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Predicting fitness to drive for drivers with Alzheimer's disease: a validation study

[1*]Doumen, M.J.A., [1]Mons, C., [1]Kamphuis, K.G. & [1]Boele, M.J.
*lead presenter [1]michelle.doumen@swov.nl SWOV Institute for Road Safety Research, The Netherlands

Introduction

Alzheimer's disease (AD), the most common form of dementia, is a progressive disease that affects the patient's cognitive functions, which, among other things, makes driving more difficult. Legislation in many countries therefore prescribes that motorists are not allowed to continue driving if AD has been diagnosed. However, research has shown that drivers who were diagnosed with very mild to mild dementia are still able to drive safely (Brouwer, 2006; Hird et al., 2016). At the same time, developments in medical science have allowed AD to be diagnosed earlier and earlier in the disease process, which has led to an increasing number of people who have wrongly been denied driving privileges. For this reason, the legislation on the fitness to drive of people with mild dementia was amended in the Netherlands: since 2009 it has been possible to retain one's driving license with a diagnosis of mild dementia provided a driving test demonstrates sufficient fitness to drive.

Since it is important for older adults to stay mobile as long as possible, and anticipating an increase in the number of drivers diagnosed with AD, a valid and easy way to test fitness to drive was needed. In an earlier research project (Fitness to drive with Cognitive Impairments, FitCI-1) SWOV, together with the University of Groningen and CBR (the Dutch driver licensing agency), investigated which combination of test results (from interviews, neuropsychological tests and simulator drives) could best predict the outcome of the official driving test. This led to a prediction model with which the result of the CBR driving test for people with AD could be predicted very accurately (Piersma et al., 2016). The current study (FitCI-2) was designed to test the procedure and this prediction model with a new group of people with AD. The research question of this validation study was: *What is the predictive value of the model developed in FitCI-1 in a new patient group with Alzheimer's disease?*

Research methodology

The FitCI-1 testing procedure was repeated as precisely as possible with a new group of people with AD (AD group) and a group of people aged 65 and older without cognitive impairments (control group). When a test is repeated after five years, small changes in a testing procedure are almost inevitable. Researchers cannot always control these changes: after the FitCI-1 data collection, for example, there were alterations in the way CBR experts reported on the driving tests taken.

The testing procedure consisted of a test day at SWOV and an on-road test drive, which was almost identical to the formal CBR driving test. The test day at SWOV had three components: 1) the participant and a relative or close acquaintance were interviewed separately about the degree of dementia after completing a questionnaire at home about the participant's driving, 2) the participant performed a number of neuropsychological tests (of attention, visual perception,

and responsiveness, among others), and 3) used a driving simulator a number of different times. After this test day, the participant had an on-road test drive. During this test fitness to drive was assessed. It was then examined to what extent the prediction model developed in FitCI-1 could have predicted a positive or negative outcome of the test drive based on the test results. This prediction was tested for diagnostic accuracy with an ROC analysis.

Results

As might be expected from tests designed to distinguish between people with and without mild dementia, we found differences between the AD group and control group in the results of the interviews and neuropsychological tests. In the driving simulator, the control group participants drove faster and benefited from a better memory, which made them less startled by an 'unexpected event' the second time one of the simulator drives was taken. While for all control group participants the result of the CBR test drive was positive, 47% of AD group participants obtained a positive result.

Within the AD group, no differences were found in the degree of dementia (total score on the Clinical Dementia Rating scale) between the participants with negative and positive results on the study test drive. However, there were small differences in subscores of the CDR scale: the participants with a negative result on the study test drive scored worse on a number of subscales. Between both AD groups, few differences were found in performance during the simulator drives. However, differences were found on the neuropsychological tests. These seemed to be due to reduced speed during task performance by participants with negative results on the study test drive. In the questionnaire they also reported more difficulty with various aspects of the driving task in everyday driving, such as changing lanes in heavy traffic.

The prediction model developed in FitCI-1 was used to predict the outcome of the test drives. The predictive value was expressed as the Area Under the Curve (AUC), where an AUC of 0.5 means that the predictive value does not exceed chance. The usual threshold value for diagnoses is an AUC of 0.8. With FitCI-1, an AUC of 0.97 was found; with FitCI-2, it was 0.69.

Discussion and conclusions

The current validation study did not allow us to confirm the predictive value of the FitCI-1 prediction model. The most likely explanation for the difference in diagnostic accuracy of the model is that the dependent variable - assessment of the CBR driving test - changed between the completion of FitCI-1 and the start of FitCI-2. The change concerns the test drive reporting, which was standardised by CBR in 2017. It is likely that this standardization affected the assessments made by the fitness to drive experts who administered the test drives.

An alternative two-stage assessment is suggested. The data collected in FitCI-1 and FitCI-2 can be used to establish and validate the prediction model that is needed for this assessment.