Detecting cognitive impairment in pediatric neurology patients using the CNS Vital Signs computerized neuropsychological battery

Brian L. Brooks[1,2] & Elisabeth M.S. Sherman[1,2]

RATIONALE

Computerized batteries, such as the CNS Vital Signs, are relatively quick (i.e., 25-35 minutes), portable (i.e., can be completed on a laptop), and easy to administer (i.e., instructions are presented on the screen, the tests are automatically scored, and a printout is provided once testing is completed).

To date, there has been a paucity of research on the clinical utility of the CNS Vital Signs in children and adolescents.

The purpose of this study was to examine the cognitive abilities of pediatric neurology patients on the CNS Vital Signs computerized neuropsychological battery.

METHODS

Participants included 166 children and adolescents (ages 7-19 years) who were consecutive referrals for neuropsychological assessments.

The 281 healthy children and adolescents (7-19 years) included in this study were derived from the CNS Vital Signs normative database.

CNS Vital Signs is composed of seven neuropsychological measures:

- Verbal Memory
- Visual Memory
- Finger Tapping
- Symbol Digit Coding
- Stroop Test
- Shifting Attention Test
- Continuous Performance Test

These measures yield an overall score, the Neurocognition Index, and five primary domain scores:

- Memory (verbal and visual)
- Psychomotor Speed
- Reaction Time
- Cognitive Flexibility
- Complex Attention

RESULTS

Demographic information is presented in Table 1. There were not significant differences between the healthy control and neurology groups for age [$t(445)=0.82$, p=.41], sex [$\chi^2(1) = 2.54$, p = .11] or race [$\chi^2(1) = 3.59$, p = .058; when dichotomized as Caucasian versus other]. There was a significant difference in handedness [$\chi^2(1) = 5.94$, p = .015].

Performance on the CNS Vital Signs domain (index) scores is presented in Table 2. The neurology group had worse overall cognition on the summary score (i.e., Neurocognition Index), with a Cohen's d effect size of d=1.08.

On the domain scores, the pediatric neurology group had significantly worse performance with verbal memory, visual memory, psychomotor speed, reaction time, complex attention, and cognitive flexibility.

The base rates of low scores, are presented in Table 3. Two or more scores ≤5th percentile is found in 3.4% of healthy control children and in 36.6% of neurology patients.

Table 1. Demographic characteristics of the healthy control and pediatric neurology samples.

Demographic Variables	Healthy Control Participants	Pediatric Neurology Patients
N	281	166
Age (Mean, SD)	13 years, 2 months (3.2)	13 years, 0 months (3.2)
Sex		
. Male	154 (54.8%)	79 (47.6%)
. Female	124 (44.1%)	87 (52.4%)
. Not documented	3 (1.1%)	0
Race		
. Caucasian	216 (76.9%)	140 (84.3%)
. African American	37 (13.2%)	4 (2.3%)
. Hispanic	16 (5.7%)	3 (1.8%)
. Asian	12 (4.3%)	8 (4.8%)
. Other	0	11 (6.6%)
Handedness		
. Right	257 (91.5%)	136 (81.9%)
. Left	24 (8.5%)	30 (18.1%)
Diagnosis		
. Epilepsy	--	62 (37.3%)
. Traumatic Brain Injury	--	44 (26.5%)
. Stroke	--	21 (12.7%)
. Hydrocephalus	--	13 (7.8%)
. Other	--	26 (15.7%)

Table note: SD = standard deviation. % = percent.

RESULTS (continued)

Table 2. Performance on the CNS Vital Signs computerized battery in healthy controls and a mixed pediatric neurology sample.

CNS Vital Signs Domain (Index) Scores	Healthy Control Participants			Pediatric Neurology Patients			p value	Cohen's d effect size
	n	Mean	SD	n	Mean	SD		
Neurocognition Index	274	99.9	10.9	148	86.6	15.2	<.001	1.08
Memory Domain	248	100.0	15.0	148	91.0	22.2	<.001	.51
Verbal Memory Domain	248	100.0	15.0	146	92.1	23.2	.006	.44
Visual Memory Domain	264	100.0	15.0	145	93.5	18.7	.001	.40
Psychomotor Speed Domain	255	100.0	14.9	155	83.1	13.2	<.001	1.19
Reaction Time Domain	267	100.0	14.9	155	92.1	19.1	<.001	.48
Complex Attention Domain	248	100.0	14.9	153	83.3	22.5	<.001	.94
Cognitive Flexibility Domain	262	100.0	14.9	154	84.5	19.1	<.001	.94

Table note: SD = Standard Deviation. Standard scores for the domain (index) scores have a mean = 100 and a standard deviation = 15. Due to differences in sample sizes, significant differences in variance for nearly all scores, and some data being skewed, group differences were examined using Mann-Whitney U tests. Effect sizes greater than d=.30 are bolded.

Table 3. Prevalence of low CNS Vital Signs domain scores

Number of Domain Scores Below Cutoff	Healthy Control Participants	Pediatric Neurology Patients
≤5th percentile		
5 low scores	0.0	3.4
4 or more	0.0	10.3
3 or more	0.5	17.9
2 or more	3.4	36.6
1 or more	26.1	57.2
0 low scores	73.9	42.8

Table note: Scores ≤5th percentile correspond to index≤76. For these analyses, the following five domain scores were included: Verbal Memory, Visual Memory, Psychomotor Speed, Reaction Time, and Complex Attention. Cognitive Flexibility was not included because of the potential for multicollinearity with Complex Attention (i.e., Pearson's r = .818 in the healthy control sample).

DISCUSSION

To our knowledge, this is the first study to demonstrate the utility of the CNS Vital Signs in a large sample of pediatric neurology patients.

In this heterogeneous pediatric neurology sample, significantly worse performance was found for all domain scores and for the majority of subtest scores.

The information on the base rates of low scores (Table 3) provides a preliminary method for quickly identifying whether a patient's cognitive profile is uncommon in healthy children and adolescents.

[1] Alberta Children's Hospital, Calgary, AB, Canada; [2] University of Calgary, AB, Canada

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