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Further Evaluation of the Scoring, Reliability, and Validity of the Hypertonia Assessment Tool (HAT)

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Abstract

We assessed the impact of videotape analysis on scoring of the Hypertonia Assessment Tool (HAT) that discriminates between hypertonia subtypes. The HAT was administered to 28 children with cerebral palsy (mean age 9 years, range 4-17 years, 61% male). HAT examinations were videotaped; scores were assigned before and after videotape review. Neurological examination provided the gold standard diagnosis. Interrater reliability, criterion validity and individual item validation were assessed using prevalence and bias-adjusted kappa (PABAK). Videotape review did not significantly change the HAT item scores or diagnoses. Item validation eliminated 1 dystonia item. Interrater reliability was moderate for dystonia (PABAK = 0.43) and excellent for spasticity and rigidity (PABAK = 0.86-1.0). Criterion validity was substantial for spasticity (PABAK = 0.71), moderate for dystonia (PABAK = 0.43-0.57) and excellent for the absence of rigidity (PABAK = 1.0). The HAT can be administered without videotape review. Dystonia item 1 did not change the HAT hypertonia diagnosis and will be removed from the HAT.

Keywords

Hypertonia Assessment Tool (HAT), hypertonia, cerebral palsy, videotape analysis spasticity, rigidity, dystonia

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Hypertonia is abnormally increased resistance to passive movement about a joint.[1] There are 3 subtypes of hypertonia: spasticity, dystonia, and rigidity. The Hypertonia Assessment Tool (HAT) is a short clinician-administered tool developed as a discriminative measure of hypertonia in children.[2] The HAT has both clinical and research purposes. Clinically, the HAT can be used to ensure that children receive appropriate treatment, since medications and dosages may vary depending on the type(s) of hypertonia present. In research settings, the HAT can be used to better classify the hypertonia subtypes of research participants and report on specific outcomes. The HAT includes 7 items in 3 subsets: 2 spasticity items, 2 rigidity items, and 3 dystonia items. Each item is scored in a yes/no format (see Figure 1). The presence of a hypertonia subtype is confirmed by a positive score in at least 1 item in that subset. The HAT was shown to have good reliability and validity for identifying spasticity and the absence of rigidity, and moderate reliability and validity for identifying dystonia.[2]

Several measures in pediatric neurology have used videotapes to improve their measurement properties. For example, the reliability of the Barry-Albright Dystonia Scale was evaluated based on review of videotapes of patients with dystonia.[3] Dystonia is variable and therefore certain HAT dystonia items may be difficult to gauge on the initial examination. It was hypothesized that the clinician administering the HAT may benefit from reviewing a videotape of the assessment prior to scoring. In addition, the HAT developers wished to further evaluate the contribution of individual items to the psychometric properties of the measure. The research objectives were to (1) determine the impact of videotape analysis on the scoring, validity, and reliability of the HAT and (2) perform individual item validation and eliminate any items that did not contribute to the hypertonia diagnoses.

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HYPERTONIA ASSESSMENT TOOL (HAT) - SCORING CHART

Name:_____ **Chart/File #:**_____

Clinical Diagnosis:_____ **Date of Birth:** _____

Limb Assessed: **Gender:** ☐ Male ☐ Female

☐ Arm ☐ Left ☐ Right **HAT Assessor:**_____

☐ Leg ☐ Left ☐ Right **Date of Assessment:** _____

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

SUMMARY SCORE – HAT DIAGNOSIS

		Check box:
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

HAT DIAGNOSIS: *(Fill in all that apply)* _____

Figure 1. The Hypertonia Assessment Tool scoring chart.

Methods

Participants

A convenience sample of children with hypertonia was consecutively recruited from outpatient clinics at a tertiary pediatric rehabilitation facility. Children aged 4 to 19 years were eligible to participate. Ethical approval was obtained from Holland Bloorview Kids Rehabilitation Research Ethics Board. Participants and/or their caregivers provided informed consent.

Study Design

Two physician examiners reviewed the HAT training manual and performed 5 practice HAT assessments. They were observed by a third clinician with expertise in the HAT to ensure consistency and accuracy of administration. During the study, the examiners independently administered the HAT to 1 randomly selected limb of each participant. A generated randomization sequence assigned the limb to be examined. All HAT assessments were videotaped. A third physician with expertise in the assessment and management of pediatric hypertonia performed the "gold standard" neurological examination to diagnose the type(s) of hypertonia present.

Examiners 1 and 2 independently assigned a HAT score (hypertonia diagnosis) to each participant immediately after administering the HAT. The examiners subsequently reviewed their videotaped HAT assessments and assigned revised HAT scores based on the videotape review. Only the items that could be assessed visually (HAT items 1, 2, 4, and 7) were rescored. The examiners had access to their original HAT scores when assigning the revised scores following the videotape review. They remained blinded to the neurological examination diagnosis of each participant.

Statistical Analysis

Positive and negative agreement, percent agreement, and prevalence-adjusted bias-adjusted kappa (PABAK) statistics were used to assess agreement. PABAK statistics were used to adjust for the imbalance in the marginal totals of the agreement matrices.[4] The strength of the PABAK scores was defined as slight (0-0.2), fair (0.21-0.40), moderate (0.41-0.60), substantial (0.61-0.80), and excellent (> 0.81).[5] Statistical analyses were performed using the Statistical Package for Social Sciences version 15.0 (SPSS Inc, Chicago, IL, USA). To evaluate the impact of videotape analysis, agreement for HAT item scores and overall hypertonia diagnoses (with and without videotape review) was compared. To evaluate interrater reliability, the HAT scores for examiners 1 and 2 (with and without videotape review) were compared. To evaluate criterion validity, the HAT scores for examiners 1 and 2 (with and without videotape review) were compared with the neurological examination diagnosis by examiner 3. Using the scores without videotape review, individual item validation was performed by calculating the agreement for each item between examiners.

Results

Twenty-eight children (mean age 9 years, range 4-17 years, male n = 17) participated in the study. All of the participants had hypertonia secondary to cerebral palsy. Nine had unilateral cerebral palsy and 19 had bilateral cerebral palsy. The participants varied across Gross Motor Function Classification System[6] levels, level I (n = 11), II (n = 5), III (n = 4), IV (n = 3), and V (n = 5), and Manual Ability Classification System[7] levels, level I (n = 12), level II (n = 10), level III (n = 1), level IV (n = 0), and level V (n = 5). Overall, 11 of the participants had spasticity, 5 had dystonia, 12 had mixed tone (including both spasticity and dystonia), and no participants had rigidity as diagnosed on the neurological examination.

After videotape review by examiners 1 and 2, the individual item scores were changed 3 times for item 1, 3 times for item 2, 4 times for item 4, and not at all for item 7. Overall, this resulted in a change in individual item score 4.5% of the time (10 changes in 224 total items). Despite these changes in item scores, there was only 1 case where the overall hypertonia diagnosis changed after videotape review. In this case, 1 examiner changed the scoring of item 4 (spastic catch) from negative to positive after reviewing the videotape, thereby altering the diagnosis of spasticity. This change produced decreased agreement with both the other HAT examiner and the neurological exam, as shown by lower PABAK scores for interrater reliability and validity of spasticity. The other PABAK scores remained unchanged with the addition of the videotape review (see Table 1). Therefore, HAT scores without videotape review are described for the remainder of the analysis.

Interrater reliability was moderate for dystonia (PABAK = 0.43) and excellent for spasticity and the absence of rigidity (PABAK = 0.86-1.0). Criterion validity was substantial for identifying spasticity (PABAK = 0.71), moderate for identifying dystonia (PABAK = 0.43-0.57), and excellent for identifying the absence of rigidity (PABAK = 1.0). Positive and negative agreement, percent agreement, and PABAK scores are reported in Table 1.

Individual item validation (Table 2) revealed excellent agreement as measured by PABAK scores between examiners for both rigidity items and substantial agreement for both spasticity items. There was fair agreement for dystonia items 2 and 7. There was slight agreement for dystonia item 1 with a PABAK score of 0 and percent agreement of 50% (no better than chance agreement). This item was positive only when at least 1 other dystonia item was also positive; therefore, it never contributed to a change in the overall HAT diagnosis.

Discussion

Despite the opportunity to reexamine the videotaped assessments for subtle dystonic movements, the videotape review did not significantly alter the HAT hypertonia diagnosis or improve the psychometric performance of the dystonia items. Therefore, the results of this study do not support the use of video as part of the HAT administration or scoring, which makes the tool more practical to use in a clinical setting. Dystonia item 1 (increased involuntary movements or postures of the designated limb with tactile stimulus of a distal body part) will also be eliminated from future versions of the HAT, as individual item validation revealed that this item performed only as well as chance and never contributed to a change in HAT diagnosis. This simplifies the HAT administration and

Table 1. Results for Interrater Reliability and Criterion Validity of the Hypertonia Assessment Tool.

	Positive agreement	Negative agreement	Percent agreement	PABAK (without video review)	PABAK (with video review)
Spasticity					
Interrater reliability	0.96	0.67	0.93	0.86	0.79
Validity (examiner 1)	0.96	0.40	0.86	0.71	0.71
Validity (examiner 2)	0.96	0.40	0.86	0.71	0.64
Dystonia					
Interrater reliability	0.77	0.64	0.71	0.43	0.43
Validity (examiner 1)	0.77	0.64	0.71	0.43	0.43
Validity (examiner 2)	0.82	0.73	0.79	0.57	0.57
Rigidity					
Interrater reliability	0	1.0	1.0	1.0	1.0
Validity (examiner 1)	0	1.0	1.0	1.0	1.0
Validity (examiner 2)	0	1.0	1.0	1.0	1.0

Abbreviation: PABAK, prevalence-adjusted bias-adjusted kappa.

Table 2. Results for Individual Item Validation of the Hypertonia Assessment Tool.

Item	Type of hypertonia	Positive agreement	Negative agreement	Percent agreement	PABAK
1	Dystonia	0.18	1.0	0.50	0
2	Dystonia	0.71	0.68	0.70	0.39
3	Spasticity	0.95	0.60	0.89	0.79
4	Spasticity	0.85	0.70	0.82	0.64
5	Rigidity	0	1.0	1.0	1.0
6	Dystonia	0.59	0.73	0.64	0.29
7	Rigidity	0	1.0	1.0	1.0

Abbreviation: PABAK, prevalence-adjusted bias-adjusted kappa.

leaves 6 remaining items, 2 for each hypertonia subtype. Following this modification, the HAT is in its final form.

This study replicated the results of the initial HAT validation study,[2] with some improvement in the interrater reliability of the spasticity and dystonia items. However, agreement remains moderate for identifying dystonia. This may be due to the subtle, variable nature of dystonia. In addition, the HAT items for dystonia require the participant to perform a number of voluntary movements, such as counting, blinking, or fist clenching. It may be more difficult to elicit dystonia in children who are limited in their ability to follow instructions.

The largest group of children in our sample had mixed tone, with the presence of both spasticity and dystonia. This is consistent with the results from the initial HAT validation study[2] and others.[8] The recognition that spasticity and dystonia frequently coexist in children with hypertonia has important clinical implications related to underlying treatments for each subtype of hypertonia.

One limitation of this study is the lack of any participants with rigidity. The HAT had excellent reliability and validity for detecting the absence of rigidity, but we were unable to determine how well the HAT could detect the presence of rigidity. Although rigidity is rare in childhood, it occurs in some pediatric neurological conditions such as juvenile parkinsonism. The HAT is designed to assess hypertonia caused by any pediatric neurological condition and is not specific to cerebral palsy. Further evaluation of the HAT in children with a broader range of causes of hypertonia will be helpful. It will also be useful to assess the HAT in a younger group of children (less than 4 years of age) to determine its validity and reliability in this age group.

Criterion validity was established by comparing the HAT diagnosis to that obtained by an experienced clinician on neurological examination. It should be noted that there is currently no true "gold standard" for the diagnoses of dystonia and rigidity. This will likely evolve as the neuropathology, neuropathophysiology, and muscle pathophysiology of these conditions become better understood. As biomechanical measures to differentiate types of hypertonia become available, it will be useful to validate the HAT against these biomechanical measures. Currently, there are several biomechanical tools to assess the severity of specific types of hypertonia, but methods to quantitatively discriminate between hypertonia subtypes are just being developed.[8,9]

Video-based training has been shown to be effective in teaching and improving the reliability of physical examination techniques.[10] A HAT training video and administration manual have been developed to improve standardization of administration and scoring. The HAT user manual and scoring charts can be accessed via the Holland Bloorview Research website at http://www.hollandbloorview.ca/research/scientistprofiles/documents/HATUserManual_Nov20102.pdf.

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Author Contributions

SK collaborated in study design, testing of participants, analysis and interpretation of results, and manuscript development and revision. SK wrote the first draft of the manuscript and completed the research as part of the requirements of her residency program in pediatrics at the University of Toronto. ND assisted with data collection and manuscript development. AK contributed to testing of participants, interpretation of results, and manuscript revision. LS assisted with data collection and entry, analysis and interpretation of results, and manuscript revision. DF provided senior mentorship in study design, testing of participants, interpretation of results, and manuscript preparation.

Declaration of Conflicting Interests

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Ethical Approval

This research study received ethical approval from the Holland Bloorview Kids Rehabilitation Hospital Research Ethics Board. Participants and/or their caregivers provided written informed consent.

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