Cognitive functioning and driving ability in HIV-infected professional drivers.

Gouse H[1]., Robbins, R[2]., Masson,C.J[1]., Henry, M[3]., Thomas, K.F.G[4]., Munsami, A[1]., London, L[5]., Kew, G[5]., Joska, J.A[1]., Marcotte, T.D[6].

[1]HIV Mental Health Research Unit, Department of Psychiatry and Mental Health, University of Cape Town (UCT); [2]HIV Center for Clinical and Behavioral Studies, New York State Psychiatric Institute and Columbia University Medical Center; [3]Centre for Higher Education Development, UCT; [4]Depeartment of Psychology, UCT; [5]School of Public Health and Family Medicine, UCT; [6]HIV Neurobehavioral Centre, University of San Diego.

Background

- Although people living with HIV (PLWH) live near-normal life-spans, HIV-associated neurocognitive impairment (NCI), especially the milder forms, remain prevalent[1].
- Because many PLWH maintain employment and occupational status, understanding the effects of HIV-associated NCI on their workplace functioning is essential.
- Such NCI might have significant safety consequences for professional drivers and those who share the road with them.
- Previously published studies report impaired driving performance in a subsample of HIV-positive lay drivers with NCI[2].
- Less is known about how HIV-associated NCI affects professional drivers, especially in high HIV prevalence and resource limited settings with high rates of driving related accidents and deaths.
- We examined the relationship between HIV, cognition and driving performance in professional truck drivers.

Methods

We conducted a cross-sectional pilot study of 20 HIV-positive and 20 HIV-negative (mean age = 39.2 ± 6.96) male professional drivers from Southern Africa, matched on age and education, who completed:

1) A comprehensive neuropsychological (NP) battery:
   - *Verbal*: Letter, Category and Action Fluency; *Abstraction*: Wisconsin Card Sorting Test (64-item computerized version), Trail Making Part B; *Perceptual-motor*: Trail Making Test Part A; *Attention-speed of information processing:* Paced Auditory Serial Addition Test (PASAT), Weschler Adult Intelligence Scale III (WAIS-III) Digit Span subtest, Digit Symbol subtest and Symbol Search subtest; *Learning*: Hopkins Verbal Learning Test (HVLT), Brief Visuo-Spatial Memory Test-Revised (BVMT-R); *Memory*: HVLT-R retention, BVMT-R retention; *Motor*: Grooved Pegboard, Finger Tapping.
   - We calculated a Global Deficit Score (GDS) by calculating deficit scores (based on t-scores) across all neuropsychological tests, using scores >0.5 as a cut-off point indicating neurocognitive impairment.

2) A driving simulator assessment:
   - The Simulator assessment (TMI Systems Technology vSIMC200, three channel array 40' LCD/LED panel, 1080p60) consisted of three interactive tasks composed of driving along a straight road, making a right turn across traffic, stopping at an amber light, crossing a busy highway, avoiding pedestrians and a divided attention task.
   - The primary outcomes on the simulator assessment were: 1) standard deviation of lateral position on the road (road excursions), 2) speed deviation, 3) crashes, and 4) response latency and accuracy on the divided attention stimulus items.

- **Analysis:** One tailed Mann-Whitney U Exact tests and Spearman's rho were conducted.

Results

Neuropsychological testing:

HIV-positive drivers performed significantly worse than HIV-negative drivers on tests of (see Tables 1):
- verbal learning and verbal memory/delayed recall;
- processing speed;
- attention/working memory; and
- visuospatial functioning (p<.038).

Using GDS, three (15%) HIV-negative drivers compared to 12 HIV-positive (60%) (Chi-square = 8.64, p = .003) drivers presented with neurocognitive impairment.

Driving simulator:

Across driving simulator tasks HIV-positive drivers were more likely than HIV-negative drivers to:
- exceed the speed limit (p=0.024),
- not maintain their lane position (p=0.020),
- and have more collisions (p=0.044).

Correlations between cognitive- and simulator performance:
- Worse performance on a processing speed test (WAIS III Digit Symbol-Coding) and on an attention/working memory test (WMS Spatial Span) were positively correlated with increased speeding (p's<.016);
- Worse performance on a processing speed test (WAIS III Symbol Search) most strongly positively correlated with road excursion and collisions (all p's<0.36).

Table 1. Demographics and HIV-positive driver characteristics

	HIV+	HIV-	X^2	p
Employment and driving training				
Employed full-time	85%	100%	3.243	.072
Professional driver training	100%	89%	2.232	.135
HIV+ driver characteristics (n=19)	Range	Mean	SD	
CD4 count	15 - 903	534.07	290.07	
Viral load	9421 - 98041	Undetectable = 16		

Note: All HIV-positive participants were on ART for at least three months

Table 2. Significance of Mann-Whitney *U*-test comparisons between HIV+ and HIV- drivers on neuropsychological tests.

Neuropsychological test	*U*	*z*	*p*
HVLT Trial 1	100.50	-2.742	.006*
HVLT Learning	127.00	-1.982	.049*
Spatial Span Backward	122.50	-2.142	.035*
Digit Symbol Coding	74.00	-3.411	.000**
Symbol Search	68.500	-3.563	.000**
Color Trails 1	112.50	-2.367	.017*
Digit Span Forward	91.00	-2.998	.003*
Digit Span Total	109.50	-2.496	.013*
Judgement of Line Orientation	82.00	-3.198	.001*

*p < 0.05. **p < .001

Figure 1. vSIMC200 driving simulator

Conclusions

- In this small pilot study, HIV+ professional drivers performed significantly more poorly on both cognitive tests and on simulator driving tasks compared to HIV- drivers.
- Relatively impaired cognitive functioning was associated with increased driving risk behavior.
- Although findings are preliminary and need to be replicated with larger samples, they indicate that professional drivers living with HIV may improve their own safety and those of others sharing the road with them if they participate in cognitive rehabilitation and/or are encouraged to expose themselves to other interventions that can impact cognition (e.g., programs targeted at improving adherence to antiretroviral therapy).

NOTE: HIV itself is not a risk factor when driving, cognitive impairment is.

References:
1. Croxford, S., Kitching, A., Desai, S., Kall, M., Edelstein, M., Skingsley, A., . . . Delpech, V. (2017). Mortality and causes of death in people diagnosed with HIV in the era of highly active antiretroviral therapy compared with the general population: an analysis of a national observational cohort. *Lancet Public Health, 2*(1), pp. E35-E46. doi:10.1016/S2468-2667(16)30020-2.
2. 2. Marcotte, T. D., Heaton, R. K., Wolfson, T., Taylor, M. J., Alhassoon, O., Arfaa, K., . . . Grant, I. (1999). The impact of HIV-related neuropsychological dysfunction on driving behavior. The HNRC Group. *Journal of the International Neuropsychological Society, 5*(7), pp. 579-592.
3. Blackstone, K., Moore, D. J., Franklin, D. R., Clifford, D. B., Collier, A. C., Marra, C. M., . . . Heaton, R. K. (2012). Defining neurocognitive impairment in HIV: deficit scores versus clinical ratings. *The Clinical Neuropsychologist, 26*(6), pp. 894-908.

Funding: Fogarty International Institute (NIH); Grant number: 1K43TW010361-01.