Published in final edited form as:

Neurology. 2008 April 1; 70(14): 1171–1178. doi:10.1212/01.wnl.0000294469.27156.30.

A Longitudinal Study of Drivers with Alzheimer Disease

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Abstract

Objective—The goal of this study was to define the natural progression of driving impairment in persons who initially have very mild to mild dementia.

Methods—We studied 128 older drivers, including 84 with early Alzheimer's disease (AD) and 44 age-matched control subjects without cognitive impairment. Subjects underwent repeated assessments of their cognitive, neurological, visual and physical function over three years. Self-reports of driving accidents and traffic violations were supplemented by reports from family informants and state records. Within two weeks of the office evaluation, subjects were examined by a professional driving instructor on a standardized road test.

Results—At baseline, AD subjects had experienced more accidents and performed more poorly on the road test, compared to controls. Over time, both groups declined in driving performance on the road test, with AD subjects declining more than controls. Survival analysis indicated that while the majority of subjects with AD passed the examination at baseline, greater severity of dementia, increased age, and lower education were associated with higher rates of failure and marginal performance.

Conclusions—This study confirms previous reports of potentially hazardous driving in persons with early AD, but also indicates that some individuals with very mild dementia can continue to drive safely for extended periods of time. Regular followup assessments, however, are warranted in those individuals.

While there is a general consensus that persons with moderately severe dementia should not drive,^{1,2} there is also evidence to suggest that not all persons with dementia are incompetent drivers, particularly in the earliest stages of disease.^{3–6} Many experts believe that, because patients with AD may still be competent to drive if their dementia is in its earliest and mildest stage, and because driving is an important factor in maintaining autonomy for older people, licenses should not be revoked by arbitrary decisions based solely on a driver's memory ability.

Performance based testing has been recommended to determine driving competence in at-risk individuals,² yet the cost -benefit in terms of time and expense of adopting such

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Disclosure: The authors report no conflicts of interest.

Dr. Ott and Dr. Papandonatos of Brown University performed the statistical analyses.

widespread testing cannot be determined without more information on the predictable course of decline in driving ability in persons with dementia.

The goal of this study was to examine the natural history of decline in driving ability as AD progresses from very mild to moderate stage disease in order to gain insight into the onset and factors associated with driving impairment among AD patients. Such information is needed to inform public policies and assist in the future development of valid assessment tools and intervention programs.

METHODS

Drivers with early stage AD were enrolled in this study and followed every six months over two to three years. A professional driving instructor administered a valid and reliable road test protocol. Data on crash and traffic violations before and during the course of the study were collected to further assess the potential public safety implications of the data. A control group of cognitively intact older drivers was included to provide a comparison with age-related decline in driving ability. Driving ability was defined by performance on the standardized road test.

AD participants completed the office and road tests at 6-month intervals over three years. Healthy control participants completed the office and road tests at baseline and at 18 months.

Subjects

We enrolled 134 older drivers, including 66 with probable AD, 23 with possible AD, and 45 controls without cognitive impairment. Enrollment occurred between April 2002 and March 2005. The last study visit was in March 2006.

Of those patients approached who met inclusion criteria, 52.6% agreed to participate in the study. The likelihood of participation was not correlated with score on the Mini-Mental State Examination (MMSE),⁷ education, gender, age, or a clinician-rated measure of dementia insight.⁸

All subjects had valid drivers' licenses. All patients were recruited from the outpatient practices of the Rhode Island Hospital Memory Assessment Program and the Memorial Hospital Alzheimer's Disease and Memory Disorders Center. Control subjects were recruited from the patients' family and friends. All subjects were between 40 and 90 years of age. All subjects signed a document of informed consent approved by the Memorial Hospital and Rhode Island Hospital human subjects committees before their participation.

Alzheimer diagnoses by the study neurologist (B.R.O.) were based on the NINCDS/ADRDA diagnostic criteria. All AD subjects had a Clinical Dementia Rating⁹ (CDR) = 0.5 or 1, indicating very mild or mild dementia. All normal subjects had a CDR=0 and a MMSE > 26. Subjects with mild cognitive impairment,¹⁰ but no impairment in activities of daily living, were excluded. The neurologist completed the CDR and MMSE before the subjects were examined with a battery of neuropsychological tests during one clinical office visit. Study procedures and methods for the office assessment and road test have been previously described in reports using baseline data from the longitudinal study.¹¹⁻¹⁴

Diagnostic laboratory tests were performed in all AD subjects including serum cobalamin, chemistry panel, thyroid function tests, syphilis serology, complete blood count, and brain imaging (computed tomography or magnetic resonance imaging) to exclude reversible

causes of confusion other than AD. Brain imaging must have been done at a time following onset of dementia.

Exclusion criteria included reversible causes of dementia and physical, ophthalmologic, or neurological disorders other than dementia that might impair driving abilities. Subjects with hypothyroidism or vitamin B12 deficiency were permitted if they showed progressive decline in cognition and function despite at least six months of adequate replacement therapy. Major physical handicaps such as frozen joints, inadequately healed fractures, monocular blindness, and amputation were exclusionary. In all subjects, corrected visual acuity was at least 20/40 on eye chart testing, and visual fields were normal on confrontation testing. Psychiatric disorders were exclusionary, including mental retardation, schizophrenia, bipolar disorder, or history of alcohol/substance abuse within the past year. Depression was allowed if it was controlled with medications. Symptomatic anti-dementia drugs (e.g. cholinesterase inhibitors) as well as antipsychotic and anxiolytic medications were permitted, but dosages were required to be stable for at least six weeks prior to entry into the study. AD subjects with a recent history of at-fault MVA during the period of their illness were also excluded from participation. MVA's were not exclusionary for controls.

Six subjects (five with AD and one control) were excluded from analysis because they did not perform a baseline road test. Three completed the clinical office visit but did not return for the road test. Two subjects failed screening criteria, and one subject experienced a stroke prior to the scheduled road test. Two subjects were terminated from the road test before completion for safety reasons; however, their data were retained, because they had a global road test score.

Among the 84 remaining AD subjects there were 52 with very mild dementia (CDR 0.5) and 32 with mild dementia (CDR 1). Of these, 61 were diagnosed with probable AD and 23 were diagnosed with possible AD. Mean MMSE for the AD group was 24.1 ± 3.6 (range 15–30). Other demographic data for the study sample are presented in Table 1. As expected, there were significant differences between AD subjects and controls for MMSE, education (controls more highly educated), miles and trips driven per week (both more frequent for controls), and road test score (less impaired for controls).

Road Test

Within two weeks of the clinical assessment, participants were administered an on-road driving test by a professional, experienced driving instructor (15 years of licensed, full-time work as a driving instructor and trained in the evaluation of neurologically disabled drivers). The road test was based on a published and reliable driving test, the Washington University Road Test⁴ adapted for comparable streets in Rhode Island. Although the streets were different, all the same maneuvers and identical scoring procedures were used in order to produce a comparable test procedure for Rhode Island.

The test was administered during daylight hours under good conditions (no precipitation or wet roads) on local streets in Pawtucket and East Providence. The instructor was blind to the participants' diagnosis. A 10–15 minute pre-test was completed in the parking lot prior to the actual road test to insure that the test was safe to perform and to familiarize the participant with the car and the instructor. The actual road test lasted approximately 45 minutes. Participants received an on-road driving score based on safe completion of each of the required maneuvers, ranging from 0 (best score) to 108 (worst score). The instructor also made a trichotomous global rating of the participant's driving ability as safe, marginal, or unsafe. The "marginal" global rating was given to subjects who passed the road test but for whom the instructor had specific concerns about their driving practices or ability. The

driving instructor shared those specific concerns with the study participant upon completion of the road test and included them in his report to the principal investigator.

Subjects who failed the road test were allowed to take the road test again once, if they felt they were too anxious during the examination. If they declined retest or failed the retest, they were advised to stop driving. A letter of recommendation to stop driving was mailed to the patient and caregiver as well as the primary care physician for all who failed the final road test. All of the participants who received such advice followed it.

Inter-rater reliability for 20 participants (rated by a second professional driving instructor in the back seat) yielded moderate to substantial agreement for the global rating ($\kappa=0.65$). Intraclass correlation coefficient between the two raters (r) for the total on-road driving score was 0.82. Only the global rating was used for the subsequent analyses.

Crash and Violation Data Collection

The history of motor vehicle crashes and traffic violations during the previous three years was obtained from the subject and their informant by interview at the baseline visit. During the course of the study, the subject and informant kept a log of any accidents and violations that were reported at the time of their study visit, as well the number of miles driven and trips taken each week. This self-report data was supplemented by reports obtained from the motor vehicle registries in the states where the subjects were licensed, since previous reports suggest that these two methods of data collection are complementary and ensure more complete capture of these relatively infrequent events.¹⁵

Analyses

Among 64 road tests in controls, there were no re-tests. Among 248 road tests in AD subjects there were 27 additional re-tests (10.9%). For purposes of analysis, the result of the retest was included as the final outcome.

Group comparisons for baseline and 18-month characteristics were made using Student's *t*-test for continuous variables and Chi square for categorical variables. All of these analyses were performed using Stata 9.2. Crash rates were calculated as number of Motor Vehicle Accidents (MVAs) per driver per year for the patient and control groups. Adjustments for miles driven were made for actively driving participants based upon their driving diaries during the preceding six months. Comparisons of MVAs per miles driven were based on fitting a Poisson regression model for accident counts using the generalized linear modeling capabilities of Splus 6.1, using miles driven as an offset variable. Significance levels for group comparisons were calculated using likelihood ratio tests.

Survival analyses were performed using Splus 6.1 to examine time to failure within the patient group, stratified by baseline CDR score. Failure was defined as either first or second time of obtaining an unsafe rating on the Road Test ($N=39$), an at-fault MVA ($N=1$) or withdrawal from the study due to dementia ($N=17$). Patients who were deceased ($N=1$), withdrew consent ($N=3$), were terminated for other reasons ($N=5$) or were otherwise lost to followup ($N=3$) were censored at the point of loss. Because of the rolling enrollment procedure, subjects that entered the study after March 2003 ($N=15$) could not have completed all study assessments; such subjects were also censored at the date of their last study visit. Survival curves for each CDR group were estimated using the Kaplan-Meier Product Limit estimator. Overall differences in the survival curves were assessed using the Log-Rank test. Cox proportional hazards models were used to adjust for potential confounding variables between the CDR groups due to baseline differences in age, gender, educational level, and driving experience.

RESULTS

The number of study participants at each study visit is presented in Table 2, subdivided according to CDR. As expected, subjects progressed in dementia severity during the initial phase of the study, as indicated by a declining percentage of subjects with CDR 0.5 and an increasing percentage of subjects with CDR 1 over time. This trend varied during the later phase of the study as subjects converted to more advanced dementia and dropped out. Although a CDR of 2 was exclusionary for study entry, a small number of subjects were examined with this stage during the study, after they progressed from CDR stage 1.

Normal controls were re-examined only at study midpoint (18 months). None of the 22 control subjects who returned for the second study visit had converted to CDR 0.5. The reasons for 22 controls (50%) not participating in followup testing at 18 months were not collected. Two AD subjects failed the pre-test in the parking lot, and were recorded as road test failures. Reasons for non-participation in followup testing at 18 months for 56 AD subjects were 1 for death, 2 for withdrawal of consent, 2 for loss to followup, 1 for at-fault MVA, 31 for failure on the road test, 11 for dementia based on decision of the family, 4 for other reasons, and 4 due to late entry into the study. The remaining 28 had at least one additional visit related to the study end date. Thus, 77% (43/56) of early terminations at 18 months were due to either hazardous driving or dementia progression.

Global road test scores at baseline and 18 months are shown by group and by CDR membership in Tables 3–5. The 18-month data reflect the performance of the remaining subjects who were judged safe enough by caregivers and the driving instructor to be examined at that time. At the 18-month visit, two patients and one control completed the office visit, but did not perform the road test. As expected, patients were more likely to fail the road test than controls, and CDR 1 patients were more likely to fail than CDR 0.5 patients. Control and patient groups both declined in performance at 18 months. At baseline and at 18 months, however, only 15% of patients failed the road test. The failure rate for CDR 1 was 22% at baseline as well as at 18 months.

The longitudinal change in driving ability for subjects based on their initial CDR rating is shown in Figure 1. In this survival analysis, safe and marginal groups were combined to contrast them with subjects who were not able to continue driving because they were judged unsafe due to road test failure, at-fault MVA, or dementia progression. The log-rank test ($p=.026$) indicated significant differences in the survival functions between the two CDR groups, with patients in the CDR=0.5 group consistently less prone to failure throughout the entire study period. In particular, patients in the CDR=0.5 group had a median time to failure of 605 days (95% Confidence Interval [CI] =391–925), whereas patients in the CDR=1 group had a median time to failure of 324 days (95% CI =196–562). Cox proportional hazard regression show that the hazard of failure in the CDR=1 group was 3.5 times higher than in the CDR=0.5 group (Hazard Ratio (HR) = 3.51, 95% CI = 1.09–11.32), after adjusting for differences in age and gender composition, educational level and years of driving experience.

Although neither gender ($p=.690$) nor years of driving experience ($p=.110$) reached statistical significance, patient's age in years ($p=.018$) and educational level measured by years of schooling ($p=.036$) were significant predictors of failure. In particular, the hazard of failure increased by about 6% (HR=1.06, 95% CI=1.01–1.11) for every year by which a subject's age exceeded the average age of the patient group (75.7 years), and by about 10% (HR=1.09, 95% CI=1.10–1.19) for every year by which the subject's schooling lagged the average educational level of the patient group (13.9 years).

As expected, a higher percentage of the patient group had experienced MVAs in the three year period before study enrollment (18% vs 11%, $\chi^2(1)=.50$, $p=.481$), though the difference was not significant. There were significant differences at baseline between the patient and control groups for total MVAs after correction for actual miles driven per week (8.78 MVA per 1,000 miles in the patient group versus 1.86 MVAs per 1,000 miles in the control group, $\chi^2(1)=8.81$, $p=.003$).

During the initial 18-month study period, a significantly higher percentage of normal controls experienced motor vehicle accidents (11% vs 1%, $\chi^2(1)=4.61$, $p=.032$). However, this difference was not significant after correction for miles driven (1.85 MVAs per 1,000 miles driven in the patient group versus 5.63 per 1,000 miles driven in the control group, $\chi^2(1)=1.91$, $p=.167$). The MVA rate per driver per year was .01 for patients and .06 for controls during the three-year study period, based on self-reports or state reports, compared to .06 for patients and .04 for controls at baseline. After the 18-month visit, i.e. between 18 and 36 months, there was one MVA from self-reports and state reports for the patient group compared to three MVAs from state reports for the control group; however, the number of persons still driving was small by that point. Overall, during the three years of the study, there were two MVAs in the patient group and five in the controls reported on state records.

The causes of MVAs were diverse. Among the patients, during the three years leading up to the study and the three years of the study, there were five rear-end, five intersection, one parking, and eight other accidents. Among the controls, during the same period of time, there were two parking, one intersection, one rear-end, and six other accidents (including one striking a pedestrian).

Occurrence of traffic violations between control and patient groups per miles driven per week were comparable at baseline (1.60 violations per 1,000 miles driven in the patient group versus 1.52 violations per 1,000 miles driven in the control group, $\chi^2(1)=.46$, $p=.5$). Neither group reported any violations in the initial 18-month study period.

It is important to note that long-term outcomes in the AD group, including road test scores and MVAs, largely reflect the performance of the best drivers who remained after many others were previously terminated for safety reasons (see Figure 1).

DISCUSSION

This longitudinal research project examined changes in on-road driving performance among actively driving subjects with early AD. It is well recognized that dementia is a risk factor among the elderly for motor vehicle crashes and fatalities. Degenerative dementias such as AD, because of their progressive nature, eventually lead to driving incompetence in all cases. A critical question that faces clinicians in everyday practice is when to advise patients with early disease to abstain from driving.

Initial recommendations from researchers suggested that all persons with a diagnosis of dementia such as AD should have their licenses revoked.^{16–19} In response to this idea, some experts have asserted that the decision whether or not to renew a license in an elderly driver should be based on competence rather than age per se or medical diagnosis.^{20–23} The Alzheimer's Association similarly stated, "The diagnosis of Alzheimer's disease is not, on its own, a sufficient reason to withdraw driving privileges. The determining factor in withdrawing driving privileges should be an individual's driving ability."²⁴

Several professional organizations and consensus groups have published recommendations regarding driving and dementia. Among those that discuss severity of dementia, all recommend cessation of driving for those with moderate to advanced dementia; however,

consensus is lacking regarding those with mild dementia.¹ Most of the published guidelines note that driving abilities are unclear in patients with mild dementia and often recommend professional assessment of driving impairment.^{25–28} Some guidelines have recommended those with a history of traffic accidents, spatial or executive/judgment impairment be particularly scrutinized.^{25,26,28} In contrast, the American Academy of Neurology's guidelines suggest that those with a Clinical Dementia Rating of 1, indicating mild dementia, should not be allowed to drive.² More recently, the position statement from the American Association for Geriatric Psychiatry affirms the American Academy of Neurology position regarding drivers with AD, suggesting "discontinuation of driving should be strongly considered for all patients with AD, even in mild dementia."²⁹

Our experience confirms previous reports that on-road performance testing of drivers with mild dementia can be safely and reliably conducted.^{4,30} Furthermore, our data confirm observations made in the longitudinal study of drivers with dementia performed at Washington University.³¹ In both studies, normal elders as well as drivers with dementia declined in driving ability over 18 months, though not as severely. Therefore vigilance and re-assessment of driving competence should be considered for all older drivers, regardless of whether or not they have cognitive impairment.

Though both studies clearly demonstrate that persons with mild dementia are often potentially hazardous drivers, many can still pass a road test. The Washington University study group found that 59% of drivers with CDR 1 passed the road test at baseline, and we found that 78% with CDR 1 passed. Therefore, we agree with their statement³¹ that the Quality Standards Subcommittee of the American Academy of Neurology guideline is too restrictive. This practice guideline was based on a review of the literature in which samples from earlier published studies were converted to CDR severity scores. The CDR conversion process may have been biased towards rating patients as less severely demented than they actually were. This in turn may have led to the discrepancy between the American Academy of Neurology recommendations and those from other professional organizations. We suggest that the American Academy of Neurology guideline be revised to be more consonant with guidelines from other organizations, regarding drivers with mild dementia.

Probably the most challenging assessment and decisions for the physician lie with the patient who is questionably or only very mildly demented. Our CDR 0.5 group performed closely to the CDR 1 group at baseline, probably because we included only patients believed to have very mild AD rather than mild cognitive impairment¹⁰ in the CDR 0.5 group. Despite their similar performance at baseline, however, the CDR 1 group had a hazard of failure that was almost four times higher than that of the CDR 0.5 group, and had a median time to failure that was almost twice as fast as that of the CDR 0.5 group (i.e., 324 vs. 605 days). Taken together, these findings suggest that in contrast to the CDR 1 group, very mild AD patients (i.e., CDR 0.5) can continue to drive safely for an extended period of time, and that greater efforts need to be focused on identifying the specific demographic, behavioral, and cognitive factors that are associated with risky driving in this population. In the present study, for example, both age and education level were additional predictors of failure.

Crash data from this study reflect small numbers of events in a limited sample size, and should therefore be interpreted cautiously. They do reveal, however, some interesting correlations with previous data as well as new insights into the magnitude of the public safety hazard posed by drivers with dementia as well as the potential impact of a formal driving assessment program. Our retrospective frequency of crashes (.06 for dementia drivers and .04 for controls) is comparable to previous reports.^{22, 32–35} As previously stated, the observation that frequency of crashes prospectively declined among dementia drivers and increased in controls likely reflects the fact that many dementia drivers stopped driving

completely during the course of the study or reduced the number of miles they drove, while the controls continued to drive but declined somewhat in their driving ability over time.

Interestingly, there was a decline in frequency of crashes in the actively driving dementia subjects in our study, even on a per mile basis, though this latter observation did not achieve statistical significance. These results suggest that a regular driving assessment program may actually reduce the frequency of motor vehicle accidents in drivers with mild dementia by increasing awareness and self-monitoring by caregivers and patients of their driving practices. Also, the greater frequency of road tests in the dementia group could have benefited them via practice effects. Alternatively, a formal driving assessment program may actually result in premature termination of driving privileges for some person with dementia. Future controlled studies are necessary to address the impact of regular on-road driving assessments on the actual driving behavior of healthy elderly and individuals with dementia. In our study the normal older drivers could have benefited from this assessment process had they participated more frequently.

Driving ability declines fairly rapidly among dementia patients; therefore, recommendations for six-month followup assessments of driving privileges in this group are reasonable,³⁶ while less frequent assessments appear to be necessary for older drivers without cognitive impairment.

An important caveat to this discussion is that our patient sample may not represent those who are commonly encountered in general clinical practice. All subjects were drawn from a memory clinic, all had reliable caregivers, and all were willing to participate in a detailed examination of their driving abilities. Consequently, our sample may represent a more compliant group of patients that may have been less risky drivers as well. Their compliance with assessments and recommendations by study personnel and family members may have contributed to the high rate of driving attrition during the course of the study. Finally, AD subjects with a history of at-fault accidents during the period of their illness were excluded out of safety concerns. While this exclusion may have contributed to the apparent safety of this group when examined at baseline, it is unlikely to have had much effect during the subsequent three years as their dementia progressed in severity, and they became more potentially hazardous drivers.

Unfortunately, not all drivers and clinicians have access to specially trained and experienced driving evaluation teams for older drivers, especially in rural areas.^{31,37} Also, the cost of a formal road test examination, generally not covered by health insurance, may be as high as \$500.^{37,38} A major challenge facing clinicians, then, is to develop valid and reliable office screening tools, which can assist the clinician with making driving assessment referrals. Identification of valid indicators of future crash risk beyond moderate dementia severity are also needed to help the clinician advise patients who should abstain from driving. Unfortunately, current literature fails to provide definitive evidence supporting the use of specific office tests with cutoff scores to identify the hazardous driver with very mild to mild dementia.^{39,40} Driving researchers also need to validate potential neuropsychological screening measures and road test procedures against real world driving practices and outcomes in future studies.

Acknowledgments

We thank Mr. Timothy Souza of ABC/ACE Driving School for performing the road test evaluations and providing helpful advice for this study.

This research was supported by grant #AG16335 from the National Institute on Aging to Dr. Ott.

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Figure 1.
Survival plot: Time to driving restriction among patient group due to failure on road tests, at-fault MVA, or dementia progression
NB: Crosses denote withdrawals from the study for reasons other than study failure.

Table 1

Demographic and baseline driving characteristics of study sample by CDR at baseline

	Controls (N = 44)	Patients (N = 84)		
	CDR = 0	CDR = 0.5	CDR = 1	All
Age (mean, SD)	73.5 (9.1)	76.0 (6.3)	75.1 (8.1)	75.7 (7.0)
Education, years (mean, SD) *	15.2 (3.0)	14.0 (3.4)	13.7 (3.3)	13.9 (3.4)
Male, %	43	67	50	61
MMSE (mean, SD) *	29.1 (1.1)	25.4 (3.0)	21.8 (3.3)	24.1 (3.6)
Ethnicity, % Caucasian	98	96	91	94
Years driving (mean, SD)	52.3 (11.5)	57.1 (9.6)	52.9 (12.0)	55.5 (10.7)
Informant hrs/wk with participant (mean, SD) *	4.3 (3.1)	22.6 (49.1)	35.7 (60.9)	27.6 (53.8)
Miles/wk informant rides with participant (mean, SD)	36.9 (69.6)	31.2 (49.4)	13.3 (15.5)	24.4 (40.9)
Trips/wk informant rides with participant (mean, SD)	3.9 (5.7)	3.2 (2.8)	2.8 (2.7)	3.04 (2.7)
Miles/week driven by participant (mean, SD) *	137.8 (121.5)	79.3 (84.8)	49.4 (62.1)	67.8 (77.8)
Trips/week driven by participant (mean, SD) *	15.4 (13.7)	9.2 (8.1)	8.2 (6.0)	8.8 (7.3)
Road test score (mean, SD) *	6.0 (4.5)	12.4 (7.8)	14.3 (8.5)	13.1 (8.1)

*
p < .05 (Patient vs. Control 2-Group Comparison)

Table 2

Number of participants (%) by CDR at each study visit

	Controls (N = 44)		Patients (N = 84)			
	CDR = 0		CDR = 0.5	CDR = 1	CDR = 2	All
Baseline	44 (100)		52 (62)	32 (38)	0 (0)	84 (100)
6 months	--		30 (47)	33 (51)	1 (2)	64 (100)
12 months	--		17 (39)	24 (54)	3 (7)	44 (100)
18 months	22 (100)		8 (29)	19 (68)	1 (3)	28 (100)
24 months	--		7 (35)	12 (60)	1 (5)	20 (100)
30 months	--		7 (54)	3 (23)	3 (23)	13 (100)
36 months	--		2 (29)	3 (43)	2 (29)	7 (100)

Table 3

Global driving rating on road test at baseline and 18-months by group

	Baseline		18-Months	
	Controls (n=44)	Patients (n=84)	Controls (n=21)	Patients (n=26)
Safe	35 (80%)	34 (41%)	12 (57%)	5 (19%)
Marginal	9 (20%)	37 (44%)	8 (38%)	17 (66%)
Unsafe	0 (0%)	13 (15%)	1 (5%)	4 (15%)

Table 4

Global driving rating on road test at baseline and 18-months by CDR at baseline

	Baseline			18-Months		
	0 (n=44)	.5 (n=52)	1 (n=32)	0 (n=21)	.5 (n=19)	1 (n=7)
Safe	35 (80%)	23 (44%)	11 (34%)	12 (57%)	3 (16%)	2 (29%)
Marginal	9 (20%)	23 (44%)	14 (44%)	8 (38%)	15 (79%)	2 (29%)
Unsafe	0 (0%)	6 (12%)	7 (22%)	1 (5%)	1 (5%)	3 (43%)

Table 5

Global driving rating on road test at baseline and 18-months by CDR at time of visit

	Baseline			18-months			
	0 (n=44)	.5 (n=52)	1 (n=32)	0 (n=21)	.5 (n=7)	1 (n=18)	2 (n=1)
Safe	35 (80%)	23 (44%)	11 (34%)	12 (57%)	1 (14%)	4 (22%)	0 (0%)
Marginal	9 (20%)	23 (44%)	14 (44%)	8 (38%)	6 (86%)	10 (56%)	1 (100%)
Unsafe	0 (0%)	6 (12%)	7 (22%)	1 (5%)	0 (0%)	4 (22%)	0 (0%)

Table 6

Cox proportional hazards model for time to study failure among patient group.

	HR	LCL	UCL	<i>p</i> -value
CDR	3.51	1.09	11.32	0.036
Education (years)	1.10	1.01	1.19	0.027
Male Gender	0.82	0.43	1.58	0.550
Age (years)	1.06	1.01	1.11	0.020
Driving Experience (years)	0.97	0.93	1.01	0.065

HR= Hazard Ratio; LCL= 95% Lower Confidence Limit; UCL= 95% Upper Confidence Limit.