

BRACHIAL
PLEXUS
OUTCOME
MEASURE

BRACHIAL PLEXUS OUTCOME MEASURE

INTRODUCTION

The Brachial Plexus Outcome Measure (BPOM) is a disease specific functional evaluation for school-aged children with obstetrical brachial plexus palsy. It has two components: Activity Scale and Self-evaluation Scale. The BPOM Activity scale evaluates the key functional movement patterns that are deficient in the affected limb of a child with obstetrical brachial plexus palsy (OBPP). The child's performance on these items is graded using a 5-point ordinal scale according to the ability to complete the task, and the quality of movement pattern executed. The BPOM Self-evaluation scale consists of 3 (100 mm) visual analog scales to evaluate the perceived function of the arm and hand and the cosmetic appearance of the limb.

The BPOM was developed to provide information to assist with decision making regarding:

- a) *Secondary reconstructive procedures*
- b) *Remedial rehabilitation interventions and,*
- c) *Recommendations for adaptations and accommodations for daily living*

The BPOM was developed on the theoretical framework of the World Health Organization, International classification of function, disability and health (ICF).¹ The BPOM is classified within the ICF *Activity and Participation* domains of functioning. The BPOM measures function in relation to the **activity limitations** resulting from the physical sequela of nerve injury to the brachial plexus at birth.

The purpose of the BPOM Activity Scale is to measure the **capacity** of the affected limb.

The ICF defines '*capacity*', as the individual's ability to execute a task or action at their maximal potential. In contrast, 'performance' is defined as what the individual actually does within their respective environments.¹

The BPOM self-evaluation scale is a screening tool to measure how a child's perception of their upper extremity function and appearance hinders or enhances his/her's **participation** in daily activities.

The BPOM is a **discriminative** outcome measure. It was developed by a team of experts and has demonstrated good construct validity and internal consistency.² Further studies are being conducted to evaluate reliability and concurrent validity of the BPOM. In 2013, the BPOM was revised to clarify the instructions and materials used to administer the test. The test items were not changed in any format from the original BPOM. The titles and descriptors of some items were edited to create a more uniform use of language.

MATERIALS

You will require the following materials to administer the BPOM Activity and Self-evaluation Scales.

BPOM FORMS

✓	BPOM Activity Scale – General Guidelines for Scoring	Page 9
✓	BPOM Activity Scale – Specific Guidelines for Scoring	Page 10
✓	BPOM Assessment and Score Sheet	Page 14

BPOM ACTIVITY SCALE ASSESSMENT TOYS



Standard Comb

Used for BPOM Activity Item:
Combs Back of Head



***5" Circular Container with Lid**

Used for BPOM Activity Items:
Places Container Above Head
Opens Large Container
Holds Plate with Palm Up



****Button/Snap Belt**

Used for BPOM Activity Item:
Undo Button at Midline



Computer Mouse

Used for BPOM Activity Item:
Uses Computer Mouse



1/2" Round Beads with Holes

Used for BPOM Activity Items:
Pretends to Eat Candy
Strings Bead



Drum Sticks

Used for BPOM Activity Item:
Plays the Drums



Theraputty (Soft/Medium soft)

Used for BPOM Activity Item:
Pulls Apart Theraputty



Shoelace

Used for BPOM Activity Item:
Strings Bead

** It is essential that the lid loosely fits on the container and should not screw on or require strength to remove*

***The child's pant button or snap is typically used for this item. If not available, a custom made adjustable cummerbund with a button and snap sewn at midline is used. Contact us for instructions: emily.ho@sickkids.ca*

ADMINISTRATION GUIDELINES

BPOM ACTIVITY SCALE

The BPOM Activity Scale is validated for children greater than 4 years of age with no significant cognitive or developmental delays.

Organize the assessment materials in a bag for ease of access and administration. Store the shoelace and beads in the large container. Use the following instructions as a guide. However, the use of play and playfulness is essential when assessing children.

The purpose of the BPOM activity scale is to evaluate the **capacity** of the child's affected limb. The unilateral items are presented to the affected limb only. This is to observe the maximum ability and quality of movement of this limb. The bilateral items are designed to evaluate the quality of the movement of the affected limb as an assisting hand.

The following sequence of presenting the BPOM Activity Items is preferred for ease of administration.

BPOM Activity Item	Instructions
<p>1 Combs Back of Head <i>- Uses affected hand to reach the back of head to comb hair</i></p>	 <p>Place the comb in the child's affected hand and ask them to comb the back of their head.</p>
<p>2 Pulls Apart Theraputty <i>- Uses power grasp to pull apart theraputty with active wrist extension with both hands</i></p>	 <p>Ask the child to pull apart the theraputty with both hands in front of them. Cue the child to keep the theraputty in front of their body.</p>
<p>3 Opens Large Container <i>- Uses both hands to open 5" diameter container with snap on lid; abducts thumb with affected hand</i></p>	 <p>Ask the child to open the large container by removing the lid. The child should use the affected hand to stabilize the container. Observe carefully if the child abducts the thumb.</p>

BPOM Activity Item

Instructions

- 4 Holds Plate with Palm Up**
- Holds plate with affected hand palm up



Once the container is opened, ask the child to pretend the lid is a plate. Ask the child to hold the plate using their affected hand with palm up.

- 5 Pretends to Eat Candy**
- Hold plate with unaffected hand, pick up bead with affected hand from plate and bring it up to mouth



Ask the child to hold the plate with their unaffected hand. Put the bead on the plate. Ask the child to pretend the bead is a candy, and pick up the bead with their affected hand and pretend to eat it.

- 6 Strings Bead**
- Uses both hands to string bead; uses precision grasp (pinch) with affected hand



Ask the child to string one bead on the shoelace. The child can use their unaffected hand to string or place the bead on the shoelace. Carefully observe the child's pattern of pinch.

- 7 Plays Drums**
- Hits drumsticks on container with both hands



Place the container with lid closed in front of the child. Give the child the drumsticks and ask them to play the drums on the container.

- 8 Places Container Above Head**
- Uses both hands to reach forward to place a container directly above their head



Pick up the container and ask the child to hold the container with both hands. Put your hand in front of the child, palms up, at the height of the child's head. Ask the child to keep both hands on the container and place it on your hand.

BPOM Activity Item

Instructions

- 9 Uses Computer Mouse**
- Uses affected hand with isolated finger flexion to click on mouse



Place the computer mouse on a desk in front of the child's affected hand. Ask the child to click on the computer mouse with their affected hand.

- 10 Undo Button at Midline**
- Undo button or snap at navel level with both hands



Ask the child to stand up and undo the button or snap on their pants or shirt at navel level. If the child is not wearing any buttons, use the custom made button belt.

- 11 Hand to Back Pant Pocket**
- Puts affected fingers into ipsilateral back pant pocket



Ask the child to place their affected hand into the back pocket of their pants.

BPOM SELF-EVALUATION SCALE

The BPOM Self-evaluation Scale is validated for children greater than 7 years of age with no significant cognitive, developmental or learning delays. Each VAS line is 100 mm in length.

Prior to administering the BPOM Self-evaluation scale, it is important to tell the child that their thoughts and feelings about their affected limb is a very important aspect of their medical care. The BPOM Self-evaluation scale may be administered prior to the BPOM Activity Scale to reinforce to the child and family that the child's perspective is greatly valued.

First, show the child the BPOM Self-evaluation Scale. Use the following instructions as a guide. However, tailor the language and instructions as required to facilitate the child's understanding of the visual analog scale.

Self-Evaluation Arm Function

My arm works . . .



Say to the child, "I would like to know how well you think your arm works." *Point to the child's arm from the shoulder down to the hand to illustrate the whole limb.*

Next, instruct the child: "Can you draw a mark on this line to tell me how you feel? If you mark the line closer to the sad face, then you think your arm works very poorly. If you mark the line closer to the happy face, then you think your arm works well. If you mark the line in the middle, then you think that your arm works neither poor or well."

"Where would you mark the line to show how well your arm works?"

Self-Evaluation Hand Function

My hand works . . .



Say to the child, "I would like to know how well you think your hand works." *Point to the child's hand.*

Next instruct the child: "Can you draw a mark on this line to tell me how you feel? If you mark the line closer to the sad face, then you think your hand works very poorly. If you mark the line

closer to the happy face, then you think your hand works well. If you mark the line in the middle, then you think that your hand works neither poor or well.”

“Where would you mark the line to show how well your hand works?”

Self-Evaluation Appearance

My arm and hand looks . . .



Say to the child, “I would like to know what you think about the look of your arm and hand.”
Point to the child’s arm from the shoulder down to the hand to illustrate the whole limb.

Next, instruct the child: “Can you draw a mark on this line to tell me how you feel? If you mark the line closer to the sad face, then you think your arm and hand looks very bad. If you mark the line closer to the happy face, then you think your arm and hand looks very good. If you mark the line in the middle, then you think that your arm and hand looks neither bad or good.”

“Where would you mark the line to show how what you think about the look of your arm and hand?”

BPOM ACTIVITY SCALE

GENERAL GUIDELINES FOR SCORING

This scale was defined by: 1) the ability to complete the task and, 2) the quality and degree of compensatory movements observed in the affected upper extremity during the task. The Functional Movement Scale is an ordinal scale from 1 to 5. A lower score represents a greater activity limitation. A child who cannot complete the BPOM Activity item is given a score of 1. A child who scores 1 or 2 does not have functional movement in their affected limb.

A score of 3 on this scale is defined as functional movement in the affected upper extremity. The child is able to complete the BPOM task at this level. However, the quality of movement in the affected limb is still significantly impaired. In developing the scale, there was a specific challenge of defining the difference between minor and major compensatory movements that are observed between grades 3 and 4 in the scale. Absent or insufficient (defined as $\leq \frac{1}{2}$ range of AROM gravity eliminated) active movement in a primary mover(s) as defined in the development of the tool was used to distinguish the quality of movement used to complete the task. A child who scores a 3, may use passive range of motion in one or more joints of the affected limb to complete the task. A child who scores 3 is functional, but may still require surgical or non-surgical intervention to optimize the quality of the movement in the affected limb.

A child who completes the task with sufficient quality of movement scores a 4. At this level only minor compensations are used to complete the task. A score of 5 is graded as movement that is symmetrical to the unaffected side.

BPOM ACTIVITY SCALE: FUNCTIONAL MOVEMENT SCORE

General Guidelines

- 1 Cannot complete task
 - Child is unable to complete task
 - Ability to complete task may be impaired due to development or behavioural factors

- 2 Completes task using only unaffected arm
 - Child only uses unaffected arm to complete task

- 3 Completes task
Absent active movement in primary mover(s).
May use passive range of motion to complete movement pattern
 - Quality of functional movement of whole limb is greatly impaired
 - Child completes task using significant compensatory movements with the affected arm
 - May use passive range of motion to complete movement pattern when active range of motion is absent or insufficient (defined as $\leq \frac{1}{2}$ range of AROM gravity eliminated; i.e. AMS score < 3) in one or more primary mover(s)
 - May use unaffected arm to move affected arm to complete the task due to absent or insufficient range of motion in one or more primary mover(s)
 - Absent or insufficient shoulder external rotation defined by the presence of a trumpet sign of greater than 90° shoulder abduction

- 4 Completes task
Initiates all movements actively
Compensatory techniques used to complete movement pattern
 - Child completes the task, but uses minor compensatory movements
 - Joint movements are initiated actively ($> \frac{1}{2}$ range of AROM gravity eliminated), but end range of motion may be completed passively using compensatory movements; or position of primary mover(s) is sufficient for function (i.e. forearm pronation and supination activity items)
 - Quality of functional movement of entire upper limb is not symmetrical as unaffected arm

- 5 Completes task
Completes movement pattern
 - Child completes task
 - Quality of functional movement of entire upper limb is symmetrical as unaffected arm

BPOM ACTIVITY SCALE

SPECIFIC GUIDELINES FOR SCORING

Activity Primary Mover(s)		1	2	3	4	5
SHOULDER						
Combs Back of Head <i>Shoulder External Rotation</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence.	Uses unaffected arm and hand only due to pain or restricted passive range of motion in shoulder abduction, external rotation and/or poor hand function on the affected side.	Uses unaffected hand to place affected hand on the back of the head to comb hair or uses table/body/back extension and momentum in affected limb to comb back of head due to absent or insufficient (AMS < 3) active shoulder external rotation.	Actively brings hand to the level of the ear using shoulder external rotation, but may use compensatory movements such as the use of the fingers to ("climb") position the hand at the back of head, trunk side flexion, swinging affected arm with momentum, back extension and/or neck flexion to comb back of head to complete the movement.	Actively brings hand to back of head using shoulder abduction, external rotation with head in neutral; symmetrical to unaffected side.	
Places Container Above Head <i>Shoulder Flexion Elbow Extension</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence	Uses unaffected arm and hand only to complete task due to pain or restricted passive range of motion in shoulder flexion or due to poor hand function on the affected side; may try to use unaffected hand to support container, but unable to complete movement pattern with affected arm.	Unable to maintain contact with container with affected hand through out the activity due to absent or insufficient (AMS < 3) active shoulder flexion. May use unaffected limb or table to support affected limb to get to end range shoulder flexion to place container.	Actively maintains both hands on container and places it using active shoulder flexion on the affected side, but may use compensatory movements such as back extension; elbow flexion may be more pronounced compared to unaffected side.	Actively maintains both hands on container and places it using full shoulder flexion; elbow flexion; symmetrical to unaffected side, including shoulder external rotation.	
Undo Button at Midline <i>Shoulder Internal Rotation</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence	Uses unaffected arm and hand only due to pain or restricted passive range of motion in shoulder internal rotation or poor hand function on the affected side.	Wrist flexed, and is only able to complete task by using unaffected limb to pull clothing towards affected hand or uses object/table/ unaffected hand to push affected hand toward navel to complete task due to absent or insufficient (AMS < 3) active shoulder internal rotation.	Actively brings hand to midline using shoulder internal rotation. May use compensatory movements such as wrist flexion on the affected side to assist.	Actively brings hand to midline using shoulder internal rotation; symmetrical to unaffected side.	

Activity
Primary Mover(s)

SHOULDER	1	2	3	4	5
Hand to Back Pant Pocket <i>Shoulder Internal Rotation</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence	Uses unaffected arm and hand only due to restricted passive range of motion in shoulder internal rotation or poor hand function on the affected side.	Unable to reach ipsilateral side beyond trunk midpoint; may use swinging and momentum or the unaffected limb to position affected limb to reach the ipsilateral back pocket due to absent or insufficient (AMS < 3) active shoulder internal rotation.	Actively brings affected hand to ipsilateral waistline at or past trunk midpoint, but may use compensatory movements such as using ("climbing") the fingers to position hand towards the back pocket.	Actively brings affected hand to ipsilateral back pocket; symmetrical to unaffected side.
ELBOW & FOREARM	1	2	3	4	5
Pretends to Eat Candy <i>Elbow Flexion</i> <i>Shoulder External Rotation</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence.	Uses unaffected arm and hand only due to pain or restricted passive range of motion in shoulder external rotation and/or elbow flexion or poor hand function on affected side.	Trumpet sign >90°; or trumpet sign <90° and absent or insufficient (AMS < 3) active shoulder external rotation and/or elbow flexion to reach mouth; may require object/ table or unaffected hand to move affected hand passively to complete task.	Trumpet sign <90°, active elbow flexion, forearm neutral/ supination but may use mild compensatory movements such as neck flexion, trunk flexion and adaptive wrist and finger positions.	Actively brings hand to mouth using elbow flexion with forearm neutral/ supinated, wrist extended, neck neutral; symmetrical with unaffected side
Uses Computer Mouse <i>Forearm Pronation</i> <i>Finger Flexion (isolated)</i> <i>Finger Extension</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence.	Uses unaffected arm and hand only due to pain or restricted passive range of motion in shoulder external rotation or forearm pronation to position arm or poor hand function on affected side.	Trumpet sign >90°; or trumpet sign < 90° and absent or insufficient (AMS < 3) active pronation; may use unaffected hand or active wrist flexion of the affected side to passively move fingers to press mouse due to absent or insufficient (AMS < 3) active finger flexion and extension.	Trumpet sign <90°, elbow flexed, forearm actively pronates or position of forearm is fixed between neutral to 90° pronation; wrist flexed or extended; active individual finger movement on affected side.	Actively brings forearm into 45-90° pronation with active individual finger movement; symmetrical with unaffected side.

Activity Primary Mover(s)					
ELBOW & FOREARM	1	2	3	4	5
Plays Drums <i>Forearm Pronation</i> <i>Finger Flexion</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence.	Uses unaffected arm and hand only due to pain or restricted passive range of motion in shoulder external rotation or forearm pronation or poor hand function on affected side.	Trumpet sign >90° to position forearm in neutral; if forearm fixed in >60° supination – may use adapted (i.e. interdigital) grip on drumstick to complete task with absent or insufficient (AMS < 3) active forearm pronation and finger flexion.	Trumpet sign <90°, elbow flexed, forearm neutral or slightly pronated; uses transpalmar or radial digital grasp to complete task; may use compensatory patterns for wrist and shoulder on affected side.	Actively pronates forearm to neutral or greater, extends wrist and uses good finger/thumb grasp; symmetrical with unaffected side.
Holds Plate with Palm up <i>Forearm Supination</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence.	Uses unaffected arm and hand only due pain or restricted supination or poor hand function on affected side.	Absent or insufficient (AMS < 3) active supination; or forearm fixed at > 60° pronation – may use adapted grip with forearm in pronated position to hold plate with affected hand.	Actively supinates forearm to neutral or beyond; or position of forearm is fixed between neutral to 90° of supination; may hold the plate with radial digital grasp or palm ups with fingers extended; may use compensatory patterns for deficits in shoulder, elbow, and wrist on the affected side.	Actively supinates forearm to end range and holds the plate with palm up and fingers extended; symmetrical with unaffected side.
WRIST, FINGER AND THUMB	1	2	3	4	5
Opens large container <i>Thumb Extension (Abduction)</i> <i>Finger Extension</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence.	Uses unaffected arm and hand only due to pain or poor hand function on affected side.	Wedges container into affected hand to passively extend thumb and fingers due to absent or insufficient (AMS < 3) active thumb or finger extension or uses unaffected hand or body/table to help hand around container.	Actively extends thumb and fingers, but may use passive movement at end range to get thumb and finger around object; may use compensatory patterns for deficits in shoulder, elbow, forearm, wrist and finger joints on the affected side.	Actively extends wrist, fingers and thumb to encircle container or lid; symmetrical with unaffected side.

Activity Primary Mover(s)					
ELBOW & FOREARM	1	2	3	4	5
Pulls Theraputty <i>Finger Flexion (Power Grasp)</i> <i>Wrist Extension</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence	Uses unaffected arm and hand only due to pain or poor hand function; or uses other body part (i.e.: shoulder adduction or legs) to stabilize putty and pull with unaffected hand.	Absent or insufficient (AMS < 3) active extension of wrist, may use table/body or the direction of pull to hold wrist in extension to pull theraputty; may use compensatory movements for deficits in fingers and thumb on the affected side.	Actively extends wrist or wrist fixed in extension; wrist may fall into flexion after activation of power grasp; may wedge putty into hand to compensate for deficits in fingers and thumb extension; may use compensatory patterns for deficits in shoulder, elbow and forearm on affected side.	Actively extends wrist, fingers and thumb with opposition to use transpalmar grasp; symmetrical with unaffected side.
Strings Beads <i>Thumb Flexion (Adduction)</i> <i>Thumb Extension</i>	Unable to perform task due to developmental age, behaviour or caregiver dependence	Uses unaffected arm and hand only due to pain or poor hand function; may bead on the table or on lap to string with unaffected hand only.	Absent or insufficient (AMS < 3) active thumb flexion and/or extension on affected side; may wedge the string or bead inbetween the thumb and index finger or palm; may use an interdigital or transpalmar grasp; may use fist or flaccid affected hand or arm to stabilize string or bead against table	Actively extends thumb and sustains lateral pinch or pincer grasp on string or bead; may use compensatory patterns for deficits in shoulder, elbow, forearm, wrist and finger joints on the affected side.	Actively extends wrist and thumb and sustains lateral pinch or pincer grasp on bead or string; symmetrical with unaffected side

REFERENCES

1. World Health Organization. *International classification of functioning, disability, and health (ICF)*. Geneva: World Health Organization; 2001.
2. Ho ES, Curtis CG, Clarke HM. The brachial plexus outcome measure: development, internal consistency, and construct validity. *J Hand Ther.* Oct 2012;25(4):406-417.

BRACHIAL PLEXUS OUTCOME MEASURE

ACTIVITY SCALE	Functional Movement Score
SHOULDER	
Combs Back of Head - Uses affected hand to reach the back of head to comb hair	
Places Container Above Head - Uses both hands to reach forward to place a container directly above their head	
Undo Button at Midline - Undo button or snap at navel level with both hands	
Hand to Back Pant Pocket - Puts affected fingers into ipsilateral back pant pocket	
ELBOW AND FOREARM	
Pretends to Eat Candy - Hold plate with unaffected hand, pick up bead with affected hand from plate and bring it up to mouth	
Uses Computer Mouse - Uses affected hand with isolated finger flexion to click on mouse	
Plays Drums - Hits drumsticks on container with both hands	
Holds Plate with Palm Up - Holds plate with affected hand palm up	
WRIST, FINGER, AND THUMB	
Opens Large Container - Uses both hands to open 5" diameter container with snap on lid; abducts thumb with affected hand	
Pulls Apart Theraputty - Uses power grasp to pull apart theraputty with active wrist extension with both hands	
Strings Bead - Uses both hands to string bead; uses precision grasp (pinch) with affected hand	

FUNCTIONAL MOVEMENT SCALE
1. Cannot complete task
2. Completes task using only unaffected arm
3. Completes task Absent active movement in primary mover(s). May use passive range of motion to complete movement pattern
4. Completes task Initiates all movement actively or position of primary mover(s) is sufficient for function. Compensatory techniques used to complete movement pattern
5. Completes task with normal movement pattern

SELF-EVALUATION SCALE

My arm works . . .

	_____	
Very POORLY		Very WELL

My hand works . . .

	_____	
Very POORLY		Very WELL

My arm and hand looks . . .

	_____	
Very BAD		Very GOOD