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COGNITIVE DEFICITS AND DRIVING ABILITY IN PATIENTS WITH PARKINSON'S DISEASE

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Introduction - Background

- **Parkinson's disease** (PD) is a slowly progressive, degenerative disease of the basal ganglia with motor dysfunction as a cardinal feature, manifesting with bradykinesia, rigidity, resting tremor, flexed posture, shuffling gait and postural instability.
- PD causes **cognitive** (memory, visuo-spatial and executive dysfunction), **emotional** depression, apathy) and **behavioral-neuropsychiatric symptoms** (agitation, hallucinations, delusions).
- The multimodal clinical picture of PD appears to **influence in a negative fashion** various aspects of cognition, behavior and motor control that are closely linked to the capacity of an individual to maintain adequate driving skills.

Main objective of this study:
Present and discuss findings from previous research that has explored the link between cognition and fitness-to-drive in patients with PD.

Methodology:
22 primary studies relevant to cognitive functioning and driving ability were examined and finally included in the current review.

Epidemiologic data and crash rates of PD

- Dubisnky et al. in the early 90s found that PD drivers with more severe motor impairment as assessed by the Hoehn & Yahr (H&Y) scale **experience an increased risk for car crashes**.
- Meindorfner et al. in 2005 in a epidemiological study showed that **15% of the PD drivers with an active driving licence was involved in car accident** during a period that covered the past five years.
- However, findings from a recent prospective cohort study **did not reveal differences in crash risk** between patients with PD and controls even after adjusting for age, education, gender, and miles driven per week at baseline (Uc et al. 2008).
- In a recent study (Stolwyk et al. 2015) it was found that **only subjective feelings of a decline in driving performance** and not objective measures of cognitive functioning and simulated driving performance played a role on the driving cessation of patients with PD.

Indicative Predictors of driving capacity

- Amick et al. (2007): **a significant association was found between a greater number of driving errors** and a poorer performance on the TMT test* in drivers with PD who underwent an on-road driving evaluation.
  *Trail Making Test (TMT), is a neuropsychological test that explores abilities such as visual search, motor speed, and spatial skills.
- **PD drivers that were characterized as unsafe** according to their on-road driving performance with increased number of driving errors, had important difficulties on the TMT test (Grace et al. 2005, Classen et al. 2009).
- Useful Field of View (UFOV) assesses visual perception and attention. The divided attention subtest of the UFOV was strongly **correlated with pass/fail driving outcome in on-road studies** (Classen et al. 2011).
- The Rey-Osterrieth complex figure test (**ROCF**) evaluates different functions, such as visuospatial abilities, attention, planning and memory. Research finding support **its capacity to serve as a predictor of driving performance in PD patients** (Grace et al. 2005, Amick et al. 2007, Uc et al. 2009).

Use of Cut-Off scores

- In a study that applied the UFOV the optimal combination of sensitivity (87%) and specificity (82%) for **passing the on-road driving test was achieved by a cutoff score** of 3 (range 1-5) in the UFOV risk index (Classen et al., 2009).
- Combination of the subtest 2 of the UFOV and the Rapid Paced Walk Test in a logistic model accurately classified 81% of the drivers (83% sensitivity and 78% specificity) **in reference to the pass/fail outcome of an on-road evaluation** (Classen et al. 2011).

Outcomes of Driving Simulator Procedures

- Stolwyk et al. 2006: Trail Making Test-B (TMT-B), the Brixton test and the Symbol Digit Modalities Test (SDMT) which assess executive function and information processing speed, **have shown strong correlation with several driving simulator measures**:
  - traffic signal approach,
  - speed,
  - traffic signal deceleration point,
  - mean curve speed, and
  - curve direction effect on mean lateral position.
- In the same study, PD drivers:
  - needed also **more time to initiate deceleration,**
  - **had greater difficulty to stop at the proper position when approaching traffic signals,**
  - **had lower speeds** during driving around curves and
  - showed **greater variation in vehicle lateral position** when driving around curves.
- Low contrast environmental conditions **have a negative impact on driving performance in PD drivers**. Neuropsychological tests that evaluate visuospatial skills and motion perception might be used as predictors of driving performance under low contrast conditions (during twilight or under foggy conditions) (Uc et al. 2009).
- PD drivers **have increased difficulty in recalling road signs**. This difficulty can be predicted by the difference between TMT-A and TMT-B score supporting the view that PD patients have executive function deficit (Ranchet et al. 2011).

Comparison of cognitive and motor measures

- The reduced driving performance of patients with PD was **linked to the functioning of visual attention, constructional skills and visual memory** (Uc et al.2007, Uc et al. 2009).
- **Executive function, information processing speed demonstrated better predictive value in predicting driving errors**, than the staging of the PD itself, as measured by the UPDRS-motor scale (Stolwyk et al. 2006).
- According to simulator data, **motor measures and not only cognitive variables could have a central role in predicting fitness to drive**, under low visibility conditions , that require sufficient response speed in order to avoid a crash (Uc et al. 2009).

Conclusions and future directions

- Driving capacity in PD patients is mainly compromised due to cognitive deficits that engage **attention, executive, and visuospatial resources,** three crucial domains which affects:
  - **journey planning**
  - **positioning and maneuvering the vehicle**
  - **judging distances**
  - **predicting the development of driving situations**
  - **estimating risk and adapting driving behavior.**
- The current knowledge about the driving performance of PD patients is based **both on on-road and simulator studies**, two different methodological approaches with different advantages and limitations.
- Prospective studies by **combining information from on-road and simulator evaluations** could reach to more solid conclusions about the role and the effect size of various predictors on driving performance measures.
- An objective of future research should be **the development of a wider array of Cut-Off scores.** This kind of information can facilitate decisions about the restriction or total loss of driving privileges.
- The combination of cognitive measures with brain imaging data **could refine the methods currently used** for assessing the driving ability of patients with PD.
- **Criteria for the selection** of patients with PD should include:
  - the presence of a valid driver's license
  - regular and not occasional car driving
  - CDR score ≤ 1, and 1 < Hoehn & Yahr score > 3.
- On the other hand, **exclusion criteria** should be alcohol or illicit substance use and the presence of significant neuropsychiatric symptoms related to PD.

- Neurological and neuropsychological testing **should be viewed as one part of the screening process** that could help the evaluation of the driving capacity of PD patients and **should not be used in isolation**, because this practice could lead to imprecise decisions that can have **dangerous consequences.**

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