Evaluation of the Validity of the Prosthetic Upper-Extremity Functional Index (the PUFi)

• Virginia Wright, MSc, BSc(PT), doctoral candidate
• Sheila Hubbard, BSc PT/OT
• Jeffrey Jutai, PhD*
• Stephen Naumann, PhD
• Susan Cohen

Bloorview MacMillan Children’s Centre, Toronto, Canada

* University of Western Ontario, London, Canada
What is the PUFI?

• A 20 to 30 minute questionnaire completed by a parent or a child to tell us about use and value of a child’s prosthesis
• Available now in a computer version (PUFI-PC) that can be used in clinic for easy completion by the parent or child
• Allows instant scoring by the clinician
Uses of the PUFI with an individual child

- To investigate ways that a child performs bilateral activities
- To evaluate the success and value of prosthetic device use as compared with residual limb
- To identify difficulties and problem areas associated with device use
- To measure change in a child’s abilities over a follow-up period (response to intervention)
Design of the PUFI

Two age-based versions are available:

- **Young child** (ages 3 to 5 years)
- **Older child** (ages 6 to 18 years)

- Can do *parent-report* questionnaire for young and older child
- Also can do *child self-report* questionnaire if child $\geq 8$ years
The PUFI’s Items

• Questions (items) focus on “2-handed” activities:
  26 activities in young child version
  38 activities in older child version

• Items cover 4 areas of activity:
  – Self-care (e.g., tie up shoelaces)
  – Domestic (e.g., spread cheese/jam on a cracker)
  – School (e.g. draw a line with a ruler)
  – Extra-curricular/sports (e.g., swing a baseball bat)
The PUFI Software

- Designed by programmers at Bloorview MacMillan Children’s Centre (2001 …)
- Requires Microsoft Access 97, 2000, or 2002, Pentium (or faster processor), 64 MB RAM, 30 MB free hard drive space for the PUFI database, monitor that can display true colours, and CD-ROM drive
- Six different languages built into software: English, French, Spanish, Swedish, Dutch and Slovenian
PUFI Part I: Introduction

- Overall evaluation of the usefulness of the prosthesis for 8 activity categories with a 3-point scale to rate usefulness
- Areas considered: Personal Care, Dressing Activities, at Home Relaxing, at School, at Work, at Social Events, Sports/Recreation, at Play
Est-ce que votre prothèse est utile pour cette activité?

1. Saison personnelle
   - La prothèse est très utile
   - La prothèse est plus ou moins utile
   - La prothèse n'est pas utile

2. Tâche habillage / Déshabillage
   - La prothèse est très utile
   - La prothèse est plus ou moins utile
   - La prothèse n'est pas utile

...Brosser ses dents, manger, hygiène, brosser ses cheveux...

...Mettre ses souliers, ses bas, un gilet, un manteau, des bijoux...

Avance automatique
PUFI Part II

A detailed inventory of 2-handed activities. Its 4 response scales evaluate:

• Method of performance
• Ease of performance with prosthesis
• Usefulness of prosthesis
• Ease of performance without prosthesis
“Method of Performance”

- Uses prosthesis actively
- Uses prosthesis passively
- With residual limb
- Without prosthesis
- Needs someone’s assistance
- Cannot do even with help
Activité: 1

Monter la fermeture éclair d'un manteau

B. De quelle façon votre enfant réussit cette activité la plupart du temps:

☐ Avec les deux mains, la prothèse étant utiliser activement
☐ Avec les deux mains, la prothèse étant utiliser passivement
☐ Avec l'aide du membre atteint
☐ En utilisant seulement le main non-atteinte
☐ Avec l'aide d'une autre personne
☐ Ne sait pas/ Pas certain

[Image of a zipper with a pull tab]
“Ease of performance with the prosthesis”

- No difficulty
- Some difficulty
- Great difficulty
- With help from someone
- Cannot do with the prosthesis
Monter la fermeture éclair d'un manteau

D. De quelle façon votre enfant fait-il cette activité lorsqu'il porte sa prothèse?

- Sans difficulté
- Avec un peu de difficulté
- Avec beaucoup de difficulté
- Avec l'aide d'une autre personne
- Ne peux pas faire l'activité avec sa prothèse
“Usefulness of the prosthesis”

- Very useful
- Somewhat useful
- Not useful
D. Est-ce que la prothèse est utile pour l’activité:

- Très utile
- Plus ou moins utile
- N’est pas utile
“Ease of performance without the prosthesis”

- No difficulty
- Some difficulty
- Great difficulty
- With help from someone
- Cannot do with the prosthesis
E. De quelle façon votre enfant fait-il cette activité lorsqu’il ne porte sa prothèse?

- Sans difficulté
- Avec un peu de difficulté
- Avec beaucoup de difficulté
- Avec l’aide d’une autre personne
- Ne peux pas faire l’activité sans sa prothèse
Example of a Child’s Response Pattern

Put on a loose pair of socks

- **METHOD:** Non-prosthetic hand alone
- **WITH PROSTHESIS:** Great difficulty
- **PROSTHESIS:** Not useful
- **WITHOUT PROSTHESIS:** Some difficulty
Example of a Child’s Response Pattern

Insert a straw into a juice box

• METHOD: Both arms together, with the prosthetic hand used actively to grasp the box or straw
  • WITH PROSTHESIS: No difficulty
  • PROSTHESIS: Very useful
  • WITHOUT PROSTHESIS: with great difficulty
PUFI-PC Reports for a Child
Frequency and % Scores

Client: Clinic 1, ChartID 00-83-79  Client Number: 00-83-79  Assessment Date: Jan-7-2003

**Does the client do the activity?**

- A. Yes 100%
- B. cannot do 0%

Number of N/A's: 11

**How does the client usually do the activity?**

- A. actively 63%
- B. passively 7%
- C. residual limb 7%
- D. one-handed 15%
- E. some help 7%
- F. cannot do 0%

- 64%
- 7%
- 7%
- 7%
- 15%
- 0%
How well does the client do the activity using the prosthesis?

- No difficulty: 46%
- A little difficulty: 29%
- Some difficulty: 29%
- Great difficulty: 7%
- Unable to do: 6%
- Cannot do: 6%

Group Mean Score = 7%

How useful is the prosthesis for the activity?

- Highly useful: 33%
- Somewhat useful: 44%
- Not useful: 23%

Group Mean Score = 55%

How well does the client do the activity without the prosthesis?

- No difficulty: 44%
- A little difficulty: 41%
- Some difficulty: 14%
- Great difficulty: 11%
- Unable to do: 4%

Group Mean Score = 18%
# Raw Scores

Client: Clinic 1, ChartID 00-83-79  
Client Number: 00-83-79  
Assessment Date: Jan-7-2003

<table>
<thead>
<tr>
<th>Activity</th>
<th>Is the activity done?</th>
<th>Usage</th>
<th>Ease of Use</th>
<th>Usefulness</th>
<th>Without Prosthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zipper</td>
<td>yes</td>
<td>prosthetic (active)</td>
<td>some difficulty</td>
<td>very useful</td>
<td>great difficulty</td>
</tr>
<tr>
<td>Shoelaces</td>
<td>yes</td>
<td>prosthetic (active)</td>
<td>no difficulty</td>
<td>very useful</td>
<td>cannot do</td>
</tr>
<tr>
<td>Tights</td>
<td>N/A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Socks</td>
<td>N/A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mittens</td>
<td>yes</td>
<td>prosthetic (active)</td>
<td>no difficulty</td>
<td>very useful</td>
<td>no difficulty</td>
</tr>
<tr>
<td>Buttons</td>
<td>yes</td>
<td>residual limb</td>
<td>no difficulty</td>
<td>somewhat useful</td>
<td>no difficulty</td>
</tr>
<tr>
<td>Pants</td>
<td>yes</td>
<td>prosthetic (active)</td>
<td>no difficulty</td>
<td>somewhat useful</td>
<td>some difficulty</td>
</tr>
<tr>
<td>Belt</td>
<td>yes</td>
<td>with help</td>
<td>cannot do</td>
<td>somewhat useful</td>
<td>some difficulty</td>
</tr>
<tr>
<td>Toothpaste</td>
<td>yes</td>
<td>non-prosthetic</td>
<td>no difficulty</td>
<td>somewhat useful</td>
<td>no difficulty</td>
</tr>
<tr>
<td>Toothbrush</td>
<td>yes</td>
<td>non-prosthetic</td>
<td>no difficulty</td>
<td>not useful</td>
<td>no difficulty</td>
</tr>
<tr>
<td>Necklace</td>
<td>N/A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fingernails</td>
<td>yes</td>
<td>with help</td>
<td>great difficulty</td>
<td>not useful</td>
<td>cannot do</td>
</tr>
<tr>
<td>Cut meat</td>
<td>yes</td>
<td>prosthetic (active)</td>
<td>no difficulty</td>
<td>very useful</td>
<td>some difficulty</td>
</tr>
<tr>
<td>Unwrap sandwich</td>
<td>yes</td>
<td>prosthetic (active)</td>
<td>no difficulty</td>
<td>very useful</td>
<td>some difficulty</td>
</tr>
<tr>
<td>Peanut butter</td>
<td>yes</td>
<td>prosthetic (passive)</td>
<td>some difficulty</td>
<td>somewhat useful</td>
<td>some difficulty</td>
</tr>
<tr>
<td>Chop fruit</td>
<td>yes</td>
<td>prosthetic (passive)</td>
<td>some difficulty</td>
<td>somewhat useful</td>
<td>some difficulty</td>
</tr>
<tr>
<td>Juice box straw</td>
<td>N/A</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
How well does the client do the activity using the prosthesis?

Client: Clinic 1, ChartID 00-83-79    Client Number: 00-83-79    Assessment Date: Jan-7-2003

These activities never need to be performed:

3. Put on tights or pantyhose
4. Put on a loose pair of socks
11. Put on a necklace or chain around the neck
17. Remove straw from a juice box and insert it
19. Use a can opener
23. Pull small building blocks apart (e.g., LEGO, Meccano)
25. Thread a string of beads to make a piece of jewelry
29. Open a zippered pencil case and take a pencil out
30. Use a small hand-held pencil sharpener
32. Play with a Game Boy
33. Skip with a skipping rope

These activities cannot be performed with the prosthesis:

8. Do up the buckle on a belt around the waist

These activities can be performed with great difficulty:

12. Groom fingernails (clip, file or polish)

These activities can be performed with some difficulty:

1. Do up the zipper of a coat or jacket
15. Spread cheese, jam or peanut butter on a cracker
16. Chop vegetables or fruit
Development and Reliability Testing of a New Functional Status Questionnaire for Children Who Use Upper Extremity Prostheses

Wright V, Hubbard S, Jutai J, Naumann S

J Hand Ther 2001;14:91-104
Evaluation of the validity of the Prosthetic Upper extremity Functional Index (PUFI) for children.

Wright V, Hubbard S, Jutai J, Naumann S.
The PUF validity study

Does the PUF differeniate between children and abilities on different tasks (as a function of age, nature of amputation, type of prosthesis, etc.)?

• Do the PUF item response patterns make sense clinically?
• Do PUFI scores correlate significantly with observed skill with the prosthesis and with scores on a recognized observational test (University of New Brunswick [UNB] Test of Prosthetic Function)?

• Is the PUFI a feasible tool for clinical use?
Validity Study: Participants

• Glenrose Rehabilitation Hospital, Edmonton, Alberta, Canada
• Institute of Biomedical Engineering, Fredericton, New Brunswick, Canada
• Area Child Amputee Center, Mary Free Bed Hospital and Rehabilitation Center, Grand Rapids, Michigan, USA
• Variety Myoelectric Center, Detroit, Michigan, USA
Demographic characteristics of older child sample (n=29)

- 20 females, 9 males
- Mean age = 10.1 yrs (7 to 18 yrs)
- 27 congenital, 2 acquired
- 5 body-powered hook, 4 body-powered adept, 17 myoelectric, 3 passive
- Wearing pattern: 1 occasional, 18 majority of day, 10 all waking hours
Demographic characteristics of younger child sample (n=12)

- 6 females, 6 males
- Mean age = 4.2 yrs (3.1 to 5.7 yrs)
- 10 congenital, 2 acquired
- 3 body-powered hook, 3 body-powered adept, 6 myoelectric
- Wearing pattern: 3 occasional, 2 regular part-day, 4 majority of day, 3 all waking hours
PUFI Part I mean scores (%): Usefulness of the prosthesis

- Older child: 74.2
- Younger child: 53.1
Usual method of performance

Older child  PUFI, 38 items, (n=29)
Usual method of performance

Younger child  PUFI, 26 items (n=12)

- Unable
- With help
- Non-prosthetic hand alone
- With assistance of residual limb
- Prosthesis used passively
- Prosthesis used actively
- N/A
Ability with the prosthesis
Older child PUFI, 38 items, (n=29)
Ability with the prosthesis

Younger child  PUFI, 26 items, (n=12)
Ability with the prosthesis

Older child PUF (n=29)

- MOST DIFFICULT ITEMS
  - groom fingernails
  - put on necklace
  - play with Game Boy
  - cut meat
  - chop veggies
  - hammer nail into board

- EASIEST ITEMS
  - cut out picture
  - take cap off marker
  - open pencil case
  - pull blocks apart
  - unwrap cookies/sandwich
  - remove a straw from juice box and insert
Ability without the prosthesis

Older child PUFI, 38 items, (n=29)

# times response option was used

- unable
- with help
- great difficulty
- some difficulty
- no difficulty
- not applicable

(0-400 scale)
Ability without the prosthesis

Younger child  PUFI, 26 items, (n=12)
Usefulness of the prosthesis

Older child  PUFI, 38 items (n=29)
Usefulness of the prosthesis
Younger child PUFI, 26 items (n=12)
Agreement between parent-report of ability and therapist’s observation of PUFi items - total sample (n=33)

For 186 observation-item pairs:

- method of performance: $\text{Kappa}=0.54$
- ability with prosthesis: $K=0.59$
- usefulness of prosthesis: $K=0.46$
- ability without prosthesis: $K=0.55$

Tendency for higher ratings from therapist observation than from parent-report
Correlations between PUFI and UNB-A

- PUFI usefulness of prosthesis and UNB-A (spontaneity)

Older child (n=29): \( r = 0.16 \)
Younger child (n=13): \( r = 0.55 \)
Total sample (n=42): \( r = 0.44, P < 0.01 \)
Correlations between PUFI and UNB-B

- PUFI usefulness of prosthesis and UNB-B (performance)

Older child (n=29): \( r = 0.57 \)
Younger child (n=13): \( r = 0.46 \)
Total sample (n=42): \( r = 0.63, P < 0.02 \)
Parents' Feedback About the PUFI

• Completion of the PUFI made them think about use of the myoelectric prosthesis for everyday tasks
• Gave them ideas for increased use of the prosthesis and activities to practice
• Often requested a copy of videotape for use by local therapist or school staff
• Paper forms were long and tedious
Study Conclusions

• Both older child and young child PUFIs were able to differentiate between children and abilities on different tasks
• Evidence that the ability to perform the activity was higher with the prosthesis than without
• Prostheses rated as “very useful” for about 50% of activities
• PUFI mean scores for self-report and observation were quite high (perhaps due to volunteer sample, i.e., “good” prosthetic users)
• Indication of a pattern of highest skill for school activities and lowest for self-care activities
• Response patterns were logical within items (i.e., method of use, ability with prosthesis and usefulness of prosthesis fit together into logical picture)
• PUFI scores showed moderate levels of agreement with scores from observation of actual performance

• There was fair to good correlation between PUFI prosthetic ability and usefulness scores and UNB-skill of prosthetic use

• Sample is too small to make any conclusion about impact of type of prosthesis on function or about factors predictive of good use
Future Directions

- Building of version 2.0 of PUIF software in progress
- Development of new versions with our partners:
  - i) teen/adult
  - ii) non-wearers
  - iii) children with hemiplegic cerebral palsy
- Refinements and validation testing with various language versions
Future Directions

- Development of an international database for longitudinal tracking and evaluation of issues such as: developmental pattern of prosthetic use (young child through teen), factors predicting success with use, differences in abilities with different types of prostheses

- Rasch analysis of PUFI with larger sample
Our Partnerships

- “Free-trade” agreements which included free use of the PUFI and provision of clinic summary reports in exchange for data
- Development of PUFI-PC language versions in exchange for translation services.
Our Partners

CANADA:

Institute of BioMedical Engineering at the University of New Brunswick, NB
Centre de readaptation Marie Enfant de L’hôpital Ste Justine, Montreal, PQ
Ottawa Children’s Treatment Centre, Ottawa, ON
Children’s Developmental Rehabilitation program, Hamilton, ON
Glenrose Rehabilitation Hospital, Edmonton, AB
Our Partners

USA:
Shriners Hospital for Children: funded research project evaluating outcomes of children with congenital below elbow deficiencies (James and Bagley) - includes Montreal Shriners Children’s Healthcare of Atlanta
Our International Partners

OVERSEAS:

The Children’s Hospital at Westmead, Australia

West Midlands Rehabilitation Centre, Birmingham, UK

King’s College Hospital, London, UK

Nottingham City Hospital, Nottingham, UK
Our International Partners ...

OVERSEAS:
Erasmus University Medical Centre, Rotterdam, Holland
Institut Republike Slovenije za rehabilitacidjo, Ljubljana, Slovenia
Orebor Universoty Hospital, Orebro, Sweden
Acknowledgements

• Funding from: Bloorview MacMillan Childrens Hospital Foundation, Bloorview MacMillan Children’s Foundation, Ontario Ministry of Health and Long-Term Care (through the Ontario Rehabilitation Technology Consortium)

• The clients and their caregivers and family members

• Our international partners
Contact Information

Virginia Wright, MSc, BSc(PT)
Principal Investigator, PUFI Team
Bloorview MacMillan Children’s Centre
150 Kilgour Rd
Toronto Ontario
M4G 1R8
416-425-6220, ext 3745
vwright@bloorviewmacmillan.on.ca
Merci!
Older Child PUFI Mean Scores
(n=29)

• Ease of performance with prosthesis:
  \[72.3\% \ (sd = 23.7, \ min = 8.8, \ max = 98.4)\]

• Ease of performance without prosthesis
  \[65.2\% \ (sd = 19.4, \ min = 17.7, \ max = 94.5)\]

• Usefulness of prosthesis
  \[61.5\% \ (sd = 23.7, \ min = 1.5, \ max = 93.2)\]
Older Child PUF1 Mean Scores
for Myoelectric users only (n=33 reliability and validity sample)

• Ease of performance with prosthesis:
  72.6% (sd = 23.8, min = 0.0, max = 98.4)

• Ease of performance without prosthesis
  67.1% (sd=19.9, min = 22.7, max = 95.0)

• Usefulness of prosthesis
  57.4% (sd = 24.8, min = 0.0, max= 93.7)
Younger Child PUF1 Mean Scores (n=13)

- Ease of performance with prosthesis: 70.9% (sd=24.2, min = 0.0, max= 95.0)
- Ease of performance without prosthesis 76.0% (sd=21.4, min = 0.0, max=76.9)
- Usefulness of prosthesis 52.1% (sd=15.4, min = 34.1, max=76.9)
Younger Child PUF1 Mean Scores for Myoelectric users only (n=14, reliability and validity sample)

- Ease of performance **with** prosthesis: **80.6** (sd=11.7, min = 57.1, max= 95.6)
- Ease of performance **without** prosthesis: **74.9** (sd=13.7, min = 46.6, max=95.8)

Usefulness of prosthesis:
- **66.1** (sd=16.7, min = 34.1, max=93.4)
PUFI Part II mean scores for ability to perform activities with and without Prosthesis

- With prosthesis - younger: 70.9
- Without prosthesis - younger: 76
- With prosthesis - older: 72.3
- Without prosthesis - older: 65.2