

# Computerized Psychometric Testing for the Diagnosis of Minimal Hepatic Encephalopathy



Prakash R, Anna K, Chikkanna R, Karanth P, Gulati D, Dosanjh G, Iduru S, Mullen K.D  
MetroHealth Medical Center, Case Western Reserve University School of Medicine, Cleveland, Ohio



## Introduction

Minimal Hepatic Encephalopathy (MHE) is widely prevalent in patients with cirrhosis. The Hepatic Encephalopathy Consensus group in 1998 nominated the Psychometric Hepatic Encephalopathy Score (PHES) as the gold standard for diagnosis of MHE. A number of factors such as availability of the test, lack of normative data in the United States, difficulty in interpretation and scoring, limits its use in the routine diagnosis of MHE in the outpatient setting. We tested CNSVS (CNS Vital Signs), a computerized psychometric test battery, which has the potential to overcome these shortcomings.

## Aim

- To validate CNSVS against the current gold standard PHES as a diagnostic tool for detection of MHE
- To assess for test-retest reliability

**Table 1 : Description of CNS VS Test Battery**

Psychometric tests	
Verbal Memory	
Symbols Digit Coding Test (approx 2 min practice run, 2 min test) Stroop Test (approx 2-3 minutes)	<ul style="list-style-type: none"> <li>➤ Verbal Learning</li> <li>➤ Memory for Words</li> <li>➤ Complex Attention</li> <li>➤ Immediate and Delayed recall</li> <li>➤ Visual-perceptual speed</li> <li>➤ Executive Function</li> <li>➤ Information Processing Speed</li> <li>➤ Simple and Choice Reaction Time</li> </ul>
Shifting Attention Test (approx 2-3 min)	<ul style="list-style-type: none"> <li>➤ Speed, Accuracy Trade-Off</li> <li>➤ Information Processing Speed</li> </ul>
Continuous Performance Test (approx 5 min)	<ul style="list-style-type: none"> <li>➤ Information Processing Speed</li> <li>➤ Reaction Time</li> <li>➤ Sustained Attention</li> </ul>

## Test Scoring:

Patient performance is reported in 6 domains (Verbal Memory, Processing Speed, Executive Function, Reaction Time, Cognitive Flexibility and Complex Attention). Scores in individual domains is represented as a standard deviation from age-adjusted mean. A composite scoring system, 0 for 0 to -1 SD, -1 for -1 to -2 SD, -2 for -2 to -3 SD and -3 for greater than -3 SD performance in individual domains, is used. MHE is diagnosed in subjects with score greater than -6 or more.

## Methods

Cirrhosis subjects were initially screened to exclude overt HE using mini-mental status examination (MMSE) followed by a detailed neurological examination. This was followed by PHES test battery (DST, NCT-A, NCT-B, SDT) and CNSVS Test Battery. Subjects were retested 2-6 weeks later for reproducibility. Matched controls were recruited. P value less than 0.05 is considered significant.

**Table 2 - Comparison between Cirrhosis and Control subjects**

	Cirrhosis (n= 83)	Controls (n = 48)	P value
Age (yrs)	53.92 +/- 14.12	51.5 +/- 8.97	0.05
Gender (M/F)	51/32	12/36	0.00
NCT A (in seconds)	38.10 +/- 17.39	26.46 +/- 7.98	0.00
NCT B (in seconds)	104.19 +/- 45.97	65.7 +/- 24.32	0.01
Digit Symbol Test	39.25 +/- 10.26	51.6 +/- 9.91	0.00
Serial Dotting Test	86.68 +/- 29.78	61.6 +/- 6.81	0.00
Child Pugh Score	6.67 +/- 3.8	N/A	-
Cirrhosis Etiology:			-
➤ Hepatitis C	42/83	-	-
➤ Alcohol	22/83	-	-
➤ Alcohol + Hep C	12/83	-	-
➤ Others	7/83	-	-

## Results

83 cirrhosis subjects and 48 controls have so far been enrolled in this ongoing study. Normative data for PHES was generated from our control population. MHE was defined as abnormality of > 2 SD (standard deviation) in at least 2 tests in PHES. CNSVS has a composite domain-based scoring system. A high correlation was observed between CNSVS and PHES (r=0.59, p=0.001). CNSVS was able to diagnose MHE with 82% sensitivity and 77% specificity. Domains within the CNSVS testing system which demonstrated maximum correlation with the diagnosis of MHE were reaction time (r=0.71), executive functioning (r=0.60) and complex attention (r= 0.48).

**Table 3 - Comparison between MHE +ve and MHE -ve**

Category	MHE +ve (n=34)	MHE -ve (n=49)	P value
Age (yrs)	54.73 +/- 7.66	53.28 +/- 8.11	0.29
Gender (M/F)	30/19	21/13	0.96
Child Pugh Score	6.97 +/- 1.74	6.44 +/- 1.68	0.17
Alcohol Cirrhosis (n=22)	9 (40.9%)	13 (59.1%)	0.83
Alcohol + Hep C (n= 12)	5 (41.7%)	7 (58.3%)	0.81
Hepatitis C Cirrhosis (n=42)	18 (42.9%)	24 (57.1%)	0.83
Cirrhosis (Other)	2 (28.6%)	5 (71.4%)	0.77
NCT A (in seconds)	51.41 +/- 19.88	28.87 +/- 5.73	0.00
NCT B (in seconds)	137.03 +/- 54.58	84.08 +/- 23.39	0.00
DST	32.61 +/- 10.27	43.85 +/- 7.39	0.00
SDT (in seconds)	99.67 +/- 33.89	73.71 +/- 17.41	0.00
Verbal Memory score	1.36 +/- 1.36	0.71 +/- 1.21	0.02
Processing speed score	1.54 +/- 1.34	0.87 +/- 1.03	0.01
Executive function score	1.78 +/- 1.36	0.39 +/- 0.95	0.00
Reaction time score	1.93 +/- 1.21	0.61 +/- 0.98	0.00
Complex attention score	1.81 +/- 1.24	0.67 +/- 0.99	0.00
Cognitive function score	1.91 +/- 1.30	0.72 +/- 1.03	0.00

## CNSVS Test Battery

Sensitivity - 82.35%

Specificity - 77.55%

Positive Predictive Value - 72%

Negative Predictive Value - 86%

Correlation Coefficient - 0.59 (p <0.05)

## Advantages of CNS VS Test battery

- Very subject friendly
- Easily administered as tests are available online
- Self explanatory with minimal instructions
- Results available immediately after the test
- Multiple domains can be tested

## Conclusion

CNSVS appears to fulfill the criteria as a reliable, sensitive and convenient alternative psychometric test for the diagnosis of MHE. The process of subject enrollment to this study is ongoing. We plan to shorten the duration of testing by identifying one or two most sensitive tests which can potentially replace the whole psychometric test battery.