# Standardized Assessments for the Management of Children with Motor Disorders

## HYPERTONIA ASSESSMENT TOOL (HAT)

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### Description of Assessment

*Purpose:* This tool was designed to clinically detect the presence of any of the different causes of hypertonia in the pediatric population. The tool discriminates between spasticity, dystonia and rigidity.

Hypertonia in children is defined as abnormally increased resistance to externally imposed movement about a joint. It may be caused by (1) spasticity, (2) dystonia, (3) rigidity, or (4) a combination of features (Sanger et al. 2003).

### Assessment Details

The HAT is a seven item tool developed for children/youth between 4 to 19 years old. The HAT is a seven-item clinical assessment tool used to differentiate the various types of pediatric hypertonia, namely spasticity, dystonia, and rigidity.

The current version of the HAT consists of seven items in total: two spasticity items, two rigidity items and 3 dystonia items. Each item has to be tested and a score of 0 (negative) is assigned for the absence or 1 (positive) for the presence of the specific item.

The presence of at least one HAT item in a hypertonia subgroup confirms the presence of the specific subtype (e.g. spasticity, dystonia or rigidity). The presence of more than one subgroup item identifies the presence of mixed tone. The HAT is capable of discriminating hypertonia subtypes for upper and lower extremities.

The patient´s position is standardized prior to the administration of the assessment; all the extremities can be evaluated but it is suggested to do one limb at a time. It usually takes less than five minutes to complete the assessment on one limb and it is also advisable that the items are administered in the listed order.

See the HAT User Manual (Fehlings et al. 2010) below for detailed instructions on the assessments.

### Principles

- Test the patient in the supine position.
- The patient needs to be comfortable, with a pillow under the head and a roll under the knee.
- The hands of the patient should be placed on the abdomen when possible.
- A controlled room temperature, unrestrictive clothing and parent/caregiver presence is suggested.
- Different joints for upper and lower limbs need to be evaluated.
- Muscle stretch is recommended to start from complete adduction to full abduction for shoulder and hip; complete flexion to full extension for elbow, wrist, knee and ankles.

### Rating System

Dichotomic values are assigned for the absence (0 = negative) or presence (1 = positive) of each item tested.
A score of 1 (positive) for a specific item confirms the presence of that type of hypertonia (e.g. spasticity, dystonia or rigidity). The presence of more than one hypertonia subgroup confirms a mixed tone abnormality.

| HAT ITEM | SCORING GUIDELINES (0 = Negative or 1 = Positive) | TYPE OF HYPERTONIA |
|---|---|---|
| 1. Increased involuntary movement/ postures of the designated limb with tactile stimulus of another body part. | **0** = No involuntary movements or postures observed.<br>**1** = Involuntary movements or postures observed. | **Dystonia** |
| 2. Increased involuntary movements/ postures with purposeful movements of another body part. | **0** = No involuntary movements or postures observed.<br>**1** = Involuntary movements or postures observed. | **Dystonia** |
| 3. Velocity dependent resistance to stretch. | **0** = No increased resistance noticed during fast stretch compared to slow stretch.<br>**1** = Increased resistance noticed during fast stretch compared to slow stretch. | **Spasticity** |
| 4. Presence of a spastic catch. | **0** = No spastic catch noted.<br>**1** = Spastic catch noted. | **Spasticity** |
| 5. Equal resistance to passive stretch during bi-directional movement of a joint. | **0** = Equal resistance not noted with bi-directional movement.<br>**1** = Equal resistance noted with bi-directional movement. | **Rigidity** |
| 6. Increased tone with movement of another body part. | **0** = No increased tone noted with purposeful movement.<br>**1** = Greater tone noted with purposeful movement. | **Dystonia** |
| 7. Maintenance of limb position after passive movement. | **0** = Limb returns (partially or fully) to original position.<br>**1** = Limb remains in final position of stretch. | **Rigidity** |

| SUMMARY SCORE – HAT DIAGNOSIS | | | |
|---|---|---|---|
| **Dystonia** | Positive score (1) on at least one of the items #1, 2, or 6. | Yes | No |
| **Spasticity** | Positive score (1) on either one or both of the items #3 or 4. | Yes | No |
| **Rigidity** | Positive score (1) on either one or both of the items #5 or 7. | Yes | No |
| **Mixed Tone** | Presence of 1 or more subgroups (e.g. dystonia, spasticity, rigidity). | Yes | No |

## Background / History

**Development of the Assessment**

After the definition of hypertonia and the different causes of hypertonia in children with motor neurological disorders was published (Sanger et al. 2003), a great need was identified to develop a tool that would help healthcare providers (physicians, therapists, etc.) to differentiate between the many types of hypertonia.

Various scales to quantify the severity of hypertonia, spasticity or dystonia have been published (Modified Ashworth Scale, Tardieu Scale, Burke-Fahn-Marsden Scale, Barry-Albright Dystonia Scale, Dyskinesia Impairment Scale, etc.), nonetheless, a standardized clinical tool to discriminate between the subtypes of hypertonia was not available.

Neurological examination is currently the gold standard to differentiate between spasticity, dystonia and rigidity, however, it lacks standardization and it depends on the experience of the clinician. With the objective to overcome these problems, Fehlings and her team developed the Hypertonia Assessment Tool (HAT) using a Guyatt framework on a preliminary group of items generated by an expert panel that included neurologists, physiatrists, orthopedic surgeons, developmental pediatricians and therapists, that was then subjected to an item reduction process and finally an evaluation of reliability and validity (Jethwa et al. 2010).

## Reliability

To evaluate Individual Item Validation, Inter-Rater Reliability, Test-Retest Reliability and Criterion Validity, 25 children with cerebral palsy were recruited and were independently examined by three physicians who administered either the HAT or a pediatric neurological examination to identify the type(s) of hypertonia present. After 2 weeks, the same children were re-examined using HAT (Jethwa et al. 2010).

- Inter-Rater Reliability: a comparison of the HAT diagnoses by the two physicians was performed and demonstrated a range from fair to excellent across the three subgroups (spasticity was 0.65, dystonia was 0.30, and rigidity was 0.91).

- Test-Retest Reliability: a comparison of the HAT diagnoses at both time points was performed and demonstrated a range from moderate to excellent (spasticity was 1.0, dystonia was 0.43, and rigidity was 1.0).

Knights et al. 2014 administered the HAT to 28 children with CP and compared results to a neurological examination. Inter-rater reliability was excellent for spasticity (0.86), moderate for dystonia (0.43), and excellent for rigidity (1.0).

In a more recent study, Marsico et al. 2017, 2 physiotherapists evaluated children with neuromotor disorders using the HAT Inter-rater reliability (n=45) by subtypes for upper and lower limbs was moderate to excellent: Spasticity showed 78-87% agreement with $K_{max}$ values of 0.69-1.0 and dystonia showed 71-80% agreement with $K_{max}$ values of 0.60-0.96. Intra-rater reliability (n=42) by subtypes for upper and lower limbs was excellent: Spasticity showed 90-95% agreement with $K_{max}$ values of 0.86-1.0 and dystonia showed 90-95% agreement with $K_{max}$ values of 0.90-1.0.

## Validity

Criterion validity was measured by comparing the HAT diagnosis to the neurological diagnosis. Across the subgroups, the validity results were mixed. However, the HAT demonstrated higher positive agreement for identifying the presence of spasticity (0.57-0.74) and dystonia (0.30-0.65), whereas the HAT showed higher positive agreement for identifying the absence of rigidity (0.91-1.0) (Jethwa et al. 2010).

In further evaluations (Knights et al. 2014), criterion validity was found to be substantial for spasticity (0.71), moderate for dystonia (0.43-0.57) and excellent for the absence of rigidity (1.0).

In a study by Marsico et al., 2 physiotherapists evaluated 45 children with neuromotor disorders and compared the HAT with the clinical diagnosis provided by the physicians. Validity for the presence of spasticity was also found to be in high agreement as well as a high agreement for positive and negative predictive values. However, for dystonia the positive predictive value was low due to higher testing of positive signs of dystonia with the HAT. The negative predictive value for dystonia was high (Marsico et al. 2017).

Rice et al. 2017 conducted a study to establish the prevalence and severity of dystonia in 151 children with CP (n=604 limbs) using the Barry-Albright Dystonia (BAD) Scale and the HAT. Additionally, the investigators examined the HAT dystonia items for construct (exploratory factor analysis) and convergence validity (polyserial correlations with BAD scores). Factor analysis indicated a lack of unidimentionality of the HAT dystonia scale, reflecting on the divergent nature of item 6 compared to the other two items. Item 6 also showed the least association with the BAD scale (0.01-0.38) compared to item 2 which exceeded 0.6. The investigators suggested that this item be removed from the tool.

## Pros & Cons

**Pros**

- Free.
- Simple scoring system.
- Can be used for every limb.
- Reasonably quick to perform.

- No additional equipment needed.
- Instructions for patient positioning and maneuvers to perform are established.
- Online free video resources are available on the developers' website.
- Can detect subtle forms of dystonia.
- Potentiality to aid in more specific management options.

**Cons**

- Not an outcome measure: discriminative tool for hypertonia subtypes, not a quantitative scale. The HAT does not indicate the severity of a particular type of hypertonia nor its contribution to function.
- Certain amount of hypertonia knowledge and experience on assessment is needed.
- Although developed to test any patient with hypertonia, validation has only been established for children with cerebral palsy aged 4 – 19.
- Needs some amount of patient cooperation.
- Assessor hand positioning and patients´ limb positioning are not clearly standardized.
- Other involuntary (e.g. mirror movements, chorea, athetosis) or voluntary movements could alter the scoring in less experienced assessors.
- Some items (e.g. item 1) may be removed from the tool in the future (Knights et al. 2014).
- Patients with fixed contractures could be very challenging to assess.

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