Process and Outcomes Evaluation Of Older Driver Screening Programs:

The Assessment of Driving-Related Skills (ADReS) Older-Driver Screening Tool

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16. Abstract

Physicians are one resource for identification of older drivers who may be at risk for decreased safe driving ability. However, physicians have not had the tools to make decisions about the safe driving ability of their patients. With this in mind, the American Medical Association (AMA), with support from the National Highway Traffic Safety Administration, published the *Physician's Guide to Assessing and Counseling Older Drivers* to provide physicians with background information and screening tools (the Assessment of Driving-Related Skills (ADReS)) for dealing with older driver issues among their patients. This study examines the effectiveness of the ADReS in identifying older drivers who may or may not be at an increased risk for unsafe driving by comparing on-road performance of participants with ADReS results. Tests of vision, cognition, and physical function were administered to older drivers. Researchers monitored a behind-the-wheel (BTW) test that included a range of roadway conditions. The prevalence of unsafe drivers, based upon the results of the global rating of the BTW, was 24.6 percent. Analyses of the sensitivity of the ADReS identified 100 percent of those participants who were found to be unsafe drivers. Analyses of the specificity of the ADReS suggested that 32.6 percent of this sample was identified as requiring an intervention yet passed the on-road test. Although the ADReS identified all who failed the BTW, the results of this study suggest that the ADReS may not be an efficient predictor of those who need a driving evaluation. Based on the results of this sample, this tool may need to be revised in order to provide physicians with a more effective screening method. The report contains specific recommendations for changes to the ADReS tool.

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INTRODUCTION

Due to the lack of acceptable alternatives to the private automobile and the negative consequences associated with driving cessation, many in the field of older driver safety have promoted the concept of enabling older people to drive safely for a longer period of time. One method to accomplish the goal is to identify older people with unacceptably high risk for crashes in order to provide them with opportunities to improve safe driving ability through driver assessment and rehabilitation programs and/or recommend the use of alternative modes of transportation.

Physicians are one resource for identification of older drivers who may be at risk for decreased safe driving ability. However, physicians have not had the tools to make decisions about the safe driving ability of their patients. With this in mind, the American Medical Association (AMA), with support from the National Highway Traffic Safety Administration, published the *Physician's Guide to Assessing and Counseling Older Drivers* [1] to provide physicians with background information and methods for dealing with older driver issues among their patients. The *Physician's Guide* discusses medical conditions and medications that may affect driving ability, and provides a State-by-State listing of State laws and requirements for driving (e.g., minimum visual acuity requirements for licensure). The *Physician's Guide* includes a screening tool, the Assessment of Driving-Related Skills (ADReS), designed to be administered by physicians, in their office, using non-specialized instruments. The ADReS can be administered in 10 to 20 minutes.

The purpose of this study is to examine the effectiveness of the ADReS in the identification of older drivers who may or may not be at an increased risk for unsafe driving. To accomplish this goal, the on-road performance of participants was compared to ADReS results.

BACKGROUND AND SIGNIFICANCE

A screening tool is generally used to detect the presence or absence of a disease, or rule out or rule in a condition. It has proved difficult to develop a screening tool for older driver safety that is evidence-based, valid, and clinically practical to administer.[2 3 4 5]

Many older drivers who seek driving evaluations from healthcare professionals do so too late in their driving careers for interventions to be effective.[6] Effective methods for screening older drivers may provide a means of earlier referrals for a driving assessment, when interventions may be more useful for prolonging safe driving ability. Perhaps the best person to provide screenings for an older driver may be the physician; and the best place is a stable, consistent environment such as the physician's office.[7]

Physicians and Older Drivers

Physicians frequently see patients with newly acquired medical conditions, exacerbation of chronic conditions, or after the onset of medical events. Many of these conditions have the potential to affect safe driving ability. Many people feel that physicians should be on the front lines of determining medical fitness to drive. However, the ability of physicians to determine whether or not a patient is safe to drive is likely to be overestimated by many.[7]

In a study by Marshall and Gilbert,[4] 523 Canadian physicians were surveyed about evaluation of older drivers. Physicians reported that they were lacking in knowledge with regard to medical conditions and their effect on driving and more than one-third of those surveyed never received specialized training. Other studies have found a lack of formal training, knowledge, assessment tools, and resources among physicians in order to assess fitness to drive.[8 9 10] In a meta-analysis by Molnar[3] to determine guidelines for screening and assessment of older drivers in a medical office, only level III evidence (consensus statements, expert opinions) was found. The author concluded, "There is no evidence based information to help physicians make decisions regarding medical fitness to drive."[3]

How do physicians address driving issues of older people? The Canadian Medical Association published the *Physicians' Guide to Driver Examination*[11]offering physicians practical guidelines to help assess fitness to drive. Now in its sixth edition and renamed *Determining Medical Fitness to Drive*,[12] one criticism of this guide is that it is not specific enough for practical clinical use.[2]

The AMA *Physician's Guide* is a comprehensive 226-page document that includes information on legal and ethical responsibilities of physicians, State-by-State licensing requirements (including reporting laws, minimal vision requirements, etc.), medications and medical conditions that may affect driving, and a chapter on counseling patients who are no longer safe to drive. Additionally, it describes the role of the driver rehabilitation specialist, should referral be warranted. In contrast to *Determining Medical Fitness to Drive*[12] and other physician resources, the *Physician's Guide* provides specific recommendations to guide the physician (2). One of these resources is the *Assessment of Driving Related Skills* (ADReS), a brief screening tool that can be administered in the office and consisting of easy-to-use tests. Physicians are encouraged to administer the ADReS to patients they suspect may be medically at-risk for unsafe driving.

The ADReS lists three "key functions" required for safe driving: vision, motor function, and cognition.[1] This tool represents a first step in guiding physicians in the decision-making process when the physician, and/or their patients and patients' families have concerns. Several of the ADReS tests have been associated with driving outcomes (i.e., crashes, citations, performance) but there is a lack of evidence with regard to the effectiveness of this combination of tests and this approach to older driver safety, thus suggesting that the ADReS battery needs further study prior to adoption or rejection.[2, p. 366]

Background: Key Functions and the ADReS

Tests of Vision

The ADReS uses two tests to determine visual abilities: confrontational field testing and the Snellen chart to determine visual acuity. Confrontational testing has several methods of administration. The ADReS employs quadrant testing in which the examiner and patient both close one eye, fix their gaze on each other's nose, and the patient is asked to identify the number of fingers the administrator is displaying in each of the quadrants of each eye. However, in a study comparing the sensitivity and specificity of seven types of confrontational methods, this style of testing was shown to be the least sensitive (35%) and was described as "inadequate" for detecting visual field deficits.[13]

Testing static acuity may have limited value as additional studies have shown that there is limited or no increase in crash risk between those with visual acuity scores of 20/40 and 20/70.[1, 14] The ADReS recommends an intervention when visual acuity is worse than 20/40 (corrected) and/or if any field deficits are identified during confrontational testing.

Tests of Motor Ability

To assess motor ability, the ADReS uses three measures: (1) the Rapid Pace Walk, (2) range of motion testing, and (3) the manual muscle test. The Rapid Pace Walk (RPW) is used as an indicator of gross proprioception and lower extremity strength.[1] This is a timed test in which the participant is required to walk a marked-off area of 10 feet, turn around and return to the starting point, using an ambulatory device if need be. The recorded score is the amount of time the participant takes to walk the 20 feet. Studies have shown an association between driving outcomes (e.g., performance, citations, crashes) and increased time to complete the Rapid Pace Walk.[15, 16] Two studies, each using a cut-off score of 7 seconds, found an increased relative crash risk of 1.25 to 2.0 for those participants exceeding the cut-off scores.[16 17] The ADReS recommends an intervention for those with cut-off scores greater than 9 seconds.

For assessing strength and range of motion, the ADReS uses practices similar to those used by American healthcare practitioners. However, the areas tested and method used for scoring ROM is less specific than normal practice as the AMA recognized that the extent to which ROM deficits interact with driving performance is dependent on compensatory techniques and the requirements of operating a particular automobile.[2] While the literature commonly addresses functional abilities in older drivers, there is a lack of evidence regarding the effects of strength and ROM deficits in older drivers on driving outcomes. Studies have, however, found that reduced neck ROM,[18] in conjunction with declines in vision[19 20] could cause problems at intersections.[17]

Tests of Cognition

To screen for cognitive deficits that might affect driving ability, the ADReS employs the Clock Drawing Test and the Trailmaking Test, Part B. The Clock Drawing Tests (CDT) is a simple measure of a range of cognitive functions[21] and has been shown to correlate with measures of cognitive functioning that require memory, attention, and executive skills.[22 23 24] The CDT may also be useful as a screening tool for mild cognitive impairment[25] or dementia.[26 27] The CDT has high correlation with other measures of cognitive functioning and is considered less time consuming than many of these other tests.[25]

In a study of 119 licensed drivers 60 and older,[28] the CDT was found to have a 90 percent accuracy rate for predicting driving outcomes, based on driving errors that occurred in a simulated driving environment. This CDT used a seven-point scale and those who scored less than five points had a higher number of driving errors ($p<.001$). The scoring method for the ADReS differs, however, and uses an eight-point scale, developed by the same authors. Those scoring less than perfect are recommended for an intervention.

The Trailmaking Test, Part B (Trails-B), is an easy-to-administer, timed, pencil-and-paper task that requires the participant to sequentially connect 12 alternate numbers and letters placed seemingly randomly on the page. This test of general cognitive ability also requires skills related to selective and divided attention, working memory, and visual processing[1] and has been correlated to driving outcomes in several studies.[29 30 31] The ADReS employs a cut-off score of 180 seconds to determine if a person should receive an intervention.

Although older-driver screening and evaluation tools should contain measures of cognition, [4 32 33] this combination of the CDT and Trails-B has not been evaluated[2] and there is little evidence of the effectiveness of the CDT in predicting driving ability.

The *Physician's Guide* provides scoring criteria for the ADReS, which been shown to have good interrater reliability (.82 to .91) in a pilot study examining agreement among different disciplines.[34] Based on cut-off scores, patients may be appropriate for an intervention, which might include a referral to other disciplines, receive medical intervention, provided with recommendations, or sent to a driving rehabilitation specialist for a comprehensive driving evaluation.

The Behind-the-Wheel Test

The behind-the-wheel (BTW) test of driving ability has been identified as the most appropriate method to determine driving competence and is the current criterion standard[35 36 37] as it assesses real-world behaviors. It is usually required to determine fitness to drive as current methods of clinical assessment are inadequate to determine all aspects of driving ability.[38] BTWs also have higher face validity, which is important to someone whose license may be at risk.[38] However, BTW performance measurement is often problematic as the scoring tends to be subjective and based on the evaluator's decision versus a quantifiable driving score.[39] It also represents a snapshot in time of performance and may not capture fluctuations in abilities that may occur throughout the day. Additionally, there is no single standard for road test routes and scoring. Whereas some evaluators may use a fixed road course, others may vary the route or just provide testing on the driver's commonly travelled routes. The BTW may be administered by a driver rehabilitation specialist (DRS) who is, most commonly, an occupational therapist, but may be conducted by driving school instructors, who, unlike occupational therapists, typically lack medical training and experience.

METHODS

Each research subject participated in a telephone interview where demographic, health-related, and other information was obtained; a clinical examination, which included ADReS administration; and an on-road test. The telephone interview was conducted by research staff at the University of Florida's National Older Driver Research and Training Center (NODRTC); the clinical exams and BTW were conducted at NODRTC's older-driver assessment and rehabilitation clinic, *Independence Drive*, by a DRS, a licensed, registered occupational therapist with more than four years experience in the field of driver assessment and rehabilitation.

Participants were recruited from among those seeking services at *Independence Drive* and from an older-person research recruitment pool. Inclusion criteria required that participants be 65 or older, hold a valid driver's license, meet Florida requirements for visual acuity (20/70, better eye) and fields (130° horizontal), and be seizure-free for at least six months prior to participation in the study. Since the ADReS employs the Rapid Pace Walk as one of its sub-tests, those unable to walk were excluded. Telephone consent to participate in the telephone interview was obtained and the participants were scheduled for a telephone interview. Telephone interviews were conducted by University of Florida researchers and staff.

The telephone interview had five components and took approximately 30 to 40 minutes to complete. The telephone interview started with the Telephone Interview for Cognitive Status (TICS),[40] which was designed to be an over-the-phone cognitive screen. The TICS is a brief, standardized test of cognitive function developed for use in situations where in-office screening is not efficient.[41] The test was standardized and validated for use with English-speaking adults 60 to 98 years old.[41 42] This test was found to be less affected by ceiling effects when compared to similar tests of cognition.[43] The telephone interview included questions on general demographic information, physical health, and medical conditions. The participant was asked about instrumental activities of daily living[44] and questioned on self-care, locomotion, and the motor section of the Functional Independence Measure (FIM).[45] The telephone interview concluded with the administration of a modified version of the Driving Habits Questionnaire.[46]

A pilot test of ADReS administration among three different types of clinicians (a physician, nurse, and an occupational therapist) found an 82 percent agreement across motor, visual, and cognitive tests, with higher agreement for the vision and cognitive tests (.93 and .95, respectively) than motor tests (.80).[47] The DRS administered all components of the ADReS to the participant and scored the results accordingly. The total time required for participation in the clinical exam was between 30 and 60 minutes. Administration of the ADReS followed the recommendations provided in the *Physician's Guide* and included the use of the ADReS score sheet.

ADReS Tests of Vision

The DRS tested participants' acuity using a 10-foot Snellen chart (this format is more likely to be used in a physician's office than the 20-foot chart). The client's acuity score was based on the smallest full row that they read correctly.[1] An intervention is recommended for clients whose visual acuity is worse than 20/40, corrected. Visual fields were tested and rated as "within normal limits" or "not within normal limits" and interventions were recommended for those found to have deficits in one or more quadrants during confrontational testing.

Tests of Motor Functioning

For the ADReS, the Manual Test of Range of Motion (ROM) included these components: neck rotation, finger curl, ankle plantar and dorsiflexion, and a combined measure of shoulder and elbow flexion. Performance for this combined measure was determined by asking the participant to imagine holding a steering wheel and making wide turns to the left and right. The examiner recorded a score of "within normal limits" or "not within normal limits" based on clinical judgment. The *Physician's Guide* acknowledged that the scoring was vague and performance on this test should be considered in conjunction with the performance on other aspects of the ADReS.[1] Within the ADReS scoring system, interventions were recommended if any of the tested body parts are scored "not within normal limits."

In clinical practice, Manual Test of Motor Strength (strength) is used to assess the ability of the participant to perform particular movements with or without resistance provided by the examiner. Training for such tests of strength is standard for medical professionals because it provides an understanding of where to explore for the causes of an individual's functional impairment. There are a total of 20 tests, 10 each on the right and left sides. Strength tests include shoulder flexion, abduction and adduction; wrist flexion and extension; hand strength; hip flexion and extension; and ankle dorsiflexion and plantar-flexion. Each joint tested receives a score ranging from zero (no muscle contraction detected) to 5/5 (normal strength). Interventions are recommended for clients who demonstrate strength less than 4/5 in any area tested. If an individual can not, for example, raise his or her arm above shoulder-level, testing is conducted in a "gravity-eliminated" position where the individual is lying down, and motor strength is generally rated lower. For this study, scores below 3/5 were rated as greater than or equal to 2/5 due to the inability to test participants in gravity-eliminated positions.

Tests of Cognition

Based on the ADReS system, a test of Trails B was administered. Consistent with the Trails B protocol, the examiner assisted the participant to correctly complete the test by pointing out errors. The total time taken to complete the task was recorded and interventions were recommended for clients requiring more than 180 seconds for task completion.

Following the protocols detailed in the ADReS system, we used a modified version of the Freund Clock Scoring for Driving Competency method[28 48] for the Clock Drawing Test. To do this, we employed eight specific scoring criteria, including having all the numbers inside the clock circle, correct placement of the clock hands based on instructions, and placing the numbers in correct order. Clients who achieved less than a perfect score were offered intervention.

Outcomes of the ADReS

Recommendations, based on the outcomes and the constructs of the ADReS, varied for each domain assessed. Results from acuity testing, for example, could lead to the outcomes of continued driving, restricted driving recommended, or referral to a DRS (provided acuity meets minimum requirements) or eye care specialist. Deficits in cognition could lead to more testing, referral to other medical specialist, the identification of the cause and provision of treatment, or referral to a DRS. For the purposes of this study, ADReS outcomes were scored as “no intervention” or “intervention” for each of the seven areas.

Other Clinical Tests

Because of the potential for detection of functional impairment that is available in other clinical tests, this study employed Useful Field of View (UFOV®, Visual Awareness, Inc.) tests to supplement the ADReS system. This computer-based test was used to measure visual processing speed, divided attention, and selective attention. Some research has suggested that the categorical score produced by this screening tool may be predictive of motor vehicle crashes of the older population.[49] At-fault crashes, specifically, were shown to be correlated with visual attention deficits as measured by the UFOV.[50] The UFOV also has shown moderate correlation with driving performance.[51]

The Behind-the-Wheel Test

The Behind-the-Wheel driving assessment was conducted by the DRS on a fixed course, which began in an empty parking lot and progressed with increasing complexity, from residential areas to an interstate, high-speed merge. The design of the road course followed recommendations from attendees of the International Older Driver Consensus Conference[52] and the Canadian Older Driver Consensus Conference. The course included a progression in complexity from simple to moderate to high complexity (e.g., more traffic signals, signs, roadway lanes, pedestrians, other vehicles), concluding after a high-speed merge on the local interstate.[39] Particular attention was given to roadway design elements that have been identified as “problematic” for older drivers.[53] The BTW test was scheduled between mid-morning and mid-afternoon to avoid rush hour and rescheduled if the testing period occurred during weather conditions that the DRS felt could affect the result. The course was designed to include at least three maneuvers in each complexity level. The BTW began with an acclimation period with the assessment vehicle (a 2005 Buick Century), which was equipped with an auxiliary brake, located on the passenger side of the car that could be used by the DRS when necessary. The participants then made simple maneuvers (e.g., parking) to become familiar with the test vehicle and began the road testing. The course required an average of 51.9 minutes (SD = 7.4) to complete the approximate 15 miles.[39]

After completing the BTW test, the DRS scored the participant's driving ability as: Pass, Pass With Recommendations, Fail But Remediable, and Fail, Not Remediable. Those achieving the highest grade were judged to be safe drivers who followed all the rules of the road and road signs and made no errors.

Drivers in the Pass With Recommendations group were thought to be safe, but might have made errors during the road test with lane maintenance, not coming to complete stops, not using turn signals appropriately, driving too fast or too slow, or/and blocking intersections during a left hand turn. They usually exhibited what the DRS interpreted as poor driving habits that could be changed. Drivers in this group received recommendations geared towards improving their driving. Recommendations included: always come to complete stops, use the turn signal for ALL turns and before a lane change, keep your vehicle within the lines, don't drive with the radio on (to reduce distractions), don't drive on highways or during rush hour, and don't drive at night.

Drivers who received the rating of Fail But Remediable, typically demonstrated poor driving skills that were often due to physical limitations. This group had potential to become safer drivers after training and some might have required use of adaptive driving equipment (e.g., hand controls). Other examples of equipment included supplemental mirrors for drivers who couldn't turn their heads to look for oncoming vehicles. The DRSs determined that some participants in this group had poor driving habits that could have been corrected through behind the wheel training and re-education of the rules of the road and road signs. A few participants in this category were referred to other healthcare professionals for additional care (e.g. a physical therapist to increase overall strength).

The final group included those who failed the road test and whose performance was thought to be irremediable and unsafe. Generally, they were unaware of their poor driving skills and had poor insight with their well-being. Some in this group had progressive or chronic disorders or diseases that interfered with their ability to drive safely. Training, the use of adaptive equipment or compensatory strategies would not have improved their driving ability. The DRS usually had to intervene (e.g., use the auxiliary brake, take control of the steering wheel) more than once or there was a dangerous incident that occurred during the road test. Participants in this group were reported to the State licensing agency.

Dangerous incidents resulted in automatic failure of the BTW test. Examples of incidents that were determined, a priori, to be classified as dangerous included: (1) striking another vehicle (parked or moving), person, bicycle or object (tree, mailbox) that leads to vehicle damage or injury; (2) an intervention by the DRS (e.g., braking the car or taking control of the steering) to avoid a potential crash; (3) driving on the left side of the road on a two-way roadway or continuously drifting to the right or especially the left and crossing the double yellow lines; (4) excessive aggressive driving; and (5) inability to operate basic vehicle controls (e.g., steering wheel, accelerator, brakes).

For portions of the analysis, these outcomes were collapsed into two levels: Pass (which included 1 and 2, above) and fail (which included 3 and 4, above).

Analysis

All statistical analyses were performed using SPSS, Version 15.0 (LEAD Technologies, Inc). To determine how well the ADReS is able to identify those who may or may not need intervention, the sensitivity and specificity was determined. To accomplish this, outcomes based on the scoring of the seven tests within the ADReS were collapsed into two levels: Intervention Recommended, and No Intervention Recommended. Additionally, the outcomes of the BTW, based on the DRS clinical judgment, were collapsed from four levels: Pass, Pass With Recommendations, Fail But Remediable, and Fail, Not Remediable, into two levels: Pass (categorical scores 1 and 2, above), and Fail (categorical scores 3 and 4, above). Collapse of these variables allowed us to create a 2x2 contingency table for sensitivity and specificity determination.

Sensitivity has been described as the proportion of those with a particular condition (e.g., unsafe driving ability) who test positive by the screening test (the ADReS). A highly sensitive test would correctly identify those with the condition in question. Sensitivity is calculated by dividing the number of true positives by the number of true positives plus the number of false negatives. These subjects all failed the road test and a proportion of these passed the screening tool. Real-world implications of a significant number of false negatives would be that the ADReS did not identify some of those who failed a road test and, therefore were unsafe drivers. A significant percentage of true positives would indicate a useful screening tool to identify those in need of further evaluation.

Specificity refers to the proportion of those who do not have a particular condition and test negative for that condition with the screening tool. Specificity is calculated by dividing the number of true negatives by the number of true negatives plus the number of false positives. For example, these participants all passed the road test, yet some of them failed the screening test. Implications of a significant number of false positives could be that the ADReS was used to refer people without the condition for an intervention or a costly driving evaluation and lead some people to stop driving (perhaps prematurely) without ever undergoing a driving assessment. A high percentage of true negatives would indicate the screening tool successfully identified those not in need of further assessment.

Whereas sensitivity and specificity describe how well the ADReS discriminated between participants who did and did not drive safely, a test's predictive value refers to how certain a particular test result relates to the probability of a particular person having that condition.[54] Positive predictive value is calculated by dividing the number of true positives by the number of true plus false positives.

Additionally, correlations were determined between the primary four-level driving outcome and ADReS components as well as the UFOV categorical score.

RESULTS

Sample Description

A total of 127 participants were recruited for this project. Of those, 120 completed the study. Participants' age ranged from 65 to 89 with a mean age of 74.7 (6.5) years. Just over half (55.1%) were male, and 61.3 percent of the sample had received a college degree. Ninety-four percent of the sample were white, non-Hispanics (Tables 1 and 2).

Table 1. Educational Level

	Frequency	Percent	Cumulative Percent
Grade 8	1	.8	.8
Grade 9	1	.8	1.7
Grade 12	16	13.0	15.1
Vocational training some college	22	17.9	33.6
Associate degree	4	3.3	37.0
College grad BA/BS	29	23.6	61.3
Professional school	1	.8	62.2
Masters degree	27	22.0	84.9
Doctoral degree	18	14.6	15.1
Total	119	96.7	100.0

Table 2: Race & Ethnicity

	Frequency	**Percent**
White	112	94.1
African-American	2	1.6
Hispanic	3	2.5
Asian	2	1.6
Total	119	100

Health status: This sample had a mean of 2.9 (2.15) medical conditions. More than 60 percent of the participants reported some sort of heart or circulatory condition, and arthritis was reported by 53.7 percent (Table 3). This group took a mean of 7.94 over-the-counter and prescription drugs daily.

Table 3: Reported Medical Conditions Condition	% Reporting This Condition
Heart disease	61.0
Arthritis	53.7
Other musculoskeletal	31.7
Have fallen within 6 months	20.3
Cancer	19.5
Other glandular disorders	17.9
Other neurological disorders	17.1
Urinary disease	17.1
Cataracts	17.1
Parkinson's disease	16.3
Dementia	13.0
Stomach or intestinal disorders	13.0
Other vision impairment	12.0
Diabetes	10.6
Respiratory disease	8.9
Glaucoma	8.1
Stroke	4.1

Functional and cognitive status: FIM Motor scores ranged from 71 to 91 out of 91 possible points with a mean of 89.96 (2.67). Seventy-four percent of the sample achieved the highest score. IADL scores ranged from 10 to a maximum score of 14 (mean= 13.65 (.86)), with 81.5 percent scoring the maximum points. MMSE scores ranged from 18 to 30 (26.57 (2.56)) with over half of the sample scoring 27 or more points.

Results of Driving Habits Questionnaire

Participants reported driving an average of 4,702 (SD 4,173) miles per year with a range of 156 to 27,768 miles. A majority of the sample (65.5%) said they had driven out of the county in which they lived within the previous month (Table 4). A high number of this group (94.9%) rated their driving ability as either “good” or “excellent” (Table 5). Fifty-nine percent reported they avoided driving in specific situations, most commonly driving during the rain (21.8%, Table 6).

Table 4: Responses (n= 123) to the question "Within the last month, have you driven out of the:"		
	Number Responding "Yes"	**%**
Region	14	11.8
State	31	26.1
County	78	65.5
City	83	69.7
Town	90	75.6
Neighborhood	103	86.6

Table 5: Responses (n= 123) to the question: "How would you rate your driving ability?"		
	Number	**%**
Excellent	43	36.1
Good	70	58.8
Average	4	3.4
Fair	2	1.7

Table 6: Responses (n= 123) to the question: "Do you avoid: "		
	Number Responding "Yes"	**%**
Driving in the rain	26	21.8
Driving at night	22	18.5
Driving alone	8	6.7
Making left turns across traffic	10	8.4
Highway merges	12	10.0
High-traffic roads	17	14.5

Results of the ADReS

The primary variables of interest were the results of the ADReS and the BTW test. Individual ADReS items were examined for overall sensitivity and specificity. Separate analyses were conducted for UFOV scores.

Tests of visual function: Only 6 participants were found to have visual field deficits during confrontational testing and 91.7 percent had binocular acuity levels of 20/40 or better as indicated by Snellen chart testing. All participants met minimal Florida acuity levels. According to the ADReS guidelines, 14 participants were indicated for intervention, 6 for field deficits and 8 for acuity levels worse than 20/40. Seven of these participants failed the BTW.

Tests of motor function: Sixty-one percent of the participants were found to have areas where range of motion was considered to be outside of normal limits. Deficits were relatively evenly dispersed among areas tested by the ADReS with many participants demonstrating ROM difficulties in more than two areas (e.g., hands and shoulders). Decreases in neck range of motion were most frequent (35%) This finding lead to 73 participants being recommended for interventions, 7 of whom failed the BTW test.

Nine participants had a muscle strength rating of less than four over five for any body part tested and were recommended for an intervention according to the guidelines. Of these, 5 failed the BTW test.

Times for the Rapid Pace Walk ranged from 3.23 to 16.1 seconds with a mean time of 6.05 (1.98) seconds. Seven participants failed to meet the cut-off of 9 seconds and were appropriate for an intervention according to the guidelines. Six of the 7 failed the BTW test.

Tests of cognitive function: Results for completion times of Trails B ranged from 42.9 seconds to over 16 minutes with a mean of 136.72 (134.44) seconds. Twenty-two people failed to complete the test within the allotted 180 seconds. Of these, 13 failed the BTW test.

Clock test results indicate that almost two thirds (60.3%) of the sample failed to draw a clock correctly, based on the modified Freund scoring technique. Of the 86 people who passed the BTW test, 43 received at least one error on this measure.

Overall, participants' performance during the ADReS administration would have resulted in 75.4 percent (n=86) of the sample being identified as appropriate for an intervention. Of these 86 subjects, 28 failed the BTW test (32.6%).

Results of On-Road Testing

Global ratings of driving performance provided by the driver rehabilitation specialist indicated that 26.0 percent achieved the highest rating (safe to drive with no recommendations). The DRS rated almost half of the participants (48.0%) passing but requiring recommendations to drive safely. Twenty-four percent were rated unsafe. Fifteen of these participants had potential to achieve safe driving abilities and were offered the opportunity for interventions geared to accomplish this goal. Fourteen participants were unsafe drivers with no potential for rehabilitation, and were advised to retire from driving (Table 7).

Table 7: Global Rating of Driving Performance		
Global Rating Score	**Frequency**	**Percent**
Pass, no recommendations	32	26.0
Pass with recommendations	59	48.0
Fail but remediable	15	12.2
Fail, not remediable	14	11.4
Total	120	100

Since one of the goals of many organizations and agencies is to prolong the safe driving careers of elders, post hoc analysis was performed to investigate differences in those participants classified as Fail but Remediable and Fail, Not Remediable. Correlations between group status and demographics, selected clinical measures, driving habits and functional measures were examined and comparison of means were determined for those associated. Interestingly, the only variables that were significantly associated and distinguished between group membership were the UFOV/s sub-test 2 score (-.584, p= .001) and UFOV categorical rating score (-.445, p= .02).

Prevalence, Sensitivity and Specificity, and Predictive Value of the ADReS

The prevalence of unsafe drivers, based upon the results of the global rating of the BTW, was 24.6 percent. Results of sensitivity calculations yield a value of 1.00, meaning that the ADReS identified 100 percent of those participants who were found to be unsafe drivers as determined by the global rating (Table 5). Specificity calculations yield a value of .326, meaning that 32.6 percent of this sample was identified by the ADReS as requiring an intervention yet passed the on-road test. The probability that an unsafe driver would be identified by the ADReS was also 32.6 percent (positive predictive value). The negative predictive value (the probability that an individual who passed the ADReS and failed the BTW) was 100 percent.

Table 8. Sensitivity and Specificity				
		On-Road Test		
ADReS		Fail	Pass	Total
	Fail	28	58	86
	Pass	0	28	28
	Total	28	86	114

Results of Correlation Analysis

Several measures were significantly associated with the primary outcome measure (Table 6). Among them, a strong correlation was found for the UFOV categorical score (r= -.624, p< .001) and moderate strength of association was found for total time for the Trailmaking Test, Part B (r= -.524, p< .001), total scores on the CDT (.486, p< .001), TICS (r= .466, p< .001), and whether the participant had range of motion deficits (r= -.457, p< .001).

Table 9: Correlation between Four-Level Global Rating Score and Selected Measures

Visual Acuity Deficit (yes/no)	-.166
Visual Field Deficit (yes/no)	-.225*
Rapid Pace Walk (seconds)	-.390**
Range of Motion Deficit (yes/no)	-.457**
Motor Strength Deficit (yes/no)	-.143
Trails B (seconds)	-.524**
Clock Test Total (total score)	.486**
UFOV (categorical score)	-.624**
IADL (total score)	.317**
FIM Motor (total score)	.145
TICS Total (total score)	.466**
MMSE Total (total score)	.358**

**significant at the .001 level (2-tailed); *significant at .05 level (2-tailed)

DISCUSSION

Summary

This study examined the relationship between the ADReS older-driver screening tool and the accepted standard to determine safe driving ability, the on-road driving test. The ADReS was successful in identifying all participants who failed the on-road test. However, ADReS scoring resulted in intervention recommendations for most of the sample. This was largely due to a high number of participants who made one error on the Clock Drawing Test. Sample size and sample selection likely affected the results of this study.

The Assessment of Driving Related Skills

Vision

Although there are many aspects to vision, the ADReS assesses distant visual acuity and visual fields only. The *Physician's Guide* acknowledges this shortcoming and suggests that contrast sensitivity, accommodation to changes in illumination, and glare recovery may also play a significant role[1] and, perhaps a more important role in driving. Confrontational quadrant testing is performed to assess for deficits in the inferior and superior, nasal and lateral quadrants of the eye. Although important, this method does not test vision along a lateral plane, the standard for which many States use to set their visual field minimum requirements. For this reason, peripheral vision testing may be more appropriate for the ADReS.

Motor Function

The finding that ROM was associated with safe driving ability in this study raises questions. First, in light of the fact that today's automobiles are virtually all equipped with power steering and brakes, it seems unlikely that range of motion deficits, other than restricted neck movements, would affect a person's ability to observe the driving environment and control an automobile. Additionally, there is a scarcity in the literature regarding ROM motion deficits affecting driving performance.

It should be noted that in the ADReS, only neck range of motion, finger curls, a combined shoulder and elbow flexion, and ankle movements are assessed. Additionally, the rating scale used (within normal limits/not within normal limits) could not be expected to identify any range of motion deficits that may exist within a person. Rather, it is designed to look for gross deficits that would likely have more impact on driving ability. It is possible that this form of ROM test, tailored to look at only those functions required for driving, is a sensitive and specific measure. At least it seems so when compared to other measures that screen in more than half the population (e.g., CDT) or detect deficiencies in only a small proportion of the sample (e.g., field testing).

Manual muscle testing may not be a useful measure for determining ability to drive. Modern automobiles have power-assisted steering and brakes resulting in little required effort to control an automobile. Whereas the range of motion test is dichotomous, per ADReS scoring, this test is very specific, requiring the rater to score each of 20 areas tested on a 0 to 5 scale. In the clinic, for clients whose muscle strength is less than 3/5, accurate determination of muscle strength has to occur in a gravity-eliminated position. This may require the subject to be tested while prone or supine. Even without having to test a patient in the gravity-eliminated position, this test is the most time consuming part of the ADReS. Since the association between strength and driving ability (or crashes) is questionable, its inclusion in a screening tool may have limited value. This is reinforced by the fact that only 9 of the participants received a recommendation for intervention, based on their strength score. For the purposes of driving a car, perhaps range of motion testing alone would be a sufficient indicator. Should strength testing be desirable in a screening tool, perhaps the 0 to 5 strength rating should be replaced with one more similar to range of motion testing ("within functional limits" or "not within functional limits") to increase the efficiency of administration. Additionally, it is not clear why some areas tested for strength are not tested for ROM. For example, hip flexion and extension are tested for strength only. In the clinic, strength can often be grossly assessed during range of motion testing. If the client can move the body part against gravity, the grade would be at least 3/5, according to the scale provided by the <u>Physician's Guide</u>. Therefore, if the range of motion test were administered prior to strength testing, and included all joints currently listed in both sections of the ADReS, this would screen out joints that did not require muscle testing. This is assuming that, given the power-assisted devices in today's cars, that a muscle strength grade of 3/5 (movement against gravity only) is sufficient to effectively operate an automobile safely.

Seven participants failed to meet the cut-off score of nine seconds for the Rapid Pace Walk. Of these, 6 of the 7 (85.7%) also failed the BTW test. However, of these 6 who failed to complete the RPW in the allotted time, 5 used mobility devices (3 canes and 3 walkers). Interestingly, no one other than these 7 participants used mobility devices in this sample.

Cognition

It was expected that the tests of cognition would be most predictive of BTW failure. Indeed, all cognitive measures used in this study were significantly correlated with the GRS. Trails-B is a widely accepted tool for use in screening tasks required for driving. Twenty-two people in this sample failed to complete the task within the 180-second cut-off score and, of these, more than half failed the road test. Although not likely to have affected the results, the ADReS uses a non-standardized version of Trails-B and does not provide a practice session beforehand, as is the protocol for Trails-B administration.

The Clock Drawing Test, for this sample, was found to be highly sensitive (92.9%). However, specificity was low (50%) as a majority of the sample (60.3%) received a recommendation for an intervention. The cut-off score of 7/8 may be too high and, in fact, is higher than that recommended by the developer of the scale.[48]

On-Road Testing

The finding that the DRS made recommendations to almost half of the sample is not solely indicative of the effects of aging, multiple medical conditions, and medications have on driving performance. Many of these participants may have always been poor drivers or have had bad driving habits. Many of us do not come to a complete stop at stop signs (i.e., “rolling stops”), for example.

The fact that the evaluator of the BTW was not blinded to ADReS results may be considered problematic. However, to ensure the safety of the BTW, it is necessary for the BTW to be knowledgeable about a client’s deficits in order to be alert for their effects in the driving environment. Additionally, the high correlation (.98, $p<.001$) in global rating scores between two BTW evaluators, one of whom was blinded, shown in a study by Justiss[39]suggests blinding is not necessary.

Participants were classified into four groups based on BTW performance. Surprisingly, the post hoc analysis between the groups that received a rating of “Fail but Remediable” and “Fail, not Remediable,” did not yield any difference in group membership for all demographic, functional and driving habit variables. It was suspected, from a clinical perspective, that the former group would have more physical limitations while the latter cognitive deficits. The UFOV categorical score and sub-test two were able to differentiate between groups, but the data yielded no information about the factors that sets these two groups apart. It is probable that the relatively small sample sizes of these groups (n= 15 and 14, respectively) prevented achievement of sufficient statistical power.

Other Measures

The UFOV was strongly associated with driving performance outcomes and has also been shown to be predictive of crashes.[49] However, the costs associated with purchasing the UFOV could be prohibitive for physicians and, possibly, licensing agencies. The two cognitive measures used in conjunction with the ADReS tools (TICS and MMSE) were both associated with the GRS, as well. Although more time-consuming than the MMSE, the TICS, which was more strongly correlated than the MMSE, can be administered over the phone. The ability to obtain a cognitive screening score prior to an office visit may provide useful information with regard to the necessity to screen for driving ability.

Study Limitations

This study had several limitations. Foremost, this study included mainly self-selected participants. The fact that participants were given the knowledge beforehand that failure of the BTW test would result in a report being sent to the Florida officials likely influenced participation. In a similar study being conducted by NODRTC, it is estimated that less than 10 percent of patients referred by physicians for a driving evaluation followed through with the recommendation. The relatively small sample size likely also affected results.

A major limitation to this study, with regard to ADReS intervention recommendations and resulting sensitivity and specificity reporting, was the absence of the clinical decision-making process. Although the ADReS has very specific scoring criteria for determining whether or not an intervention is warranted, the selection of the type of intervention would be based on clinical decisions. Therefore, it is not known if a clinician would refer a patient whose ADReS results indicated an intervention for a comprehensive driving assessment. This decision would largely be based on the clinician's knowledge and/or the geographic availability of this service.

This sample was underrepresented by minorities with only 4 participants of non-White status. Additionally, this group was highly educated, as 44 percent held either a masters or doctorate degree, and was relatively well functioning as indicated by upper scores in the functional status measures used here.

Conclusions

Although the ADReS was designed to be administered in 10 to 20 minutes, many physicians have reported that they do not have the time for its administration (Dr. Joanne G. Schwartzberg, director, Department of Geriatric Health, American Medical Association, 2005, personal communication). Although the ADReS identified all who failed the BTW, the results of this study suggest that the ADReS may not be an efficient predictor of those who need a driving evaluation. Based on the results of this sample, this tool may need to be revised in order to provide physicians with a more effective screening method.

Specifically, based on this sample, strength testing could be eliminated. Strength testing may no longer be an important issue given the decreased physical requirements of operating a modern automobile. Elimination of this test would also decrease the time required to administer this test, especially for patients who had to be tested in gravity-eliminated positions.

The ROM test was associated with the driving outcome. Range of motion deficits in particular body parts that may interfere with the basic requirement of maneuvering a car (i.e., turning head to check for traffic, turning steering wheel, using accelerator and brake) are good candidates for interventions. A logical intervention, in many cases, would be a referral to a DRS, who has the medical background to determine if the client would benefit better by compensation (e.g., the use of adaptive equipment) or remediation (e.g., to increase range of motion).

Future Research

There are many entities involved with enabling older people to remain safely mobile, which includes extending safe driving. Those involved with older-driver screening (e.g., motor vehicle departments, physicians) and assessment (e.g., DRS) need to have clinically administered tools that are indicative of safe driving abilities and performance. The findings that the ADReS may have significant weaknesses, both in administration and prediction, focus on the need to enhance this tool's effectiveness. Perhaps other clinical exams, proven to be more useful, could be substituted for some currently used in the ADReS to accomplish this goal.

More research is needed to understand the role that each component of vision plays in the ability to operate a car safely. Perhaps other aspects of vision (e.g., glare recovery, dynamic visual acuity, contrast sensitivity) are more important to assess than the accepted standards of distant static acuity and fields. The extent to which acuity and fields contribute to driving ability, and the interaction of the two, also needs to be examined. Results would have implications for minimal vision standards, which vary considerably among States.

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