CL-ART: A novel smartphone application that can help predict future hospitalisation secondary to cirrhosis acute decompensation.

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Introduction

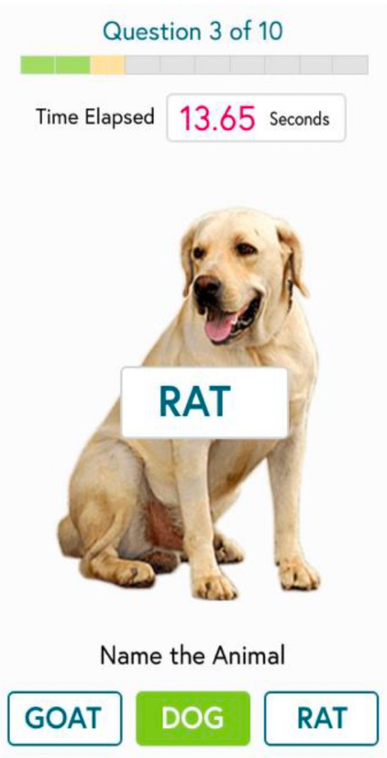
- Hepatic encephalopathy (HE) is the most frequent cirrhosis complication leading to hospital admissions and is associated with significant mortality.
- The aim of this study was to determine the ability of the CyberLiver-Animal Recognition Test (CL-ART) to predict future hospitalisation due to decompensation, especially through HE, comparing its performance to established HE tests.

Methods

- A prospective study of cirrhosis patients applying three different cognitive tests at two tertiary hepatology centres was performed.
- The CL-ART involved a timed (usually <30 seconds) recognition of animals using a smartphone app (Figure 1). EncephalApp Stroop Test and Psychometric Hepatic Encephalopathy Score (PHES) were chosen as test comparisons.
- Follow-up clinical data was collected for a 6-month period.

Results

- 43 healthy controls and 103 cirrhosis patients at risk of decompensation were included (CL-ART time 15.7s vs 24.0s).
- Baseline characteristics of cirrhosis patients:
  - 65% male; median 58 years
  - Child-Pugh Score 8 [IQR 7-10]
  - MELD-Na 15 [IQR 11-19]
  - CLIF-AD score 48 [IQR 45-52] .
- CL-ART demonstrated a good correlation with EncephalApp (r=0.81, p<0.001) and PHES (r= -0.63, p<0.001) although demonstrated superior participant useability (Figure 1).
- When analysing patients admitted due to HE during their follow-up, baseline CL-ART was significantly higher compared to participants who were not hospitalised (31.5 vs 22.6s, p<0.001).
- The AUROC for predicting future HE admissions for the CL-ART was 0.85 (95% CI 0.77-0.93), compared to EncephalApp (AUROC 0.83, 95% CI 0.74-0.92) and ammonia (AUROC 0.81, 95% CI 0.71-0.91).
- In multiple logistic regression, CL-ART remained an independent predictor of future HE admissions (Figure 2).
- Using the Youden index, the optimal CL-ART cut-off for predicting HE-related admissions is 26s (sensitivity 91.7%, specificity 71.4%)
- When analysing all subsequent admissions due to any decompensation event, baseline CL-ART scores were significantly higher in those subsequently hospitalised (27.0 vs 21.3s, p<0.001) with an AUROC of 0.76 (95% CI 0.66-0.85).



Test Question	PHES	EncephalApp	CL-ART
The test is easy to perform (1-10)	7.32	8.08	9.17
The test seems an appropriate length of time (1-10)	7.91	8.17	9.24
I would feel comfortable doing this test again (1-10)	8.26	8.60	9.34

Figure 1: Sample smartphone display of a CL-ART test question and the mean results from participant feedback questionnaires. A scale of 1-10 was used, where 1 represented 'completely disagree' and 10 represented 'completely agree'.

Variable	Odds ratio	95% CI	*p* value
Sex	0.68	0.06-7.14	0.748
Age	1.11	0.97-1.28	0.122
Diabetes	0.72	0.04-14.28	0.831
Rifaximin	1.57	0.16-15.77	0.700
Beta blockers	0.52	0.04-6.12	0.605
Previous HE	2.80	0.21-37.78	0.438
Sodium	1.15	0.86-1.54	0.342
Bilirubin	1.00	0.99-1.01	0.798
Albumin	1.00	0.82-1.21	0.989
White blood cells	1.14	0.89-1.46	0.314
CRP	0.99	0.93-1.05	0.728
Creatinine	0.98	0.95-1.01	0.201
EncephalApp	1.00	0.98-1.01	0.573
Ammonia	**1.04**	**1.01-1.07**	**0.018**
CL-ART	**1.15**	**1.00-1.32**	**0.049**

Figure 2: Multiple logistic regression to determine the ability of variables to independently predict future hospital admissions due to HE.

Conclusions

- CL-ART can help predict hospitalisation due to all decompensation, with highest sensitivity and specificity for HE-related admissions.
- Its rapid testing, smartphone application and high useability mean it can be used remotely, and therefore, play a crucial role in predicting decompensation, enabling early community intervention.

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