Research Article

The DriveABLE Competence Screen as a predictor of on-road driving in a clinical sample

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Background/aim: There is growing concern regarding the need for screening of older drivers. The objective of this study was to determine whether the DriveABLE Competence Screen, a computerised test, predicts on-road driving outcome in clients referred for a driving assessment.

Methods: This retrospective study evaluated the predictive validity of pre-road testing using the DriveABLE Screen. Fifty-two clients with varying health conditions were consecutively referred to a private practice that conducts comprehensive driving evaluations. Screen results are classified as recommend cessation of driving, indeterminate (requires on-road evaluation), or no evidence of reduced competence. The DriveABLE Road Test classifies subjects as pass, borderline pass, or fail.

Results: Sensitivity, specificity, positive and negative predictive values were generated using the Road Test as the criterion outcome. The positive predictive validity of the Screen in identifying those who would fail the Road Test was 97% (n = 32 of 33). The negative predictive validity was 47%. The sensitivity was 76% with a corresponding specificity of 90%.

Conclusion: The DriveABLE Screen, when used as a case finding tool, is highly predictive of clients who will fail an on-road driving evaluation.

KEY WORDS aged, automobile driving, disability evaluation, evaluation studies, predictive value of tests, sensitivity and specificity, visual perception.

Introduction

The driving assessment process often begins when a physician or other professional refers a client to a driving evaluation service, where typically a trained occupational therapist with expertise in driver evaluation performs an assessment. It is common for this evaluation to include an off-road component consisting of motor, visual perception and cognitive tests, followed by an on-road evaluation. However, there is increasing awareness that an on-road evaluation should not be automatic, as some individuals may be too impaired to undergo on-road assessment. It would be logical if these individuals were detected through screening with the goal of either providing appropriate interventions, or recommending driving cessation.

If a relatively quick screening process could be shown to accurately identify those who are not safe; those who do not have the capacity to return to driving, and those who require specific interventions targeted at improving safe driving, this would have important implications for the driver assessment process. With these goals in mind we conducted two studies to determine the value of commonly used tests of visual perception in identifying individuals with stroke who would pass or fail an on-road driving test (Korner-Bitensky et al., 2000; Mazer, Korner-Bitensky & Sofer, 1998). In the first study (Mazer et al.), a single site study of nine visual perception and cognitive tests evaluated for their predictive value, the Motor Free Visual Perception Test (MVPT) (Colarusso & Hammill, 1996) was found to be the most predictive of on-road driving performance. The MVPT had a positive predictive value of 86% when a cut-off score of > 30 was used. In the second study, we again examined the usefulness of the MVPT, this time in six centres across North America (Korner-Bitensky et al., 2000). The positive predictive validity, when used across clinical settings, ranged from 48 to 77% — possibly in part because of large differences between centres in the on-road pass or fail criteria.

None of the above-mentioned tools were created specifically to assess the prerequisite skills important for driving. Other tools, developed specifically as pre-road...
tests of driving, have been evaluated. One is the Cognitive Behavioral Driver's Inventory (CBDI) (Engum, Cron, Hulse & Pendergrass, 1988) consisting of 27 tests of vision, perception and cognitive skills. In 56 persons with stroke, the CBDI accurately classified 66% as having either failed or passed the road test (Klavora, Heslegrave & Young, 2000): there was a high false negative, that is, 30% of those predicted to fail based on CBDI results passed the on-road test. Two issues arise regarding these findings. First, the authors use the term false negative that is somewhat confusing given the generally accepted use of the term. Commonly in screening this finding is termed a false positive, that is, an individual is identified as having a trait (usually a disease, or condition; for driving it would be poor CBDI results) but not having the trait based on the more detailed evaluation, the on-road assessment (Petticrew, Sowden, Lister-Sharp & Wright, 2000). Klavora et al.'s findings also raise concern because of their implications: the results suggest that a high percentage of subjects would have been forced to give up driving if the decisions were based solely on the screening outcome, when in fact, their on-road performance resulted in a pass. An additional hurdle to the use of the CBDI is its length in that it often takes an hour or more to administer. Also, some of the 27 tests are designed for exclusive use by specific disciplines. At times this has led to the use of only parts of the test in clinical practice, potentially lowering predictive value (Duquette, 2002).

Another tool, the DriveABLE Competence Screen (Dobbs, 1997), hereafter referred to as the Screen, is also specifically designed to test the prerequisite skills of driving. The Screen is accompanied by a standardised Road Test that has undergone preliminary validation (Dobbs; Dobbs, Heller & Schopflocher, 1998). During the tool’s development, Dobbs and colleagues identified the on-road driving errors that distinguish elderly drivers with cognitive decline from those of normal drivers and used these errors to develop the scoring system of the Road Test. Driving errors that were typically seen with equal frequency in three groups (young, elderly and cognitively impaired drivers) were not penalised as these were considered to be bad habits and not necessarily indicative of a decline in competence.

The DriveABLE has been used in Canada, the USA, Europe and more recently, has been adapted for use in Australia, specifically to reflect the left side/right side driving differences (personal communication with A. Dobbs, September 17, 2007). The question arises as to the value of using the Screen in a clinical driver evaluation service where clients present with diverse health conditions.

Thus, the objective of this study was to investigate the validity of the DriveABLE Screen when used in clinical practice. Specifically, we identified the sensitivity, specificity and positive and negative predictive validity of the Screen in identifying on-road driving performance (as measured using the standardised DriveABLE Road Test), of individuals with varying diagnoses who were referred for driving evaluation. In addition, we explored the contribution of potential explanatory variables on diagnostic accuracy.

**Methods**

**Participants**

Participants were consecutive clients referred to a driving evaluation service in Montreal, Canada, who underwent DriveABLE testing. They came from various referral sources, with physicians being the primary source. To be eligible for driving evaluation according to provincial licensure requirements, clients have to be free of medical conditions that legally preclude driving including: visual homonymous hemianopsia, a primary visual impairment inadequately improved by corrective lenses, cardiac status that poses a high risk for a cardiac event while driving, and uncontrolled seizures. The referring physician generally provides this information. Often an ophthalmology report is also available. In addition, individuals require a valid driver’s license or a temporary driver’s permit that enables them to undergo evaluation. Additional exclusion criteria were related to the Screen. Specifically, the Screen requires use of the dominant hand, so those with motor or sensory impairments of the dominant hand were excluded. Finally, those who received driver retraining between the assessment on the Screen and Road Test were excluded. All individuals referred for evaluation, regardless of diagnosis, were tested when their health condition was considered stable. For example, those tested post-stroke were considered to have completed their active rehabilitation phase.

**Sample size considerations**

The prevalence of poor Screen outcome was expected to be fairly high, as referrals for driving evaluation are usually made only once there is considerable concern regarding driving safety. This was an important consideration in determining sample size as prevalence of the trait being studied influences predictive values. Thus, while there were no specific calculations to indicate sample sizes for insuring accurate estimates (Irwig, Bossuyt, Glasziou, Gatsonis & Lijmer, 2002), it was anticipated that a sample of 50 subjects would result in a sufficient prevalence of both outcomes (pass/fail) to allow stable estimates of sensitivity and specificity and to a lesser extent, predictive values.

**Procedures**

Each client’s chart was systematically reviewed to extract information on eligibility (specifically that they had undergone both the Screen and the road test and had not had training between the two) and potential explanatory variables such as age, sex, diagnosis, and delay between the Screen test and Road Test. Research ethics approval was obtained from the Institutional
Review Board, McGill University, Montreal, Quebec, Canada.

**DriveABLE Competence Screen**

The Screen (DriveABLE Assessment Centres Inc., 1998) consists of a series of computer-presented tests that can be run on a standard computer with a touch screen monitor. The testing process requires no computer keyboard skills as most tasks require only the participant to touch the monitor or click a mouse button. There are six subtests measuring: motor speed and control, attention shifting, executive function, complex judgment, attentional field and component driving abilities. During testing, the subject is seated in front of a computer monitor and instructed to use the index finger of his/her dominant hand to either click the computer mouse or touch the monitor, depending on the standardised instructions provided by the evaluator. The total testing time is 35–50 min.

The motor speed and control subtest requires visual motor speed and coordination of the upper extremity. The attention shifting subtest requires sustained attention and concentration skills, as well as the ability to disengage from a task. The client is asked to indicate where the target was presented on the monitor by giving a response using the mouse. The executive function subtest requires the skills of reasoning, mental flexibility, memory and visual motor coordination. The complex judgment subtest evaluates judgment and decision-making skills. The attentional field subtest assesses speed of visual information processing, divided attention and selective attention. Finally, the component driving abilities subtest uses brief video presentations of actual driving situations. During the video presentation, an announcer briefly describes the driving scenario and poses a question. The client must choose the most appropriate answer by touching the monitor.

An experienced occupational therapist who was certified in driving evaluation tested the participants. She used standard instructions, provided either in English or in French according to the preference of the client. It is important to note that, while this occupational therapist observed each participant’s overall performance while administering the Screen, she was not responsible for scoring performance or classifying outcomes.

**Standardised Road Test**

The standardised Road Test (DriveABLE Assessment Centres Inc., 1998) was performed on a specifically mapped road course. As previously mentioned, the DriveABLE course is designed to assess driving situations that have been identified to discriminate between individuals who are medically compromised drivers and normal drivers with bad habits. Regardless of where a route is established, each is designed to evaluate the same driving behaviours and requires the same driving manoeuvres, thus enabling consistency across sites. The route includes left and right turns, merges, controlled and uncontrolled intersections and is graded, beginning with a low speed portion in a traffic-reduced area, proceeding to busy traffic situations and highway driving.

The Road Test was undertaken a week to 10 days after the Screen. During testing, a specialised driving instructor who was blind to the outcome of the Screen and an occupational therapist who had administered the Screen, but who was not responsible for calculating the results, accompanied the client in a midsize car equipped with a dual brake. A client with right hemiparesis was included in this study only if the person was left-hand dominant. If so, they were instructed on how to use the spinner knob placed on the left side of the steering wheel and the left accelerator.

The standard testing procedure for the Road Test is as follows. The instructor provides an introduction to the vehicle and proceeds with a standard series of instructions regarding the route, manoeuvres, etc. that the client is to follow. The average time taken to complete the route is about 50 min. The occupational therapist, who sits in the back seat, observes and records, on a standardised scoring sheet, a score for each specific manoeuvre on the route. This information is then entered into the computer program that allows calculation of outcomes based on the standardised algorithm (see below).

**Data analysis**

All information regarding potential explanatory variables was abstracted from the charts and entered into a computerised database, as were the results from the Screen and Road Test. To clarify, participants’ responses on the Screen are recorded by the computer program and sent via the Internet to the DriveABLE laboratory in Alberta, Canada, where they were analysed. Specifically, for each of the subtests, a Z score (+1, 0, –1, –2) is calculated in relation to the normal distribution of scores according to age. For the test as a whole, two results are provided: a percentage of predicted probability of failing the Road Test based on the Screen results and a classification into one of three recommendations: no evidence of reduced competency (pass), indeterminate range requiring a road test to resolve competency, or driving cessation (fail).

The three outcomes based on the client’s performance on the Road Test are: recommend pass, borderline pass, or recommend cessation (fail). Again, there is a validated DriveABLE algorithm used to determine these classifications based on the standardised written report submitted by the occupational therapist who evaluated Road Test performance.

To determine the Screen’s ability to correctly classify outcome on the Road Test, we created 3 by 3 tables, where the two variables of interest were the three potential Screen outcomes and the three potential Road Test outcomes.

To assist in health service delivery decision-making, it was also important to determine the proportion of
individuals who needlessly underwent the Road Test, defined as those in which the Screen results accurately classified Road Test results. Descriptive statistics were used to calculate these percentages. Sensitivity, specificity, positive and negative predictive values were then calculated (Kramer, 1988) by collapsing the categories into 2 by 2 tables to classify clients as failing or passing (pass/borderline pass) the Road Test and failing or not failing (indeterminate/no evidence of reduced competency) the Screen. To clarify, the sensitivity of the Screen was calculated as a/a + c that is, of all those with a trait (failed Road Test), the proportion identified by the Screen as having the trait (cessation recommended).

To explore the association between client-specific variables and on-road outcomes, Spearman’s rhos were calculated. Chi-square analyses were used to compare proportions: t-tests to compare means.

**Results**

**Participants**

Sixty-nine charts of consecutively assessed individuals were reviewed for eligibility. Seven individuals did not hold a valid driver’s permit and failed the Screen, so the decision was made not to apply for a temporary permit that would have enabled them to undergo the Road Test. Two people decided to discontinue driving based on feedback regarding poor Screen results. One individual underwent driver retraining between the Screen and Road Test. Six individuals were deemed to be highly unsafe to proceed to the Road Test based on their Screen results; an additional subject performed so poorly on the Screen that it could not be completed. The remaining 52 people had complete data on both the Screen and the Road Test.

The average age of the group was 71.6 (± 13.6) years, with a range of 29–93 years: 14 (27%) were female and 38 (73%) were male. The most frequent diagnoses were: potential or identified cognitive decline (n = 20; 38.5%); neurological conditions including stroke, traumatic head injury and Parkinson’s disease (n = 10; 19.2%); psychological conditions including schizophrenia, bipolar conditions, depression (n = 4; 7.7%) and other including orthopaedic conditions, rheumatoid arthritis, etc. (n = 18; 34.6%). This distribution is representative of the diagnostic prevalence typically reported by driving evaluation clinics across North America (Korner-Bitensky, Bitensky, Sofer, Man-Son-Hing & Gelinas, 2006).

**Screen results**

The classification of subjects according to their Screen and Road Test results are presented in Tables 1 and 2. The Screen correctly classified 67% (35 of 52) of subjects, that is, there was consistency between the Screen and the Road Test such that there was: a recommendation of cessation on the Screen and a fail on the Road test, or, an indeterminate on the Screen and a borderline on the Road Test; or, a Screen result of no evidence of reduced competence and a pass on the Road Test.

When variables associated with correct classification were explored including sex, age, diagnosis, and delay between the Screen and the Road Test, the proportion of males and females where the two test results concurred was similar as per the chi-square analyses: 64% for females and 68% for males. The delay between testing was shorter but not significantly so for those correctly classified by the Screen (x = 7.3 days, ±7.8 days vs x = 15.6 days, ±18.6; P = 0.09 using a two-tailed independent samples t-test with the assumption of unequal variance). When the analysis was redone with one outlier excluded, the analysis using the assumption of equal variance resulted in a P = 0.03. The mean age of those for whom the two tests were in agreement was 73.5 years (± 11.6) versus 67.7 years (± 16.5) when the tests did not concur: the independent samples t-test indicated a non-significant finding of P = 0.15. When we explored correct classification according to diagnosis, those classified as having neurological conditions were most likely to be correctly classified (n = 9 of 10). Correct classification was less likely with cognitive disorders (n = 13 of 20) and those classified as having other conditions (11 of 18). For

| TABLE 1: Participants’ classification on DriveABLE Screen and Road Test |
|-------------------------|------------------|------------------|
| On-road outcome         | Borderline | Pass | Pass |
| DriveABLE               | Recommend cessation | 32 | 1 | 0 |
| Outcome                 | Indeterminate | 9 | 2 | 4 |

| TABLE 2: Participants’ classification* on DriveABLE Screen and Road Test |
|-------------------------|------------------|------------------|
| On-road outcome         | Borderline | Pass | Pass |
| DriveABLE               | Recommend cessation | 32 | 1 | 0 |
| Outcome                 | Indeterminate and no evidence of reduced competence | 10 | 9 | 0 |

*With outcome dichotomised.
individuals with psychological conditions, of which there were only four, the Screen correctly classified two.

Of the 52 subjects, 19 (36.5%) were classified by the Screen as either indeterminate or no evidence of reduced competence. The remaining 33 (63.5%) failed the Screen, indicating that almost two-thirds of subjects would not have undergone a road test if a ‘fail’ on the Screen was used to make a final determination regarding driving competence. The pass rate on the road was low at only 19% (10 of 52 subjects).

The sensitivity of the Screen was 76%, that is, of the 42 subjects who failed the Road Test, 32 were classified as a recommended cessation on the Screen. The specificity was 90%: of the 10 subjects who passed the Road Test only one had been classified as recommended cessation. The positive predictive value of the Screen was 97%; of the 33 subjects where cessation was recommended, 32 failed the road test. Of the 19 classified as indeterminate or no evidence of reduced competence, nine passed the on-road test (borderline pass or pass) for a negative predictive value of only 47%.

Discussion

Occupational therapists, health authorities and licensing agencies are aware of an urgent need to identify standardised screening and assessment tools that will accurately identify those who are safe or unsafe to undergo on-road testing. The individuals studied here exhibited a high road test failure rate that is likely a reflection of how clients were identified. Typically, by the time a physician or family member becomes sufficiently concerned and refers the client for assessment, the situation is serious. It is also worth mentioning that there was a group who never completed the Road Test because they were deemed too dangerous based on their Screen results (16 of the 69 clients). Had these individuals been included in the analysis, the failure rate would likely have been higher and the positive predictive validity of the Screen would likely have approached 100%.

Our findings suggest that the Screen, when used in clinical assessment of clients with varying diagnoses, may have higher positive predictive validity compared to standardised paper and pencil tests such as the MVPT or Trails A and B (Korner-Bitensky et al., 2000; Mazer et al., 1998). However, given the high prevalence of on-road failure in this study group, the predictive validity should be explored in subsequent studies that include less severely impaired individuals. To clarify, statistically, sensitivity and specificity are not affected by the prevalence of the trait in the population under study and as such are likely to be stable in other samples. However, for any given sensitivity, the positive predictive value will be much lower when the prevalence of the condition (dangerous driving) is low.

This statistical issue leads to an important discussion point based on the potential use of the Screen in health service delivery. As mentioned earlier, the clients studied here were not healthy individuals for example, 80-year-olds who are screened as part of national or regional licensure renewal requirements. Rather, this group was investigated under the auspices of case finding, where case finding evaluates those in whom a concern has already been identified (Williamson, Smith & Burley, 1987). This distinction is essential given that screening of healthy subjects would likely result in a much lower prevalence of disability and this in turn would have affected the positive predictive values of the Screen. Thus, while the findings presented here begin to answer the question regarding the value of the Screen in the case finding process, there are still unanswered questions regarding its predictive value in population screening of healthy elders. Indeed, if future studies indicate that the Screen is highly predictive in a population screening situation, this will have important implications for licensing bodies that are currently trying to identify effective screening processes.

A major concern of any screening process is what happens when it produces errors. For example, if the Screen indicates that a client is in the fail (should not drive) category, but the Road Test would have revealed driving competence, this false positive result can be life altering for the client. This concern is a likely explanation for what we have identified to be a common clinician practice of putting almost everyone on the road. Unfortunately, this process, while arguably compassionate, is also potentially dangerous.

In this study, individuals with various health conditions underwent driving assessment. Some of this variability may have affected the results. The Screen was developed and validated for use on the elderly, primarily those with cognitive decline. However, the tool also measures visual–perceptual abilities that are commonly affected by neurological events and therefore is being used in clinical practice to screen individuals with a wide array of conditions. Indeed, of the four groups studied, the tool most accurately classified driving performance in those with neurological conditions.

A limitation of this study was that it was undertaken in only one driving centre and that the study was insufficiently powered to allow for subgroup analyses. It will be important to further examine the Screen’s ability to predict Road Test failure in routine clinical practice.

It is also important to consider the feasibility of using the DriveABLE internationally. Given that all the data are transmitted by Internet, the DriveABLE could be used anywhere with an Internet connection. This provides opportunities for international collaborations using consistent pre-road screening, road routes and standardised scoring. Given the tremendous variation in driver assessment practices (Korner-Bitensky et al., 1998; Korner-Bitensky et al., 2006), this is an exciting possibility. Also, given the leading role of the Australian research and clinical community in research related to predicting on-road

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performance and increasing the rigor of on-road testing (Di Stefano & Macdonald, 2003), its use would be one step towards combining our efforts internationally to advance the scientific evidence regarding driver assessment.

In conducting a study of this nature it is always important that the developers of the tool, especially if it is a for-profit product, be at arms length from the research. While the DriveABLE team programmed the algorithms from which we conducted the statistical analyses, they were blinded regarding which Screen and Road Test results matched.

Conclusion

As a predictor of on-road failure, the Screen was found to have excellent diagnostic properties in a sample of medically impaired drivers referred for driving evaluation. Other studies across various settings must substantiate these finding before supporting its use in clinical practice.

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