Slow Speech Can Identify Patients with Hepatic Encephalopathy

Patricia P Bloom[1], Jessica Robin[2], Anna SF Lok[1]

[1]University of Michigan, Dept of Medicine, Division of Gastroenterology and Hepatology, [2]Winterlight Labs

MICHIGAN MEDICINE
UNIVERSITY OF MICHIGAN

BACKGROUND

There is high demand for a simple diagnostic test to identify hepatic encephalopathy (HE), especially minimal HE (MHE).

In an earlier study we found patients with a history of HE had slow speech.

Aim: to assess if speech in non-cirrhotic controls differs from cirrhosis patients with MHE or prior HE.

METHODS

Subject Population
We enrolled 88 outpatients with cirrhosis and 22 non-cirrhotic controls (no fibrosis on transient elastography).
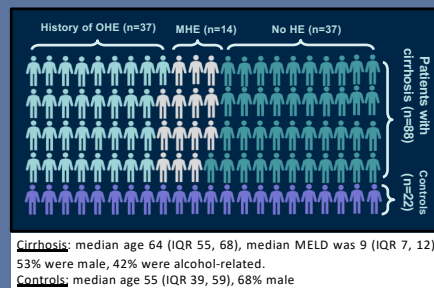
Procedures
▶ Psychometric HE score (PHES, validated for identifying MHE (PHES ≤ -4))
▶ Animal naming task
▶ Audio recording of paragraph reading and picture description tasks

Variables
Speech variables (acoustic, lexical, and syntactic) were automatically extracted from the audio recordings via the Winterlight Labs pipeline. Based on our work in HE and prior work in dementia, we selected a priori 9 variables per task that might be important in differentiating patients with HE.
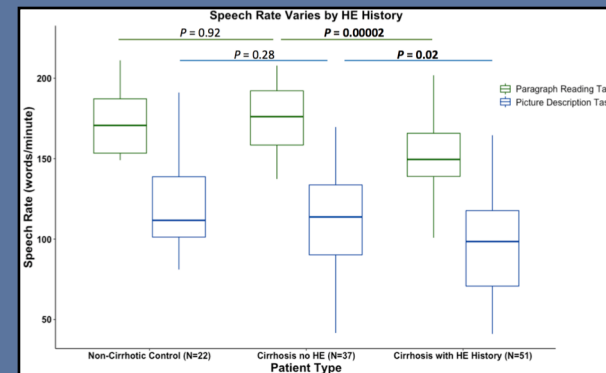
Analysis
We performed linear regression of these variables to construct a model for predicting PHES and compared the final model between non-cirrhotic controls, cirrhosis without HE (no prior overt HE and no MHE on PHES), and cirrhosis with HE (prior overt HE or MHE on PHES).

RESULTS

History of OHE (n=37)   MHE (n=14)   No HE (n=37)
Patients with cirrhosis (n=88)
Controls (n=22)

Cirrhosis: median age 64 (IQR 55, 68), median MELD was 9 (IQR 7, 12), 53% were male, 42% were alcohol-related.
Controls: median age 55 (IQR 39, 59), 68% male

Speech Variable	Category	Definition
Speech rate	Timing	# of words / minute
Unfilled pause count	Timing	# of pauses / task
Average word duration	Timing	Total audio duration (seconds) / # of words
Total duration audio	Timing	Total audio duration (seconds)
Mean pause duration	Timing	Total duration of unvoiced pauses (seconds) / total # of pauses
Semantic relevance	Lexical	Number of correct distinct words

Speech Rate Varies by HE History

$P = 0.92$ $P = 0.00002$
$P = 0.28$ $P = 0.02$

Non-Cirrhotic Control (N=22)   Cirrhosis no HE (N=37)   Cirrhosis with HE History (N=51)

Paragraph Reading Task
Variables significantly associated with PHES: ($P < 0.005$)
▶ **Speech rate**
▶ **Unfilled pause ct.**
▶ **Ave. word duration**
▶ **Tot. audio duration**

The strongest model for predicting PHES in the paragraph reading task included average word duration, speech rate, and total duration audio: adjusted $r^2 = 0.26$, $P < 0.0001$

Picture Description Task
Variables significantly associated with PHES: ($P < 0.02$)
▶ Speech rate
▶ **Mean pause duration**
▶ **Semantic relevance**

The strongest model in the picture description task included mean pause duration and a semantic relevance measure: adjusted $r^2 = 0.15$, $P < 0.0001$

These models differentiated cirrhosis with vs. without HE (paragraph reading, AUC: 0.77; picture description, AUC: 0.68), comparable to the animal naming task (AUC 0.73).

Neither model nor animal naming task differentiated controls vs. cirrhosis without HE.

Speech rate alone in both paragraph reading and picture description tasks differentiated cirrhosis with vs. without HE (AUC 0.75; **Figure**).

Patients with cirrhosis and MHE and no history of overt HE, had slower speech rate compared to patients with cirrhosis without any HE, 149 vs. 174 words/minute ($P = 0.001$).

CONCLUSION

Speech of patients with cirrhosis and HE, including those with MHE, was slower than those with cirrhosis without HE and non-cirrhotic controls. Models including acoustic and other variables may further improve detection of HE.