get his/her school work done

n = 99; a subsample from the study 1
Study 4: It is feasible to administer CAT in pediatric neuro-oncology clinics?
### Results: Time and # of items to complete CAT

<table>
<thead>
<tr>
<th>Itm bank</th>
<th>Time (SD)(^a)</th>
<th>Number of items administered</th>
<th>Mean (SD)(^b)</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety</td>
<td>1.38 (1.69)</td>
<td></td>
<td>9.7 (2.9)</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Fatigue</td>
<td>2.01 (3.96)</td>
<td></td>
<td>8.7 (2.8)</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Mobility</td>
<td>1.46 (0.98)</td>
<td></td>
<td>8.1 (3.3)</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Upper Extremity</td>
<td>1.3 (0.97)</td>
<td></td>
<td>10.4 (2.7)</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Depression</td>
<td>1.31 (2.46)</td>
<td></td>
<td>8.3 (3.4)</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>Peer relationship</td>
<td>1.49 (1.95)</td>
<td></td>
<td>8.1 (3.2)</td>
<td>5</td>
<td>15</td>
</tr>
</tbody>
</table>

\(^a\) Time to complete CAT, in minutes  
\(^b\) Number of CAT items administered  

(Lai et al, 2017)

Study 5: (Minimally) important differences
The estimated important differences (IDs) for parent-rated T-scores were: Anxiety 3-7 points, Depression, 3.5-6.5 points, Fatigue 4.5-7.5 points, Mobility 4-6 points, Peer Relationships 3-5 points, Upper Extremity Function 4-7.5 points, and Cognition 2.5 - 4.5 points.

Symbols in figure represent minimum, 1st quartile, median, 3rd quartile, and maximum values for the list of included cross-sectional and longitudinal anchor-based differences.
The estimated important differences (IDs) for child-rated T-scores were: Anxiety 4-6 points, Depression, 4-5 points, Fatigue 4.5-6.5 points, Mobility 3-6.5 points, Upper Extremity 2.5-8 points, and Cognition 2.5 - 5.5 points. None of the anchor-based analyses for child-rated Peer Relationships met the criteria for inclusion.

Symbols in figure represent minimum, 1st quartile, median, 3rd quartile, and maximum values for the list of included cross-sectional and longitudinal anchor-based differences.
Children with other chronic conditions such as NF1-associated plexiform neurofibromas
QOL vs. General Population Norms (mean=50 SD=10)

<table>
<thead>
<tr>
<th></th>
<th>Psychological Stress Experiences</th>
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<tbody>
<tr>
<td>T-Score</td>
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<tr>
<td>Anxiety</td>
<td>53.2</td>
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<tr>
<td>Depressive symptom</td>
<td>53.54</td>
</tr>
<tr>
<td>Fatigue</td>
<td>50.25</td>
</tr>
<tr>
<td>Pain</td>
<td>53.53</td>
</tr>
<tr>
<td>Stigma</td>
<td>53.32</td>
</tr>
</tbody>
</table>

Higher Scores Represent Worse Function
QOL vs. General Population Norms (mean=50 SD=10)

Higher Scores Represent Better Function

Meaning and Purpose
Mobility
Peer relationships
Positive Affect & Well-Being
Upper extremity function

<table>
<thead>
<tr>
<th>T-Score</th>
<th>Meaning and Purpose</th>
<th>Mobility</th>
<th>Peer relationships</th>
<th>Positive Affect &amp; Well-Being</th>
<th>Upper extremity function</th>
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<tbody>
<tr>
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<tr>
<td>Positive Affect &amp; Well-Being</td>
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(ANOVA) *** p<0.001; ** p<0.01; * 0<0.05
### v.s. Demographic & Clinical Variables

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<tr>
<th>Variable</th>
<th>Gender</th>
<th>family w/ NF1 besides your child</th>
<th>chronic itch</th>
<th>Pain</th>
<th>age at diagnosis</th>
<th># of café-au-lait spots</th>
<th># of plexiform neurofibroma</th>
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<td>&lt;.0001</td>
<td>&lt;.0001</td>
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</table>

Age at diagnosis: “10-17 years old” vs. “5-9 years old” vs. “Under 5 years old”


# of plexiform neurofibroma(s): “No” vs. “Yes: just one” vs. “Yes: 1-5” vs. “Yes: 5 or more”
Conclusions

1. Empirical evidences support pediatric PROMIS is a valid measurement system to evaluate symptom burden/health-related quality of life on children with brain tumors.

2. Symptom-based measurement systems can be used on children with various conditions who experience same symptoms such as fatigue, depression etc.

3. National based norms -- common reference group
   - Particularly important for children with rare diseases
   - Core set items + condition specific items

4. The need of individualized, tailored assessment such as PROMIS CATs when monitoring patients’ HRQOL across the disease continuum
   - ~ 2 min to complete each CAT – *individualized & tailored*
   - PROMIS is available in Epic 2017 and newer versions – *feasible in clinics*
   - Link to adult measures – *across the lifespan*
Using Perceived Stigma as an Example
Core Stigma Item Set + Condition Specific Items

Make it possible to compare stigma perceived between patients with stroke vs. skin condition without losing the sensitivity to capture stigma resulted from each condition

core + condition specific items -- capturing unique condition/disease experiences
Perceived Stigma across Conditions

Distribution of $\Theta_{24}$ by Diag

- Cancer
- EB
- Eczema
- Ichthyos
- MD
- NF1-pNF
- Psoriasis
- Epilepsy

Worse

Least

Neuro-QoL/PEPR example
Acknowledgement

This study was supported by the National Cancer Institute (R01CA174452; PI: Jin-Shei Lai)

js-lai@northwestern.edu

http://www.healthmeasures.net/