Accuracy of the DriveABLE cognitive assessment to determine cognitive fitness to drive

Allen R. Dobbs PhD

Abstract

Objective To evaluate the accuracy of the DriveABLE In-Office cognitive assessment in predicting cognitively impaired drivers' performance on the DriveABLE On-Road Evaluation (DORE).

Design Retrospective study comparing data from DriveABLE In-Office cognitive assessment outcomes with DORE outcomes.

Setting Nineteen of the locations in North America providing the DriveABLE assessment between the years 2007 and 2010.

Participants Database records from 3662 patients (2639 men, mean age 74.1 years, range 18 to 99 years of age; 1023 women, mean age 73.5 years, range 18 to 94 years of age) with suspected or confirmed cognitive impairment. All patients were referred for DriveABLE evaluation and received both the In-Office cognitive assessment and, regardless of the In-Office test results, the DORE. This is a subset of the database because typically the DriveABLE In-Office cognitive assessment serves as the cognitive assessment and only those whose results are in the indeterminate range go on to complete the road test (ie, DORE).

Main outcome measures Accuracy of the In-Office assessment for predicting the outcome of the DORE.

Results For the total sample, the error rate for predicting actual performance on the road test was 1.7% for pass predictions and 5.6% for fail predictions. Notably, these low error rates were consistent across the 4 years. On the basis of performance on the In-Office cognitive assessment, pass or fail decisions could have been made for more than half of the referrals, reducing the need to take dangerous drivers on the road and reducing the cost of the assessment process for patients and the system.

Conclusion The accuracy of the DriveABLE In-Office cognitive assessment was evaluated in the context of normal clinical referral processes, with a large sample of referrals during a 4-year period and from multiple sites. The high and stable accuracy rates provide the evidence physicians need to be confident in using the recommendations from the DriveABLE cognitive evaluation to assist them in making evidence-based decisions about their patients' ability to continue driving.

EDITOR'S KEY POINTS

- Cognitive impairment is one of the most important medical conditions for increasing the safety risk to the patient driver, his or her passengers, and other road users. Unfortunately, it has been difficult for physicians to know what type or what degree of cognitive impairment is needed to make patients unsafe to drive.
- The goal of this study was to evaluate the accuracy and stability of the DriveABLE cognitive assessment in extended clinical use.
- This study demonstrated that the DriveABLE In-Office assessment was highly accurate in identifying drivers with suspected or confirmed cognitive impairment who would pass or fail the DriveABLE On-Road Evaluation. This accuracy means that the number of patients who would have needed to be road-tested could be reduced by more than 50%, thereby increasing road safety and reducing the cost of the assessment process for patients and government payers.

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Précision de l'instrument d'évaluation cognitive DriveABLE pour évaluer la capacité cognitive de conduire

Allen R. Dobbs PhD

Résumé

Objectif Déterminer la précision de l'instrument d'évaluation cognitive DriveABLE In Office pour prédire la performance des conducteurs présentant un déficit cognitif au DriveABLE On Road Evaluation (DORE).

Type d'étude Étude rétrospective comparant les résultats de l'évaluation cognitive par le DriveABLE In-Office à ceux du DORE.

Contexte Dix-neuf des sites nord-américains qui offraient l'évaluation DriveABLE entre 2007 et 2010.

Participants Les registres d'une banque de données concernant 3662 patients présentant un déficit cognitif soupçonné ou confirmé, soit 2639 hommes de 18 à 99 ans (moyenne 74,4 ans) et 1023 femmes de 18 à 9 ans (moyenne 73,5 ans). Tous les patients ont été soumis à l'évaluation DriveABLE et à l'évaluation cognitive In-Office et, sans égard au résultat du test In-Office, au DORE. Il s'agit là d'un sous-ensemble de la base de données parce que habituellement, l'évaluation cognitive DriveSABLE In-Office sert à évaluer les fonctions cognitives et seuls ceux qui ont des résultats incertains sont appelés à passer le test sur route (c.-à-d. le DORE).

Principal paramètre à l'étude La précision de l'évaluation In-Office pour prédire le résultat du DORE.

Résultats Pour l'ensemble de l'échantillon, le taux d'erreurs pour prédire les résultats du test sur route était de 1,7% pour le succès et de 5,6% pour l'échec. Ces taux d'erreurs étaient remarquablement semblables pour les 4 années étudiées. En se basant sur les résultats de l'évaluation cognitive In-Office, on aurait pu prendre une décision de succès ou échec dans plus de la moitié des cas étudiés, réduisant ainsi la nécessité d'amener des conducteurs dangereux sur la route tout en diminuant les coûts du processus d'évaluation tant pour les patients que pour le système.

Conclusion On a évalué la précision de l'évaluation cognitive DriveABLE In-Office dans le contexte du processus normal des demandes en clinique, à partir d'un large échantillon de cas provenant de plusieurs sites et sur une période de 4 ans. Les taux de précision élevés et stables permettent aux médecins d'utiliser les résultats de l'évaluation cognitive DriveAble avec confiance lorsqu'ils doivent prendre une décision basée sur des données probantes au sujet de la capacité de conduire de leurs patients.

POINTS DE REPÈRE DU RÉDACTEUR

- Les déficits cognitifs sont des conditions médicales très importantes qui mettent en danger la sécurité des patients conducteurs, de leurs passagers et des autres utilisateurs de la route. Il est malheureusement difficile pour le médecin de savoir quel type ou degré de déficit cognitif permet d'établir qu'un patient n'est plus sécuritaire au volant.
- Cette étude avait pour but d'évaluer la précision et la stabilité de l'évaluation cognitive DriveABLE sur une longue période d'utilisation clinique.
- L'étude a démontré que l'évaluation DriveABLE In-Office permettait d'identifier de façon très précise ceux, parmi les conducteurs présentant des déficits cognitifs soupçonnés ou confirmés, qui réussiraient ou échoueraient au DriveABLE On-Road Evaluation. Compte tenu de cette précision, le nombre de patients ayant besoin de subir le test sur route aurait pu être réduit de plus de 50%, augmentant ainsi la sécurité routière tout en réduisant les coûts du processus d'évaluation pour le patient comme pour le gouvernement.

Cet article a fait l'objet d'une révision par des pairs.
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Family physicians play an important role in evaluating the medical fitness to drive of their patients. As age is a leading risk factor for cognitive impairment, the already challenging responsibility of determining patients' ability to drive will become even greater for physicians as large numbers of baby boomers enter their senior years.

Cognitive impairment is one of the most important medical conditions for increasing the safety risk to patient drivers, their passengers, and other road users.[1] Unfortunately, it has been difficult for physicians to know what type or what degree of cognitive impairment makes a patient unfit to drive. This is reflected in the Canadian Medical Association's guidelines,[2] which, in the case of dementia, recommend that physicians refer patients for specialized driving evaluation to determine fitness to drive. Presumably this recommendation would apply to cognitive impairment due to other medical conditions that result in persistent cognitive impairment. This places great importance on the specialized driving evaluation.

In general, research intended to validate in-office assessments for drivers with cognitive impairment has not met with good success.[3] Moreover, data are often reported as correlations between the individual tests and driving evaluations. Correlations without explicit cut points defining the outcomes are of little use to clinicians.[4]

The DriveABLE assessment has been cited as perhaps the most widely used driving evaluation protocol specialized for patients with suspected or confirmed cognitive impairment.[5] In the development of the In-Office assessment, explicit attention was given to the development of cut points in the research phases, which resulted in what has been described as a "pioneering" approach[6] to assigning outcomes. Two cut points rather than 1 are used to separate patients into a 3-way classification of functional status for driving (pass, indeterminate, and fail).[7] This trichotomy was developed primarily to maximize the accuracy of recommendations. It enabled setting cut points from research findings that identified drivers who would pass or fail the road test with high accuracy and used the road test to resolve driving competence for the remaining (indeterminate) drivers. More important, this approach also provided an increase in the assessment of safety by eliminating the need of on-road tests for drivers who were most likely to make dangerous driving errors.

A 2001 review[8] cited DriveABLE as "the most effective driving evaluation to date," and that conclusion was included in a 2005 review.[9] The DriveABLE On-Road Evaluation (DORE) has been described as the most highly developed of the driving evaluations for medically at-risk drivers.[10] However, there is no published study about the predictive accuracy of the In-Office cognitive assessment for identifying medically impaired, unsafe drivers when the assessment is used within *standard clinical practice*. The goal of the present research is to provide that evaluation based on data from a large sample referred during 4 years of clinical use. This can be accomplished because data are available for patients who received both the In-Office cognitive assessment and, regardless of outcome, the DORE.

METHODS

Participants

Patients were referred for the DriveABLE evaluation owing to medical conditions, treatments, medications, or combinations of these that resulted in suspected or confirmed cognitive impairment. A subset of all patients in DriveABLE's database was identified for this research. The only selection criteria were that patients were assessed between the years 2007 and 2010 and that they received both the In-Office cognitive assessment and, regardless of outcome, the DORE. Data from 3662 patients from 19 different sites met the 2 criteria and were included in the data set. The data set included no personal information. There were 2639 men (mean [SD] age of 74.1 [12.9] years, range 18 to 99 years) and 1023 females (mean [SD] age of 73.5 [12.9] years, range 18 to 94 years). This sample is approximately 23% of the total sample. In some jurisdictions, accrediting of the DriveABLE assessment by the licensing authority required that both the In-Office cognitive assessment and the On-Road (ie, DORE) tests were given to all patients. Other sites opted to use both In-Office and On-Road assessments for all patients, at least for a period of time. Although a few patients received both tests by physician and licensing authority request (<2%), there was no selection bias in these samples.

Design

Data from the outcomes of the DriveABLE In-Office cognitive assessment were compared with the DORE outcomes in a retrospective study.

Assessment tools

The In-Office cognitive assessment consists of 6 tests: motor speed and control, span of attentional field, spatial judgment and decision making, speed of attentional shifting, executive functions, and identification of hazardous driving situations. (Descriptions of the In-Office cognitive assessment are available from **CFPlus**.*)

The In-Office cognitive assessment is completed and scored on a computer. A certified assessor provides standardized instructions and gives 1 to 3 practice

*Descriptions of the In-Office cognitive assessment are available at **www.cfp.ca**. Go to the full text of the article online, then click on **CFPlus** in the menu at the top right-hand side of the page.

trials, as necessary, before each test to ensure that the patient understands what it is he or she needs to do. The assessor remains with the patient throughout the evaluation. The patient responds by simply touching the touch-sensitive screen or pressing a button.

Scoring and report generation are automated through the data flow illustrated in **Figure 1**. Encrypted data are sent via the Internet to the DriveABLE host computer. In data scoring, the effects of age are removed from each variable. This is done by adjusting the performance score by the mean age effect obtained in a normative sample of cognitively healthy persons on that performance variable. The results are compared against norms; outcome data are encrypted then returned to the test site. A report is automatically generated based on the findings. The outcome measure is the predicted probability of failing the DORE. Cut points segregate outcomes into pass (<0.30), indeterminate (0.30 to <0.71), and fail (≥0.71).

The DORE is completed in an automobile equipped with dual brakes. Explicit instructions are given for each driving maneuver, and any errors are scored in terms of the scheme developed during the research phases.[11] (The research phases identified the driving errors of cognitively impaired drivers that indicated decline in driver competence.) The basic components of the scoring scheme have been validated by other research.[12,13] The road course at each assessment site is designed to be consistent with the road-course criteria defined through research.

The error data are entered into the site's database using DriveABLE software, which encrypts and transmits the data via the Internet to the DriveABLE host computer. The competence errors are segregated from "bad habit" and other noncompetence driving errors common among competent, experienced drivers. The competence errors are compared with normative data and an outcome score is calculated based only on the number and severity of driving errors that have been shown to indicate a decline in competence. The scored data are encrypted and returned to the site's computer, and a report is automatically generated through a process analogous to that shown in **Figure 1**.

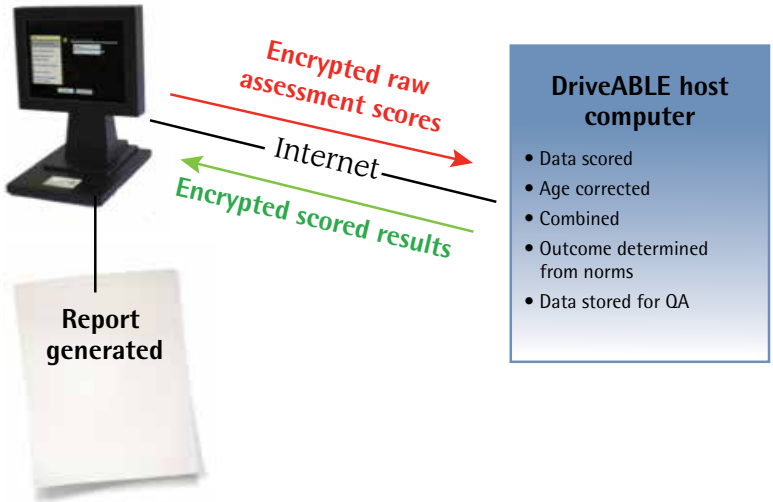
The criterion for fail is based on normative data that puts the failing scores beyond the research-established range of driving errors for cognitively normal, experienced drivers when tested in similar driving situations. This protects competent drivers from being falsely identified as not competent. The normatively based criterion of DriveABLE is important in Canada because it is consistent with a Supreme Court of Canada ruling[14] concerning nondiscriminatory evaluation of medically disabled drivers. A pass outcome occurs when the driving errors fall within the range of cognitively competent drivers given the driving evaluation. A borderline outcome is when drivers score within a driving error of the pass-fail criterion. In these cases it is judicious to seek other clinical information for continued driving decisions in the medical context (eg, rate of progression or recovery). In the licensing authority context, different interpretations of the borderline outcome can occur because different jurisdictions place a different emphasis on driver mobility versus public safety.

This research received ethical approval from the Community Research Ethics Board of Alberta.

RESULTS

Table 1 shows the relationship between In-Office cognitive assessment outcomes and the DORE outcomes for the patient sample, summed over the 4-year span (2007 to 2010). If continued driving recommendations were made on the basis of the In-Office cognitive assessment pass and fail outcomes alone, drive or no-drive recommendations would have been made for more than half of the patients (pass + fail = 54.0%), and the On-Road testing would not have been necessary. The remaining patients received an outcome of

Figure 1. Illustration of the data flow from the assessment site to the DriveABLE host computer for scoring and quality assurance, and return of the outcome data to the assessment site computer for automated printing of the report



QA—quality assurance.

Table 1. The relationship between the In-Office cognitive assessment and the DORE outcomes

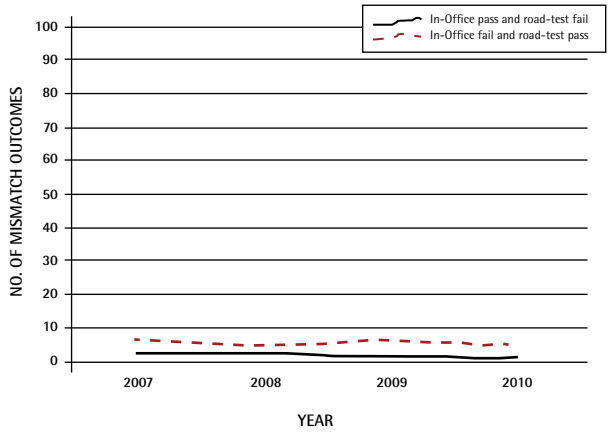
	ON-ROAD EVALUATION OUTCOME			
IN-OFFICE COGNITIVE ASSESSMENT OUTCOME	PASS, %	FAIL, %	BORDERLINE, %	TOTAL, % (N)
Pass	9.4	1.7	2.7	13.7 (504)
Fail	5.6	30.0	4.7	40.3 (1474)
Indeterminate	16.5	18.4	11.0	46.0 (1684)
Total	31.5	50.1	18.4	100 (3662)

DORE—DriveABLE On-Road Evaluation.

indeterminate and rightly went on to complete the DORE to determine driving competency.

Most important, the mismatches between the In-Office cognitive assessment outcomes and the DORE outcomes provide an explicit measure of the accuracy of the pass and fail outcomes of the In-Office cognitive assessment as a valid measure of driving competence. For the total sample, only 1.7% of the patients who received an In-Office pass outcome received a mismatching DORE outcome of fail. The errors for the fail outcome were somewhat higher but still low (5.6%). **Figure 2** shows that these low mismatch levels remained very stable across the 4 years. Regression analyses were performed on the mismatched data to evaluate possible year-to-year changes. The significance *t* test evaluates the obtained slope coefficient against zero. The In-Office fail error rate remained statistically stable ($t=-0.789$, $P>.429$). The trend for increased accuracy for the pass predictions was small but statistically significant ($t=-2.39$, $P<.016$).

Figure 2. Number of mismatches between In-Office cognitive assessment outcomes and road-test outcomes



DISCUSSION

The goal of this study was to evaluate the accuracy and stability of the DriveABLE cognitive assessment in extended clinical use. The low and stable error rates demonstrate that the assessment is highly accurate in identifying drivers with suspected or confirmed cognitive impairment who would pass or fail the DORE. This accuracy means the number of patients who would have needed to be road-tested could be reduced by more than 50%, thereby increasing road safety and reducing the cost of evaluations.

It is important to note that the data were obtained when the assessment procedure was in clinical use, with more than several thousand patients and across 19 different sites, with no attempt to reduce the variability or to increase the accuracy by selecting patients on any characteristic such as cognitive impairment pathogenesis, number and type of comorbidities, medications, or treatments. This was not a carefully controlled evaluation of the In-Office cognitive assessment, conducted in a research setting where the sample consisted of willing volunteers, with standardized clinical evaluations before referral, or specific inclusion and exclusion criteria intended to make the sample homogeneous or to enable factoring out medical condition pathogenesis or medication variability. In contrast, the accuracy of the In-Office cognitive assessment for predicting DORE outcomes was obtained with a substantial patient sample representing all the variation in patients who were evaluated by physicians as having clinically suspected or confirmed cognitive impairment and whose physicians had concerns about those patients' competence to drive. The size of the sample and multiple locations of the physicians and assessment service indicate assessment accuracy with patients representative of those whose family physicians can be expected to refer across diverse practice contexts.

Limitations

One limitation of this study might be that it was not accomplished by independent researchers. Thirty-four percent of the cases came from the Edmonton, Alta, office. However, the testing there was done in the context of an evaluation service and not a research validation study. The driving evaluator was blind to the result of the In-Office test result and both the In-Office and On-Road data were scored by computer. Most of the remaining patients were tested by health care or other professionals who used the DriveABLE assessment, but none was employed by DriveABLE.

Conclusion

The current research showing high and stable accuracy levels was documented using normal physician referral processes across multiple sites and years. The findings provide the evidence physicians need to be confident in using the recommendations from the DriveABLE In-Office cognitive evaluation to assist them in making accurate, evidence-based decisions about their patients' fitness to drive.

In addition, the use of a clinically validated, arm's length driving assessment allows family physicians to remain advocates for their patients, discussing assessment outcomes and next steps just as they would for x-ray scans, magnetic resonance imaging, or other diagnostic results.

Dr Dobbs is Professor Emeritus at the University of Alberta in Edmonton, and Chief Scientific Officer of the DriveABLE Assessment Centres in Edmonton.

Competing interests

Dr Dobbs was the principle investigator in the developmental phases of what is now the DriveABLE evaluation while he was a professor at the University of Alberta in Edmonton. He formed the DriveABLE Assessment Centres as a University of Alberta spinoff company, and now serves as Chief Scientific Officer.

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