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Cognitive Dysfunction is Associated with Poor Socio-Economic Status in Patients with Cirrhosis: an International Multi-Center Study

Jasmohan S Bajaj[1], **Oliviero Riggio**[2], **Sanath Allampati**[3], **Ravi Prakash**[3], **Stefania Gioia**[2], **Eugenia Onori**[2], **Nicole Piazza**[2], **Nicole A Noble**[1], **Melanie B White**[1], and **Kevin D Mullen**[3]

[1]Division of Gastroenterology, Hepatology and Nutrition, Virginia Commonwealth University and McGuire VA Medical Center, Richmond, Virginia, USA

[2]Gastroenterology Department, La'Sapienza, University of Rome, Rome, Italy

[3]Division of Gastroenterology and Hepatology, Metrohealth Medical Center, Case Western Reserve University, Cleveland, Ohio, USA

Abstract

Background & Aims—In patients with cirrhosis, cognitive dysfunction most often results from covert hepatic encephalopathy (HE). These patients are not routinely tested for cognitive dysfunction, despite single-center evidence that it could be associated with poor socio-economic status (SES). We investigated the association between SES and cognition in a multi-center study of cirrhosis.

Methods—In a cross-sectional study, 236 cirrhotic patients from 3 centers (84 subjects from Virginia, 102 from Ohio, and 50 from Rome, Italy; age 57.7±8.6 y; 14% with prior overt HE) were given recommended cognitive tests and a validated SES questionnaire, which included questions about employment, personal and family income, and overall financial security. Comparisons were made among centers and between subjects who were employed or not. Regression analysis was performed using employment and personal income as outcomes.

Results—Only 37% of subjects had been employed in the last year. Subjects had substantial financial insecurity—their yearly personal income ranged from $16,000 to $24,999 and their family income ranged from $25,000 to $49,999. They were only able to maintain a residence for 3–6 months if their income stopped, and their current liquid assets were $500–$4999 (<$500 if debt was subtracted). Cognition and SES were worst in Ohio and best in Virginia. Cognition correlated with personal and family income, within and between centers. On regression analysis,

Corresponding Author: Jasmohan S Bajaj, MD Division of Gastroenterology, Hepatology and Nutrition, Virginia Commonwealth University and McGuire VA Medical Center, 1201 Broad Rock Boulevard, Richmond, Virginia, 23249 USA Telephone: (804) 675-5021, Fax: (804) 675-5816 jsbajaj@vcu.edu.

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cognitive performance (digit symbol, lures, and line tracing) was associated with personal yearly income, after controlling for demographics, country, employment, and overt HE. Unemployed subjects had a higher rate of overt HE, worse cognition, and lower personal income than employed subjects. On regression analysis, performance on digit symbol, line tracing, inhibitory control test lures, and serial dotting tests remained associated with income, similar to employment.

Conclusions—In an international, multi-center study of patients with cirrhosis, socio-economic condition, based on employment and personal income, was strongly associated with cognitive performance, independent of age, education, and country.

Keywords

minimal hepatic encephalopathy; covert hepatic encephalopathy; caregivers; purchasing power

Introduction

Cognitive dysfunction in cirrhosis, which is most often associated with covert hepatic encephalopathy (HE), is associated with difficulties in quality of life, increased progression to overt HE and problems with daily functioning[1-4]. However, it is not standard to test for cognitive dysfunction and minimal HE in cirrhosis[5]. Another essential aspect of daily functioning that is not routinely inquired is the socio-economic status (SES), which could affect insight into the disease and adherence with medications and follow-up[6-8]. There is limited single-center evidence of the association of SES with cognition in cirrhosis; a multi-center analysis is needed to increase generalizability[9]. A strong association of cognitive performance with SES across multiple centers could increase its “real-world” relevance to clinicians and potentially increase the rates of testing and subsequent therapy.

The aim was to study the association between cognitive performance and socio-economic status in an international, multi-center study. The *a priori* hypothesis was that cognitive function in cirrhosis will be directly linked to socio-economic status across all centers.

Methods

This was a prospective study of cirrhotic patients in three centers (a) Virginia Commonwealth University, Richmond, USA, (b) Metrohealth Medical Center, Cleveland, USA and (c) La'Sapienza University, Rome, Italy.

We included patients with cirrhosis proven by biopsy, endoscopic or radiological evidence, who were able to give written informed consent, had a mini-mental status exam score >25, were not on psychoactive medications apart from stable anti-depressants, and were able to perform the cognitive tests and complete the questionnaires[10]. We excluded patients who were not able to give consent, had an unclear diagnosis of cirrhosis and were on psychoactive medications other than anti-depressants.

Study procedures

All subjects were enrolled after written informed consent and underwent cognitive testing and completed questionnaires at the same sitting. Demographic information, level of education, severity of cirrhosis, prior overt HE episodes and MELD score was entered.

Cognitive tests

we used (1) PHES[11] : psychometric hepatic encephalopathy score [number connection test-A/B (NCT-A/B: subjects “join the dots” between numbers or numbers and letters in a timed fashion), digit symbol (DST: subjects need to pair numbers with special symbols correctly

within 90 seconds), line tracing (LTT: subjects trace a line between two parallel lines, time required is noted; errors were not recorded at all sites) and serial dotting (SDT, subjects need to dot the center of a group of blank circles)] and (2) Inhibitory control test (ICT) [12][subjects respond to alternating presentations of X and Y on the screen (targets) while inhibiting response when they do not alternate (lures)] in all patients. A high score on DST and ICT targets and a low score on the rest of the tests indicates good performance. These tests are used to diagnose covert HE when they are impaired compared to the local population, however we used each test result individually since cognition is a continuum.

SES evaluation

The MacArthur foundation socio-demographic questionnaire (http://www.macses.ucsf.edu/research/socialenviron/sociodemographic.php) was used to assess SES[9]. This consists of questions pertaining to subjects' assessment of their personal standing within their community and country, recent/current employment, educational status and living situation. It also inquires about personal and combined family income, ability to continue in their current situation if all the income ran out and liquid worth availability with and without current debt. The income variables are presented as ranked ordinal multiple-choice questions. The US centers used English versions while translated Italian versions of the SES questionnaire and cognitive tests were used for the Italian population.

Statistical analysis

The centers were compared with respect to demographics, SES and cirrhosis severity using ANOVA and Kruskal-Wallis tests as appropriate. Due to purchasing power parity results US $1 was considered equal to €1 and the income-related variables were directly compared between countries and centers[13]. Employed cirrhotic patients were compared to their unemployed counterparts with respect to education, demographics and cognitive performance using t-tests. Logistic regression was used to analyze factors that were associated with employment. The annual personal income was correlated with education, age and cognitive tests and regression was performed for annual personal income in the entire group to determine the relevant predictors. The predictors used were age, education, MELD score, sodium, alcoholic etiology, current employment, prior overt HE, country of origin and the cognitive tests. These analyses were also performed within each center.

Results

A total of 243 patients were enrolled; seven patients provided incomplete information regarding SES; therefore we had data from 236 patients of which 84 were from Virginia, 102 from Ohio and 50 from Rome. The mean age was 57.7±8.6 years with an educational level of 12.5±2.3 years. Fourteen percent of patients had prior overt HE which was currently controlled. Only 37% of respondents had been fully or partly employed over the last year. There was a median of 2 people in the household and 2 people were income bringers in the family. The median yearly personal income was $16,000-24,999 while the entire family income was $25,000-49,999. If all income stopped the family could live for a median of 3-6 months at their house. The median liquid assets were $500-4,999, which reduced to <$500 if current debt was subtracted. There were significant differences in the demographics and cirrhosis severity between the centers (table 1). The Italian patients were significantly older and less educated than the US counterparts. There was a significantly higher rate of full-time/part-time employment in the last 12 months in patients from Virginia compared to the rest; correspondingly the proportion of retired subjects was highest in Italy. When the percentage of patients who were either employed or retired was compared between sites, patients from Virginia and Rome were equivalent at 81% and 83%, which was significantly higher than the Ohio patients (62%, p=0.001), indicating that more patients from Ohio were

neither working nor had retired from work within the last 12 months, despite being of similar age as patients from Virginia. The cognitive performance was best in patients from Virginia compared to the rest. Socio-economic variables revealed that the Italians considered their status in the country to be higher than that of the rest while community standings were similar between groups. The SES was significantly worse in Ohio with respect to all financial variables despite the lowest number of mean family members in the household. When patients with prior overt HE were compared with those without, there was a significantly worse cognitive performance overall with higher rates of unemployment and worse personal income in those with prior overt HE (Table 2).

In the overall group, personal income was correlated with education ($r=0.4$, $p<0.0001$), NCT-A ($r=-0.22$, $p=0.001$), NCT-B ($r=-0.3$, $p<0.0001$), Digit ($r=0.4$, $p<0.0001$), Serial dotting ($r=-0.27$, $p<0.0001$) Line tracing time ($r=-0.22$, $p=0.001$), ICT lures ($r=0.2$, $p=0.05$) and targets ($r=0.21$, $p=0.001$) but not with age ($r=0.06$, $p=0.37$). Similarly, family income was significantly correlated with education ($r=0.3$, $p<0.0001$) but not with age ($r=0.03$, $p=0.7$). Cognition was linked to family income as well ; NCT-A ($r= -0.3$, $p=0.002$), NCT-B ($r=-0.2$, $p=0.006$), DST ($r=0.4$, $p<0.0001$), LTT ($r=-0.2$, $p=0.02$), SDT ($r=-0.24$, $p<0.0001$), ICT lures ($r=-0.2$, $p=0.04$) and ICT targets ($r=0.2$, $p=0.03$).

Using regression with personal income as the outcome, the significant predictors were education ($p<0.0001$), DST ($p<0.0001$), employment ($p<0.0001$), age ($p=0.002$), ICT lures ($p=0.02$), alcoholic etiology ($p=0.16$), which explained a variance of 33%. Prior overt HE, MELD score, sodium, country of origin and other cognitive tests were not significantly additive.

Employment

The proportion of patients who were employed full-time/part-time was highest in Virginia and lowest in Rome. Subjects unemployed over the last 12 months were more likely to be older, less educated and have a history of prior overt HE (Table 3). All cognitive tests were significantly impaired in the unemployed patients compared to unemployed ones. As expected, currently employed subjects were had a higher personal and family income and had comparatively more stable financially compared to unemployed subjects. The community standings were similar but the employed subjects thought their country-wise standing was higher compared to the rest. When logistic regression was applied, employment was affected by age (OR: 0.95), education (OR: 1.13), prior overt HE (OR: 0.34), DST (OR: 1.05), LTT (OR:1.01), SDT (OR:0.98) and ICT lures (OR:0.97) which meant that a higher age, lower education, lower score on digit and a high score on serial dotting, lures and line tracing tests predicted the lack of employment. The country of origin, MELD score, sodium and remaining cognitive tests were not significant.

Individual center analysis

The comparison between those working or not working showed significantly worse cognitive function in those who were not working in each center (tables 4A,B and C). On regression using personal earning as the outcome in Virginia, the significant contributors were education ($p=0.04$) and ICT targets ($p=0.05$), in Rome, the contributors were education($p<0.0001$), age ($p=0.002$), NCT-B ($p<0.0001$), ICT lures ($p=0.007$), ICT targets($p=0.007$), prior overt HE($p=0.06$), SDT($p=0.09$) while in Ohio education ($p=0.014$), alcoholic etiology ($p=0.04$) and ICT lures ($p=0.05$) were significant.

Discussion

The current study shows a strong linkage between cognitive function and socio-economic status that is relevant across centers in the US and Italy. We found that despite controlling for country of origin, cirrhosis severity, age and education, employment and economic status were related with key cognitive tests in the whole group and in individual centers. These results are relevant because the underlying socio-economic status deeply influences the patients and caregivers' understanding of the disease process, their adherence to clinic visits and medications and their overall standing in society[7, 9]. Issues of socio-economic status are usually outside the purview of the usual clinic visit but our results indicate that this may be a fruitful area to investigate in order to improve adherence and outcomes[14].

Cognitive testing in cirrhosis is often not performed routinely outside of specialized centers, in part because the clinical relevance of these results is not clear[5]. The current study shows that performances on tests that evaluate a large range of neuro-cognitive domains strongly reflect the underlying socio-economic reality of the disease. The tests that were most predictive of employment status and personal income were digit symbol, line tracing tests and ICT lures. Psychomotor speed, working memory and response inhibition underlie the cognitive basis of these particular tests, which are recommended to diagnose covert HE[15]. These domains are germane to performing daily tasks such as operating machinery, driving, navigating and housework[16]. Cognitive dysfunction is most often due to covert HE, which is made when these results are compared to the local population and other reasons for cognitive dysfunction are excluded. However, since individual test performance can fall within a spectrum of neuro-cognitive impairment in cirrhosis (SONIC), we studied cognition as a continuum rather than dividing patients into covert HE or not[15]. Therefore impairment in these tests has clear consequences in the patient and family's SES. The strong correlation with all aspects of SES with cognitive performance, independent of age, education and country of origin, shows that these results are important in identifying patients who are not only at increased medical risk, but also at a significant risk from a socio-economic standpoint. Current evidence shows that even the needed specialty medical care is often not available to cirrhotic patients; our results indicate that this care deficit is even greater because there is also need for interventions or communications targeted at incorporating the SES using social workers, financial counselors or psychologists into a global multi-disciplinary approach[14, 17].

Cirrhotic patients and their caregivers have impaired daily functioning owing to the medical and financial demands placed on them by the disease process[9, 18, 19]. In a prior study, there was a strong correlation between cognitive tests and SES, which was significantly worse in those with prior overt HE[9]. Our results confirm and extend those observations into multiple centers. Interestingly, although patients with prior overt HE had lower employment rates and personal income, there was no significant difference in the family income and were similar in their ability to deal with stoppage of income. This may be in part due to the relatively few patients with overt HE with most of them being from Virginia, the center with the highest SES. However, the overall SES of our patients, regardless of overt HE, showed significant financial insecurity with low cash reserves, that would likely affect their ability to adhere to clinic visits and medications if not recognized and addressed.

Unemployed patients were more likely to be cognitively impaired and less educated compared to those who were fully or partly employed within the last 12 months as a group or in individual centers. It is likely that cognitive function, independent of prior overt HE, affected the employability of these patients since they were independent on regression analysis. It follows that unemployed patients have a lower personal income but interestingly, the income of the whole family was also related to the patient's cognitive performance.

While part of it may be due to the effect of lowered patient's income but could also reflect the reduction in income due to other family members' having to work less in order to take care of the patient.

There were major differences, as was expected, in the socio-demographic make-up of the samples between centers. This is likely to reflect the underlying social and health system of the country (Rome with socialized health care and larger families) and the catchment area for the particular hospitals (Ohio with indigent patients). The median family size and number of people bringing income was significantly higher in Rome, which could account for the relatively similar family income variables as Ohio patients despite having the highest proportion of retirees. And in individual center analyses of personal income, cognitive tests continued to be significant contributors. However, despite these issues, there was no significant difference in the patients' standing in their communities, although their perceived standing within the country reflected their socio-economic reality. This disconnect could indicate that their communities are likely to share the SES of the respondents. The cognitive performance on most tests paralleled the SES across centers, with subjects from Virginia having the best and those from Ohio the worst performance.

The study is limited by cross-sectional data, which limits our understanding of the temporal nature of the process. It is possible that employment could be additionally affected by the overall economic conditions prevalent in US and Italy; however the results are consistent with the prior US study. The patient population varied widely across centers, however we were able to control for that in our analysis and found similar overall patterns within centers. However, despite these limitations, the data show that socio-economic status, represented by employment and personal income is strongly associated with cognitive performance on tests used for covert HE diagnosis independent of age, education and country of residence in this international, multi-center study. These findings should encourage clinicians to initiate cognitive evaluation for covert HE in order gain insight into medical and socio-economic risks faced by their patients and potentially identify strategies to manage these risks by creating multi-disciplinary clinic models for patients and their caregivers.

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References

1. Ortiz M, Jacas C, Cordoba J. Minimal hepatic encephalopathy: diagnosis, clinical significance and recommendations. J Hepatol. 2005; 42(Suppl):S45–53. [PubMed: 15777572]
2. Groeneweg M, Quero JC, De Bruijn I, Hartmann IJ, Essink-bot ML, Hop WC, Schalm SW. Subclinical hepatic encephalopathy impairs daily functioning. Hepatology. 1998; 28:45–9. [PubMed: 9657095]
3. Kappus MR, Bajaj JS. Covert hepatic encephalopathy: not as minimal as you might think. Clin Gastroenterol Hepatol. 2012; 10:1208–19. [PubMed: 22728384]
4. Stepanova M, Mishra A, Venkatesan C, Younossi ZM. In-hospital mortality and economic burden associated with hepatic encephalopathy in the United States from 2005 to 2009. Clin Gastroenterol Hepatol. 2012; 10:1034–41. e1. [PubMed: 22642955]
5. Bajaj JS, Hafeezullah M, Hoffmann RG, Saeian K. Minimal hepatic encephalopathy: a vehicle for accidents and traffic violations. Am J Gastroenterol. 2007; 102:1903–9. [PubMed: 17640323]
6. Stilley CS, DiMartini AF, de Vera ME, Flynn WB, King J, Sereika S, Tarter RE, Dew MA, Rathnamala G. Individual and environmental correlates and predictors of early adherence and

outcomes after liver transplantation. Prog Transplant. 2010; 20:58–66. quiz 67. [PubMed: 20397348]

7. Bernheim SM, Ross JS, Krumholz HM, Bradley EH. Influence of patients' socioeconomic status on clinical management decisions: a qualitative study. Ann Fam Med. 2008; 6:53–9. [PubMed: 18195315]
8. Zaya M, Phan A, Schwarz ER. The dilemma, causes and approaches to avoid recurrent hospital readmissions for patients with chronic heart failure. Heart Fail Rev. 2011; 17:345–53. [PubMed: 21643964]
9. Bajaj JS, Wade JB, Gibson DP, Heuman DM, Thacker LR, Sterling RK, Stravitz RT, Luketic V, Fuchs M, White MB, Bell DE, Gilles H, Morton K, Noble N, Puri P, Sanyal AJ. The multi-dimensional burden of cirrhosis and hepatic encephalopathy on patients and caregivers. Am J Gastroenterol. 2011; 106:1646–53. [PubMed: 21556040]
10. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res. 1975; 12:189–98. [PubMed: 1202204]
11. Ferenci P, Lockwood A, Mullen K, Tarter R, Weissenborn K, Blei AT. Hepatic encephalopathy--definition, nomenclature, diagnosis, and quantification: final report of the working party at the 11th World Congresses of Gastroenterology, Vienna, 1998. Hepatology. 2002; 35:716–21. [PubMed: 11870389]
12. Bajaj JS, Hafeezullah M, Franco J, Varma RR, Hoffmann RG, Knox JF, Hischke D, Hammeke TA, Pinkerton SD, Saeian K. Inhibitory control test for the diagnosis of minimal hepatic encephalopathy. Gastroenterology. 2008; 135:1591–1600. e1. [PubMed: 18723018]
13. Haidar JI. Currency Valuation and Purchasing Power Parity. World Economics- The Oxford Institute for Economic Policy. 2011; 12:1–12.
14. Mellinger JL, Volk ML. Multidisciplinary Management of Patients With Cirrhosis: A Need for Care Coordination. Clin Gastroenterol Hepatol. 2012
15. Bajaj JS, Wade JB, Sanyal AJ. Spectrum of neurocognitive impairment in cirrhosis: Implications for the assessment of hepatic encephalopathy. Hepatology. 2009; 50:2014–21. [PubMed: 19787808]
16. Weissenborn K, Ennen JC, Schomerus H, Ruckert N, Hecker H. Neuropsychological characterization of hepatic encephalopathy. J Hepatol. 2001; 34:768–73. [PubMed: 11434627]
17. Kanwal F, Kramer J, Asch SM, El-Serag H, Spiegel BM, Edmundowicz S, Sanyal AJ, Dominitz JA, McQuaid KR, Martin P, Keeffe EB, Friedman LS, Ho SB, Durazo F, Bacon BR. An explicit quality indicator set for measurement of quality of care in patients with cirrhosis. Clin Gastroenterol Hepatol. 2010; 8:709–17. [PubMed: 20385251]
18. Rakoski MO, McCammon RJ, Piette JD, Iwashyna TJ, Marrero JA, Lok AS, Langa KM, Volk ML. Burden of cirrhosis on older Americans and their families: analysis of the health and retirement study. Hepatology. 2012; 55:184–91. [PubMed: 21858847]
19. Miyazaki ET, Dos Santos R Jr. Miyazaki MC, Domingos NM, Felicio HC, Rocha MF, Arroyo PC Jr. Duca WJ, Silva RF, Silva RC. Patients on the waiting list for liver transplantation: caregiver burden and stress. Liver Transpl. 16:1164–8. [PubMed: 20879014]

Table 1

Comparison of demographics, cognition and MacArthur questionnaire results between the sites

	Virginia (n=84)	Rome (n=50)	Ohio (n=102)	P value
Age (years)	56.3 ± 5.6	64.4 ± 11.1	55.9 ± 8.6	<0.0001
Education (years)	13.3 ± 2.3	10.5 ± 4.8	12.5 ± 2.5	<0.0001
MELD score	11.8±5.6	10.8±3.5	10.3±4.1	0.08
Etiology %(HCV/Alcohol/HCV+Alcohol/NASH/Other)	48/10/6/21/15	46/29/6/6/13	30/20/34/10/6	0.0001
Etiology % (any alcohol/nonalcoholic	16/84	35/65	54/46	0.0001
Serum Sodium (mEq/L)	136.9±5.9	137.7±3.9	136.7±3.2	0.41
Prior overt HE (%)	24%	17%	12%	0.06
Number connection-A (sec)	41.2 ± 28.1	57.0 ± 20.1	43.9 ± 20.5	<0.0001
Number connection-B (sec)	106.8 ± 77.9	112.1 ± 40.8	120.5 ± 58.5	0.30
Digit Symbol (score)	56.7 ± 20.2	25.7 ± 9.2	37.1 ± 11.5	<0.0001
Line tracing time (sec)	106.1 ± 49.9	96.9 ± 31.64	123.5 ± 46.9	0.001
Serial Dotting (sec)	68.7 ± 31.7	63.1 ± 19.1	95.5 ± 36.3	<0.0001
ICT lures (number)	9.7 ± 7.5	22.1 ± 10.3	14.6 ± 9.6	<0.0001
ICT targets (% correct)	93.2 ± 12.7	86.6 ± 12.8	88.2 ± 16.4	0.006
Weighted lures	15.6 ± 34.8	31.1 ± 16.6	20.5 ± 15.4	<0.0001
MacArthur Questionnaire				
Working full or part-time in last year (%)	63%	16%	25%	<0.0001
Retired (for the last year) (%)	21%	70%	38%	<0.0001
Median number of people bringing income in the family	2	4	1	<0.0001
Perceived standing in the Community	6.0	6.5	6.0	0.38
Perceived standing in the Country (mean)	5.2	6.0	4.5	<0.0001
Housing situation % (Own/Rent/Other)	71/12/1	36/10/4	72/22/8	0.5
Mean people in household	2.7	2.5	2.2	0.004
Median personal income (past year $)	25000-49999	12,000-15999	5000-11999	<0.0001
Median family income (past year $)	50,000-74,999	16,000-24,999	12,000-15,999	<0.0001
How long could they continue living at the place if all income stopped	3-6 months	3-6 months	1-2 months	<0.0001
Money if all liquid assets were cashed ($)	20,000-49,999	10,000-19,999	<500	<0.0001
If debt were subtracted from all assets above ($)	5,000-9,999	5,000-9,999	<500	<0.0001

Patients from Ohio had the worst and those from Virginia had the best overall socio-economic status.

Table 2

Comparison between patients with prior overt HE compared to those without overt HE

	No history of overt HE (n=202)	Prior overt HE (n=34)	P value
Age (years)	57.97 ± 7.17	59.38 ± 9.34	0.4
Education (years)	12.41 ± 3.3	12.5 ± 2.9	0.92
Number connection-A (sec)	42.6 ± 19.8	56.4 ± 38.5	0.02
Number connection-B (sec)	105.5 ± 54.5	141.5 ± 84.7	0.009
Digit Symbol (score)	45.0 ± 20.5	35.3 ± 13.7	<0.0001
Line tracing time (sec)	104.9 ± 40.7	137.3 ± 62.1	0.001
Serial Dotting (sec)	74.6 ± 33.5	92.7 ± 36.6	0.003
ICT lures (number)	13.8 ± 10.1	14.54 ± 9.48	0.62
ICT targets (% correct)	91.9 ± 12.0	81.9 ± 20.5	0.002
Weighted Lures	17.7 ± 14.5	32.0 ± 52.6	0.07
MacArthur Questionnaire			
Employed part-time/full-time in the last year	65%	18%	0.001
Perceived standing in the Community	6	6	0.61
Perceived standing in the Country (mean)	5	5	0.81
Median personal income (past year $)	16,000-24,999	12,000-15,999	0.027
Median family income (past year $)	25,000-49,999	16,000-24,999	0.35
How long could they continue living at the place if all income stopped	3-6 months	3-6 months	0.97
Money if all liquid assets were cashed ($)	500-4,999	500-4,999	0.69
If debt were subtracted from all assets above ($)	<500	<500	0.63

Table 3

Comparison between patients who were employed (part-time or full-time) within the past year compared to those who were not in the entire group

	Employed, full-time or part-time (n=88)	Unemployed, including retired (n=148)	P value
Age (years)	54.56 ± 9.1	56.9 ± 6.9	<0.0001
Education (years)	13.38 ± 2.51	11.66 ± 3.38	<0.0001
Prior overt HE	39.5%	17.6%	0.01
Serum sodium (meq/L)	138.5 ± 3.7	137.1 ± 3.7	0.011
MELD score	9.9 ± 3.7	10.7 ± 3.7	0.141
Alcoholic Etiology	28%	39%	0.09
Number connection-A (sec)	33.3 ± 14.6	50.5 ± 21.7	<0.0001
Number connection-B (sec)	79.8 ± 34.0	123.6 ± 59.8	<0.0001
Digit Symbol (score)	56.3 ± 18.7	35.0 ± 15.4	<0.0001
Line tracing time (sec)	98.5 ± 39.9	115.7 ± 46.0	0.003
Serial Dotting (sec)	63.2 ± 21.3	85.5 ± 36.5	<0.0001
ICT lures (number)	9.5 ± 6.8	16.8 ± 10.9	<0.0001
ICT targets (% correct)	95.7 ± 7.6	87.7 ± 15.7	<0.0001
Weighted Lures	11.0 ± 8.8	23.7 ± 17.1	<0.0001
MacArthur Questionnaire			
Perceived standing in the Community	6	6	0.54
Perceived standing in the Country (mean)	5.4	4.7	0.007
Median personal income (past year $)	25000-49999	5000-11999	<0.0001
Median family income (past year $)	50000-74999	16,000-24999	<0.0001
How long could they continue living at the place if all income stopped	3-6 months	1-2 months	0.025
Money if all liquid assets were cashed ($)	5000-9999	500-4999	<0.0001
If debt were subtracted from all assets above ($)	500-4999	<500	0.025

Table 4A

Individual center comparisons of cognition, demographics and cirrhosis details In Virginia only

	Employed, full-time or part-time (n=53)	Unemployed, including retired (n=31)	p-value
Age	55.0±5.9	57.2±4.4	0.06
Education (years)	13.5±2.1	12.9±2.3	0.27
Prior overt HE	12%	27.5%	0.05
MELD	9.6±2.9	11.5±3.6	0.035
Alcoholic etiology	37.5%	12.5%	0.54
Serum sodium (meq/L)	139.5±3.1	137.8±5.0	0.16
Number connection-A (sec)	31.0±11.8	47.0±24.1	0.002
Number connection-B (sec)	72.1±27.8	117.6±77.7	0.004
Digit Symbol (score)	66.3±16.0	50.7±19.0	0.0001
Line tracing time (sec)	92.5±41.7	109.7±45.8	0.09
Serial Dotting (sec)	55.1±16.6	77.1±30.1	0.001
ICT lures (number)	7.6±5.8	10.1±7.9	0.13
ICT targets (% correct)	97.8±3.6	92.0±13.2	0.05

Table 4B

In Rome only

	Employed, full-time or part-time (n=8)	Unemployed, including retired (n=42)	p-value
Age	57.1±6.4	65.3±11.3	0.011
Education (years)	12.6±4.4	9.8±4.6	0.133
Prior overt HE	0%	19%	0.32
MELD	11.8±3.5	10.5±3.5	0.32
Alcoholic etiology	62.5%	12.5%	0.10
Serum sodium (meq/L)	137.8±5.5	137.8±9.9	0.98
Number connection-A (sec)	48.0±19.9	58.4±20.0	0.21
Number connection-B (sec)	95.0±32.3	114.7±42.0	0.16
Digit Symbol (score)	32.6±12.6	24.4±8.2	0.05
Line tracing time (sec)	91.5±34.8	98.9±31.2	0.59
Serial Dotting (sec)	62.0±15.5	62.3±20.3	0.85
ICT lures (number)	16.1±6.6	23.4±10.7	0.02
ICT targets (% correct)	88.9±9.8	86.7±13.0	0.59

Table 4C

In Ohio only

	Employed, full-time or part-time (n=27)	Unemployed, including retired (n=75)	p-value
Age	52.9±9.2	56.9±8.1	0.05
Education (years)	13.4±2.6	12.2±2.5	0.04
Prior overt HE	0%	16%	0.03
MELD	9.7±4.6	10.5±3.9	0.45
Alcoholic etiology	50%	53%	0.73
Serum sodium(meq/L)	137.2±3.2	136.5±3.3	0.34
Number connection-A (sec)	33.4±15.7	47.5±20.8	0.001
Number connection-B (sec)	90.1±41.8	130.9±59.9	0.0001
Digit Symbol (score)	44.1±8.9	34.7±11.3	0.0001
Line tracing time (sec)	112.3±35.3	127.4±50.0	0.09
Serial Dotting (sec)	79.5±22.3	101.0±38.6	0.001
ICT lures (number)	11.3±7.0	15.7±10.1	0.018
ICT targets (% correct)	93.8±10.8	86.3±17.6	0.013